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SUMMER RESEARCH PROGRAM -- 1998

SUMMER RESEARCH PROGRAM FINAL REPORTS

VOLUME 1

RESEARCH & DEVELOPMENT LABORATORIES

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PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 15 volumes describing the 1998 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2	Armstrong Laboratory
3	Phillips Laboratory
4	Rome Laboratory
5A & 5B	Wright Laboratory
6	Arnold Engineering Development Center, Air Logistics Centers, United States Air Force Academy and Wilford Hall Medical Center
	Graduate Student Research Program (GSRP) Reports
7	Armstrong Laboratory
8	Phillips Laboratory
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11	Arnold Engineering Development Center, and Wilford Hall Medical Center
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12	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15A, 15B & 15C	Wright Laboratory

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The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. The management volume consists of a program overview, program management statistics, a listing of the participants, and an abstract for each participants summer research.

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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The numbers of projected summer research participants in each of the three categories and SREP "grants" are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest, and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1997 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL (in 1993) won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

YEAR	SRP Participation, by Year			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442
1995	190	115	137	442
1996	188	109	138	435
1997	148	98	140	427
1998	85	40	88	213

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1998 are shown in this table.

1998 Applicants and Participants			
PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP	382	85	13
(HBCU/MI)	(0)	(0)	(0)
GSRP	130	40	7
(HBCU/MI)	(0)	(0)	(0)
HSAP	328	88	22
TOTAL	840	213	42

4. SITE VISITS

During June and July of 1998, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates.

SRP HBCU/MI Participation, By Year				
YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1998 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1998 SRP selected participants are shown here.

1998 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	67	38	75
USAF Laboratory Funds	17	2	13
Slots Added by AFOSR (Leftover Funds)	0	0	0
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	0	0	N/A
TOTAL	84	40	88

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1998 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996	1997	1998
Faculty Members	$690	$718	$740	$740	$740	$770	$770	$793
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470	$470	$484
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400	$400	$412
High School Student (First Year)	$200	$200	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $52/day for faculty and $41/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 65 % claimed travel reimbursements at an average round-trip cost of $730.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-three percent (85 out of 188) of faculty associates took orientation trips at an average cost of $449. By contrast, in 1993, 58 % of SFRP associates elected to take an orientation visits at an average cost of $685; that was the highest

percentage of associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

This is the third year of using direct deposit for the SFRP and GSRP associates. The process went much more smoothly with respect to obtaining required information from the associates, about 15% of the associates' information needed clarification in order for direct deposit to properly function as opposed to 7% from last year. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1998 REPORT

The complete set of reports for the 1998 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1998 associates, as indicated below:

1998 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, USAFA, WHMC	6	11	

APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. Selectees represent 44 states.

GSRP - Applicants came from 44 states. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	85
GSRP	40
HSAP	88
TOTAL	213

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	83	0	83
Master's	1	3	4
Bachelor's	0	22	22
TOTAL	186	25	109

SFRP Academic Titles	
Assistant Professor	36
Associate Professor	34
Professor	15
Instructor	0
Chairman	0
Visiting Professor	0
Visiting Assoc. Prof.	0
Research Associate	0
TOTAL	85

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	177	47
Colleague familiar with SRP	104	24
Brochure mailed to institution	101	21
Contact with Air Force laboratory	101	39
IEEE Spectrum	12	1
BIIHE	4	0
Other source	117	30
TOTAL	616	162

APPENDIX B – SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	100
HSAPs	75
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Faculty Associates suggest higher stipends for SFRP associates.

C. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1998 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ? (% Response)											
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
USAFA	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	**84**	**32%**	**50%**	**13%**	**5%**	**80%**	**11%**	**6%**	**0%**	**73%**	**23%**	**4%**	**0%**

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5. a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
    b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*USAFA*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1998 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 120 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1998 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13. a. Would you apply again?
    b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
    a. At Home:
    b. With Friend:
    c. On Local Economy:
    d. Base Quarters:
17. Value of orientation visit:
    a. Essential:
    b. Convenient:
    c. Not Worth Cost:
    d. Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1997 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1998 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1998 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 23 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year? Yes (92 %)
14. Will you pursue future studies related to this research? Yes (68 %)
15. Was Tour length satisfactory? Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100 %	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100 %	100%	50%	86%	60%	80%	82%

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AL/CF
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AL/CF
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WL/AA
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PL/VT
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WL/ML
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RL/IR
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WL/FI
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RL/IR
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AL/CF
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WL/PO
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RL/IR
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Laboratory: Wright Laboratory
WL/PO
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WL/AA
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RL/IR
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MULTIRESOLUTIONAL INFORMATION FEATURE FOR DYNAMIC CHANGE DETECTION IN IMAGE SEQUENCES

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Abstract

Processing of large databases of image and video sequences is becoming increasingly more challenging with the rapid growth of multimedia applications. Efficient storage and retrieval techniques necessitate the smart detection of dynamic changes in an image sequence, which may be used to form an index database. This report proposes to use a multiresolutional information metric in the determination of dynamic changes in an image sequence. In particular, scene-cut detection performance from an image sequence will be furnished. Noise tolerance of the proposed metric will also be addressed. The results developed here can be extended to the quality assessment of IR and SAR imagery.

Effect of Environmental Variables on Aging Aircraft

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Abstract

This report is intended to evaluate environmental data collected by ARING from six Air Force Bases, Hickam, Kadena, Macdill, Mildenhall, Pease, and Seymour-Johnson for the period between January 1997 and April 1998. The environmental variables measured were air temperature, surface temperature, rainfall, rain pH, time-of wetness, and concentrations of NO_2 and Cl_2. Time domain plots (plots of sensor responses as a function of time) are the bases for the finding in this report.

TEMPORAL CHARACTERISATION OF A SYNCHRONOUSLY-PUMPED PERIODICALLY-POLED LITHIUM NIOBATE OPTICAL PARAMETRIC OSCILLATOR

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Abstract

The temporal characterisation of a synchronously-pumped periodically-poled Lithium Niobate optical parametric oscillator through OPO switch-on to steady state oscillation is presented. The micron-spatial and picosecond-temporal resolution of the detection system is used to explore the dynamics of the OPO through switch-on and build-up to steady state oscillation. The dynamical nature of the system, it is hypothesied, can be modeled by a simple damped harmonic oscillator. The oscillations are manifest in the pump transmission as energy flows between the pump field and the signal field. By varying the cavity losses through a variable reflectivity output coupler experimental evidence was collected to support this hypothesis. The characteristic times obtained for energy oscillation between the pump and signal field is found to be in the tens of Kilohertz with a decay constant of ~20 μs, indicating that the system can be empirically modeled using a slightly underdamped harmonic oscillator model.

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DESIGN OF A MICROWAVE-TO-OPTICAL LINK AMPLIFIER FOR RADAR APPLICATIONS

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Abstract

The ultimate goal is to design, simulate, build and test a MMIC low noise amplifier that will perform as a link between a receiving antenna of a radar and an optical fiber that acts as the feed line to the receiver. To investigate potential problems with MMIC, this short summer period was used to first implement the device using hybrid MIC technology: Here a hybrid microwave amplifier operating in the frequency band 3.1 GHz - 3.5 GHz is designed to deliver power to a laser diode which has an equivalent input impedance of $Z_{in}=4.4+j\ 19\ \Omega$ in the band of interest. The design specifications include reasonably high and flat gain, low noise figure and large dynamic range. The design was simulated on microstrips using commercial software Serenade v.7.5. Detailed analysis on stability, ac performance, dc bias conditions and optimization was carried out. Finally a statistical analysis was performed to investigate the overall performance of the device. The simulation results are promising. The circuit was then built as a two-stage amplifier and preliminary test results are satisfactory.

The Impact of Bright Light and A Moderate Dose of Caffeine on Nocturnal Performance: A Preliminary Experiment

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Abstract

The impact of the combined and separate effects of a one hour exposure to bright light (~3000 Lux) and to a moderate dose of caffeine on nocturnal performance during a shift-work schedule was studied. Physiological, psychological, performance and biochemical variables were measured during a work-schedule, beginning 1730 in the evening and ending ~1000 the following morning. In the preliminary experiment, five subjects were tested under the four combinations: 1) One hour Bright Light-Placebo; 2) Dim-Light-Placebo; 3) Dim Light-Caffeine; 4) Bright Light-Caffeine. Six other subjects were tested under the "Dim Light-Caffeine" and "Bright Light-Placebo" conditions. This paper reports on the analyses of the impact of the manipulations on the vital signs. Under all experimental conditions, body temperature and heart rate reached their circadian nadir approximately 0430. The reduction in temperature was significantly attenuated by exposure to the bright light. Although the administration of 200 mg caffeine showed a slight trend to attenuate the reduction in body temperature, the change was not significant. For the subjects tested on all four conditions, one hour exposure to an average of 3560 LUX and 200 mg caffeine significantly attenuated the reduction in body temperature relative to the Dim Light-Placebo condition. Changes in heart rate showed a significant circadian rhythm, similar to body temperature and reduced approximately 5 bpm from the evening-night sessions to the late night-early morning sessions. However, in contrast to body temperature, neither exposure to one hour of 3560 LUX nor the ingestion of 200 mg caffeine attenuated the reduction in heart rate associated with the circadian rhythm.

Stable Controller Design for Deployable Precision Structures Using Perturbation Theory

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ABSTRACT. Perturbation methods for linear operators are commonly used in the analysis of systems that tend to deviate linearly from a given reference model. The construction of an operator with a first order perturbation is investigated and the resulting eigenvalue series is constructed. It is shown that a simplified perturbation series can be obtained for matrix operators with special structure. The given theory is applied to a reduced order model (ROM) control scenario and an algorithm for computing an $O(\varepsilon^2)$ eigenvalue approximation is described.

INTRODUCTION

Modern modeling of large dimensional physical systems primarily employs matrix methods, often via finite elements or partial differential equations. Due to implementation constraints from a control standpoint, however, an adequate model reduction is needed. Model approximations can be used to design controllers, but compensation for observation spillover may be required for stability. It has been shown in [1] that addition of a residual mode filter to the reduced order model controller can stabilize the entire system in modal coordinates. The question now becomes: What components of the spectrum were destabilized? An eigenvalue perturbation method, developed in [3], has been proposed for full rank operators with no multiplicities. In this paper, we have expanded this technique to consider multiple eigenvalues and also provide proof of the order of approximation.

Applied mathematicians, engineers and physicists frequently use perturbation methods to solve a variety of different problems. Even though solutions to intractable nonlinear differential equations can be approximated using perturbation theory, this paper's focus will only encompass linear deviations of finite-dimensional linear operators. The reader is also referred to an "in-depth" treatment of the perturbation theory of linear operators [4], where the subsequent derivations become special cases.

The following definitions lay the groundwork for the construction of an eigenvalue perturbation series. The type of structure imparted upon a matrix operator of interest is illustrated and the corresponding eigenvalue series is given. An example of the application to the control design of a spectral system is explained. A proof and the numerical algorithm for this approach are given in the appendices.

OPERATOR PERTURBATIONS

INFORMATION PROTECTION TOOLS AND METHODS

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Abstract

This report is an outcome of preparations to produce a working prototype system compliant with the Computer Security Assistance Program for the 21st Century (CSAP21) architecture. CSAP21 architecture was proposed as a way to provide integrated information protection operation for the Air Force. The architecture describes a computer system which is as automated as possible, with the task to help human personnel in daily information protection at Air Force sites. The basic premise is that software and other sensors will be placed on the network(s) of interest, and the sensor data will be used for information environment security, attack detection, attack response, and capability restoration.

The report includes an outline of several software sensors used for intrusion detection: ASIM, ISS Internet Scanner, ISS RealSecure, NetRadar and NetRanger. We also describe TIS Gauntlet firewall. For each sensor, we provide a brief description, capabilities, general structure, and data used and produced.

ADAPTIVE ROBUST SPREAD-SPECTRUM RECEIVERS

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Abstract

We consider the problem of adaptive robust detection of a Spread-Spectrum (SS) signal in the presence of unknown correlated SS interference and additive non-Gaussian noise. The proposed general SS receiver structure is comprised by a vector of adaptive chip-based non-linearities followed by an adaptive Auxiliary-Vector linear tap-weight filter. The novel characteristics of our approach are as follows: First, the non-linear receiver front-end adapts itself to the unknown prevailing noise environment providing robust performance over a wide range of underlying noise distributions. Second, the adaptive Auxiliary-Vector linear tap-weight filter that follows the non-linearly processed chip-samples, allows rapid adaptation for SS interference suppression with limited data record. We examine a clipper-type, as well as a puncher type and a Hampel-type non-linearity. Numerical and simulation results demonstrate the performance of the proposed approach and offer comparisons with the conventional Minimum-Variance-Distortionless-Response (MVDR) filter, as well as the MVDR filter preceded by a vector of adaptive chip-based non-linearities.

SYNTHESIS OF 7-BENZOTHIAZOL-2-YL-9,9-DIDECYLFLUORENE-2-YLAMINE: A VERSATILE INTERMEDIATE FOR A NEW SERIES OF TWO PHOTON ABSORBING MATERIALS & THREE NOVEL TPA DYES

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Abstract

The synthesis of of a new, useful intermediate, 7-benzothiazol-2-yl-9,9-didecylfluorene-2-ylamine, was accomplished starting with fluorene. Regiospecific nitration of fluorene with HNO_3 and CH_3CO_2H at 85 °C led to formation of 2-nitrofluorene in 80% yield. Regiospecific iodonation of 2-nitrofluorene with I_2, $NaNO_2$, H_2SO_4, and CH_3CO_2H at 115 °C afforded 7-iodo-2-nitrofluorene in 79% yield, after recrystallization. Alkylation of 7-iodo-2-nitrofluorene was accomplished with 1-bromodecane and KOH in DMSO at room temperature, yielding 9,9-didecyl-7-iodo-2-nitrofluorene in 77% yield (after column chromatographic purification). 2-(Tri-n-butylstannyl)benzothiazole was synthesized in 90% yield (after distillation) by reaction of benzothiazole with n-BuLi at -78 °C in THF, followed by addition of tri-n-butyltin chloride. 9,9-Didecyl-7-iodo-2-nitrofluorene and 2-(tri-n-butylstannyl)benzothiazole were subjected to Stille coupling with either tetrakis(triphenylphosphine)palladium (0) or dichlorobis(triphenylphosphine)palladium (II) in toluene at 110 °C under Ar, providing 2-(9,9-didecyl-7-nitrofluoren-2-yl)benzothiazole in 61% yield. Quantitative reduction of 2-(9,9-didecyl-7-nitrofluoren-2-yl)benzothiazole with NH_2NH_2 and 10% Pd/C in EtOH/THF at 70 °C produced 7-benzothiazol-2-yl-9,9-didecylfluorene-2-ylamine in 30% overall yield from fluorene.

RECOGNIZING LINEARITIES IN MATERIALS DATABASES

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Abstract

The Multi-dimensional Hough Transform is proposed as a technique for searching for linearities in databases. This Transform is described and then explicitly programmed in Common Lisp. The system is illustrated by showing that it finds linearities in data representing the edge of a circle and the surface of a sphere. The system was then used to search for linearities in 21 materials datasets each involving about fifty chemical compounds and five properties. The results of one such dataset are described herein. Overall, this research suggests that the Multi-dimensional Hough Transform has potential for both organizing and simplifying data for input to various automatic classification and theory formation systems and for assessing the quality of the results of such systems.

CHARACTERIZATION OF ACOUSTIC SOURCES FOR HYPERSONIC RECEPTIVITY RESEARCH

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Abstract

Transition from a laminar state of fluid motion to a turbulent flow remains one of the most complex, as well as one of the most important, unsolved problems in fluid mechanics. In the design of supersonic and hypersonic aircraft, prediction of boundary layer transition is of paramount importance because the turbulence dramatically increases both heat transfer and skin friction drag, with attendant increases in weight and cost, and decreases in aerodynamic performance and flight range.

Although a number of theories currently exist to predict transition, they rest heavily on knowledge of initial disturbance amplitudes in the boundary layer, which are coupled in some manner to the freestream fluctuations. The process by which freestream disturbances generate instabilities in the boundary layer is referred to as *receptivity*, and plays a pivotal role in transition. Despite several decades of intense study, receptivity mechanisms are inadequately understood at present, particularly for acoustic disturbances in supersonic boundary layers, and the need for additional experimental confirmation of theory is generally recognized. In order to conduct experimental studies of the receptivity of hypersonic boundary layers to acoustic disturbances, a controllable and measurable source of disturbances is required.

In this study, candidates for acoustic sources were identified and used to introduce disturbances into the test section of a Mach 2.8 wind tunnel. These included: 1) a simple rectangular cutout or cavity in the wind tunnel floor, 2) a rectangular cavity periodically excited by ultrasonic piezoceramic transducers tuned to 25 kHz and 40kHz, and 3) a spark source generated by repeatedly applying a high voltage across two tungsten electrodes placed in a cylindrical cavity in the wind tunnel floor. Velocity disturbances induced by the various sources were sensed using both a hot-film anemometer and a silicon diaphragm piezoresistive dynamic pressure sensor (Kulite). Schlieren photography was also used to visualize density differences in the flow and to document probe positions.

The results indicate that by means of appropriate source excitation, signal sampling and averaging, disturbances from both the excited cavity and the spark source can be successfully identified within the disturbance Mach cone, despite the presence of large amplitude acoustic noise radiated from the turbulent side wall boundary layers of the wind tunnel. Accounting for differences in sensor frequency response, both hot-film and Kulite measurements qualitatively duplicate the dynamic characteristics of the sources; in general, the Kulite probe, although physically larger, provides a higher sensitivity. However, the low signal to noise ratio and the presence of multiple sources of noise, give rise to a number of operational restrictions; continued source and sensor development is warranted.

SOME CRITICAL ISSUES OF THE NEXT GENERATION TRANSPARENCY PROGRAM

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Abstract

Low-pressure injection molding of polycarbonate is a new promising technology for manufacture of fighter aircraft transparencies. Compared to the current method, this approach has the benefits of reducing the manufacturing cycle time, eliminating the metal frame assembly, and forming geometrically complex shapes. A program, called Next Generation Transparency (NGT), has been initiated to reduce risk for the development of an injection molded frameless transparency for the Jointer Strike Fighter. The focus of this summer research is to investigate two critical issues of the NGT program: through-canopy escape by explosive severance and fabrication of optical quality NGTs.

Current escape clearance techniques are either canopy fracturing using explosive cords or rocket jettison of canopies. For the NGT program, the former approach is preferred since it is faster, lighter, and more efficient. However, the injection-molded polycarbonate, chosen to resist bird strike, is very fracture resistant. Little is known concerning how to design and configure an explosive severance system for this type of material. Explosive severance tests performed up to this point have achieved some success in fracturing ploycarbonate, but significant testing will be required to develop a reliable through-canopy escape system. This summer, the principal investigator studied the previous test results thoroughly and, based on his understanding, he proposed to perform 3-D modeling and analysis for this problem at his institution to complement future experiments that will be conducted.

MODELING AND SIMULATION OF MEMS RESONATORS

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Abstract

The Micro-electro-mechanical Systems (MEMS) CAD Software MEMCAD 4.0 and CFD-ACE+ were reviewed for applications in the development of MEMS models. The software MEMCAD 4.0 was used to develop two MEMS Resonator models. Results from the simulation models were used to study the behavior of the Macromodel using the software SIMULINK and MATLAB.

TOWARD AN ARCHITECTURE FOR A GLOBAL INFORMATION BASE

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Abstract

A global information base is a comprehensive warehouse of information and a full suite of access services that satisfy the information needs of a variety of users in a timely manner. In the context of Air Force applications, the spectrum of users may span the warfighter through the theater commander and chief of staff and the legislators to the president. The information base would involve a variety of media, such as text, speech, audio, image, video, etc., be stored in multiple repositories, and be accessible from many different locations. It is also expected to be dynamic in the sense that the information base organizes itself over time to satisfy the information needs of users.

The short time span of this project forces us to limit the scope of this work to the textual medium, but we expect that some of the ideas apply to other media, as well. In arriving at a better understanding of the vision of the global information base leading to an architecture, we follow Booch's macro development process. We first conceptualize the vision, analyze the desired system behavior through scenarios, and arrive at an architecture, keeping the current state of the art in mind.

Documentation of the Airflow Patterns within an Aircraft Engine Nacelle Simulator

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Abstract

Airflow patterns within the F-22 Aircraft Engine Nacelle Fire Test Simulator located at Wright-Patterson Air Force base were studied. By passively tagging the nacelle airflow with smoke particles and illuminating the flow field with either laser or halogen light, the flow patterns within the nacelle were recorded. The experimental results indicate that the inlet screen produced multiple adjacent jet flows that strongly interacted with one another, resulting in the gross instability of the inlet flow. The nature of the flow pattern within this first nacelle compartment effectively acts as a cross flow, thereby forcing each of the multiple jet structures to take on a kidney shape. It was further observed, that within this kidney structure two counter-rotating streamwise vortices occurred.

SENSORS FOR FOCAL PLANE ARRAY PASSIVE MILLIMETER-WAVE IMAGING

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Abstract

Sensors for focal plane array passive millimeter-wave imaging have been investigated. Passive Millimeter-Wave (PMMW) imaging systems open a new window in the electromagnetic spectrum for imaging through fog, clouds, dry snow, smoke, and sandstorms. A PMMW camera capable of generating real time display of the imaged scene, similar to video camera, has been developed by TRW[1]. In order to achieve reasonable price/performance tradeoff, low cost sensors for PMMW imaging are required. We have investigated sensors for direct detection radiometers, superheterodyne radiometers, and microbolomers. Results show that monolithic superheterodyne receivers have price/performance advantage compared to other technologies.

EXPOSURE OF FEMALE RATS TO A 35 GHz ELECTROMAGNETIC FIELD ON DAY 1 OF GESTATION DOES NOT ALTER PREGNANCY RECOGNITION, PREIMPLANTATION EMBRYONIC SURVIVAL, IMPLANTATION RATE, OR EMBRYONIC AND FETAL SURVIVAL TO TERM

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and

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Abstract

To evaluate whether exposure to a radiofrequency or microwave electromagnetic field (EMF) has the potential to affect developmental processes, studies were initiated using a rat model at the Directed Energy Bioeffects Laboratory at Brooks AFB, TX. Prior studies with this model (Dooley et al., 1996; Dooley et al., 1997) used a microwave transmitter that was capable of generating electromagnetic pulses ranging from near DC to several GHz, but had, as a primary component, microwave pulses in the MHz range. In the present study, a total of 12 male and 26 female rats were obtained from a commercial vendor (Charles River Laboratories, Inc.) and used to determine the effects of exposure of mated females to a 35 GHz electromagnetic field (EMF) on reproductive processes. Females were caged in pairs and estrous females were mated and then allocated to treatment such that females were provided a sham-treatment or exposed to the 35 GHz electromagnetic field (whole body average specific absorption rate = 13 W/Kg) for 25 minutes. Rats were exposed on day 1 of pregnancy. Females were then monitored daily for health and general condition, pregnancy, birth and survival of offspring, and the offspring born to control and treated dams were evaluated for the presence of gross abnormalities and to determine the sex of the feti that were derived from sham-exposed and EMF-exposed embryos. One of 13 rats exposed to the 35 GHz electromagnetic field died during exposure; this death was attributed to the anesthetic protocol. The remaining microwave-exposed rats remained pregnant and produced live offspring at term. Data analysis did not reveal an effect of microwave exposure on the number of females to remain pregnant or the viability and development of embryos, including embryonic survival to term. The proportion of male offspring born to females that were exposed to the 35 GHz electromagnetic field on day 1 or pregnancy was not different from that of the sham-treated females. These results indicate that a 25-minute exposure of recently mated rats to a 35 GHz electromagnetic field at an incident power density of 75 mW/cm^2 was not harmful to the dam or to the establishment and maintenance of pregnancy, when performed under conditions that did not result in hyperthermia of rats (defined here as core temperature < 38 C).

NATURAL ATTENUATION EVALUATION SUMMARY FOR A CHLORINATED SOLVENT PLUME, OU1, HILL AFB, UTAH

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Abstract

An evaluation of the natural attenuation of chlorinated solvents (TCE and its daughter products) was conducted for a contaminated groundwater system at Hill Air Force Base, OU1, using a quantitative natural attenuation evaluation protocol. As part of this evaluation protocol the following plume characteristics were determined: stability of the parent compound dissolved plume via centerline, dissolved plume mass, and center of mass estimates; geochemical indicator parameter results for plume terminal electron acceptors and degradation products; free product evaluation and dissolved plume composition estimates; parent compound and intermediate product degradation rates; plume lifetime predictions; and long-term monitoring and site management recommendations. Using this evaluation protocol it was determined that the OU1 dissolved plume is actually declining in mass, being indicative of a pulse or weathered free product source. Contaminant pseudo-first order degradation rates within the dissolved plume were estimated to range from -0.0002 to -0.0068/d for cis-DCE and trans-DCE, respectively. Required timeframes for plume management ranged from 2 to 33 years, with cis-DCE requiring the longest time before reaching MCLs required for site closure.

The methods used in this evaluation protocol are described in this final report along with results specific for OU1. A long-term monitoring strategy is defined, as is a recommended management approach for this dissolved plume. Finally, recommendations are provided for the investigation of methods that can be used for the acceleration of natural degradation processes DCE dechlorination taking place throughout the site.

INVESTIGATING THE USE OF OPTICAL FIBER AS OPTICAL DELAY LINE FOR ADAPTIVE OPTICS SYSTEMS

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Abstract

Experiments were performed in order to determine whether optical fibers wound around piezoelectric tubes, PZT, which are connected in cascade, can be used as optical delay lines. The experiment performed consisted in winding two different lengths of fibers around two different PZT stretchers in cascade. The fibers were then spliced to each other and stretched. An optical interferometer was built in order to determine the resulting phase shift due to the stretching of the fibers. It was found, as expected, that the two stretchers added up to the number of fringes displaced in the interferometer. This simple experiment has demonstrated that multiple PZT stretchers may be used in cascade in order to achieve long Optical Phase Differences, OPD.

A DEVICE FOR EXPERIMENTAL MEASUREMENTS OF ELECTROSTATIC SHIELDING IN A SPATIALLY NON-UNIFORM PLASMA

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Abstract

The effects of Debye shielding in a spatially non-uniform plasma are of interest in understanding wake charging phenomena associated with one low-Earth-orbiting spacecraft in the plasma wake of another. This report describes an apparatus for simulating this configuration in a laboratory-based experiment. A graded boom assembly is used to suspend one electrically-biased object behind another, while eliminating the perturbation caused by the boom to the electric fields in the wake region. A versatile set of plasma diagnostics, consisting of a segmented current-collecting probe with a built-in retarding potential analyzer and a hot-filament emissive probe allow the ion density, flow velocity, perpendicular and parallel temperatures, and the local space potential to be determined as the graded boom assembly is placed in a flowing plasma. An automated fitting routine used to determine the space potential is shown to be able to determine the space potential to within ±0.5 V. Comparisons of predicted and measured potential distributions along the graded boom are presented. Ambient and wake measurements of plasma parameters are given for a typical flowing plasma, in particular showing the effects of a finite-sized plasma source on the wake structure in the laboratory.

NEURAL NETWORK CONTROL OF WIND TUNNELS FOR CYCLE TIME REDUCTION

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Abstract

Simulation results are given which compare a standard controller and a neural network controller that hold Mach and Reynolds number in a generic wind tunnel model. Results show that the neural network controller reduces Mach number IAE [1] error by 58% and reduces settling time [2] by 29%. These performance improvements mean that desired test conditions can be reached quicker, and therefore the neural network controller can provide higher quality test conditions and reduce testing costs as compared to a standard controller.

KINETIC MODELING OF SLOW DISSOCIATION OF BROMOSULPHOPHTHALEIN FROM ALBUMIN IN PERFUSED RAT LIVER: TOXICOLOGICAL IMPLICATIONS.

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Abstract

Due to strong binding between organic anions and albumin, the kinetics of the binding process must be carefully considered in biologically-based models used for predictive toxicology applications. Specifically, the slow dissociation rate of an organic anion from the protein may lead to reduced availability of free anion in its flow through the capillaries of an organ. In this work, the anion bromosulphophthalein (BSP) was studied in isolated perfused rat livers in the presence of albumin concentrations of 0.25, 1, and 4% (w/v). The uptake of BSP from the perfusion medium was modeled using a biologically based kinetic model of the sinusoidal and intracellular liver compartments. The best fit of the model to data resulted in the prediction of a slow dissociation rate constant for the BSP-albumin of between 0.097 and 0.133 s^{-1}. Assuming BSP and albumin to be in binding equilibrium in the sinusoidal space with rapid binding rate constants, as is often done, produced an unacceptable fit. These results indicate that a strong binding interaction, beyond keeping the concentration of free chemical low due to a small equilibrium dissociation constant, can also reduce uptake by an organ due to the slow release of chemical from the protein during passage through the capillaries. The implication of this dissociation limited condition when extrapolating to other doses and *in vivo* situations is discussed.

MECHANICAL STRENGTH MODELING OF PARTICLE STRENGTHENED NICKEL-ALUMINUM ALLOYS STRENGTHENED BY INTERMETALLIC γ'(Ni_3Al) PRECIPITATES

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Abstract

A nickel-aluminum alloy strengthened by the γ' (Ni_3Al) intermetallic ordered coherent precipitates was used as a demonstration material to develop the method of modeling to predict strengthening behavior during plastic deformation as a consequence of the γ' particles acting as obstacles to the dislocations and thus impeding their glide motion through the alloy. The two most dominate strengthening mechanisms in the Ni-Al system are order strengthening when the particles were smaller than the critical looping radius, and Orowan strengthening when the particles were larger than the looping radius. In the overaged condition when the particles are large in size, the dislocations bypass and loop the particles by the Orowan mechanism. In the underaged to peak aged conditions where the particles are usually smaller than the looping radius, the dislocations shear the precipitates during deformation. The overall approach was determined from the particle coarsening kinetics, dislocation mechanics, thermodynamics, resolved shear stress and texture, as well as the dislocation particle interaction mechanisms. The single crystal strength for particle strengthening was used as the basis for estimating the total polycrystalline strength. Thus, the total precipitation strengthening response of the demonstration alloy was determined from the active microstructural strengthening mechanisms in the underaged, peak-aged, and overaged conditions. The total polycrystalline yield strength included contributions from the intrinsic lattice strength, the solid solution strengthening, grain size strengthening, and particle strengthening which included the order hardening and Orowan strengthening contributions. The total mechanical yield strength for a Ni-6.27wt.%Al alloy was predicted for the peak-aged condition, and was found to be in good agreement with the experimental peak yield polycrystalline strength data for Ni-6.27wt.%Al.

The overall goal of this research was not only to develop a strength model for Ni-Al, but to provide the framework and basis for mechanical strength modeling of high temperature superalloys and high temperature discontinuously reinforced aluminum alloys that are strengthened by γ' (Ni_3Al). The theoretical work described in this report provides a solid foundation for future mechanical behavior modeling research for much more complex alloy systems, such as various high temperature superalloys, and high temperature discontinuously reinforced aluminum alloys, and would incorporate the microstructural parameters and processing variables of alloys with very unique microstructures. Most of the theoretical modeling would apply to these other alloys, however, the extent of the interactions and contributions of the various strengthening mechanisms would be different.

LOW LIGHT LEVEL ADAPTIVE OPTICS APPLIED TO VERY HIGH RESOLUION IMAGING

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Abstract

Very High Resolution Optical Instruments (VHROI) typically have conjugate limited fields of view. To achieve this high resolution the light from dispersed elements must be accurately combined. The individual element beams must be in phase at the detector and have aligned and equivalent fields of view. Because of turbulence in the light path from target source to detector even the light from a moderately sized mirror is not coherent across the mirror. Separated elements introduce greater dislocations in the wavefront. If a high resolution image is to be created all of the dislocations in phase must be adequately compensated for. This generally requires an adaptive optics system. The shorter the wavelength, the larger the separation, and the larger the individual elements the greater the need for high order corrections by the adaptive optics. In this way a VHROI places very high constraints on the adaptive optics system. In addition there are other considerations that must be made in the physical design of the VHROI that have to do with adequate sampling of the source and minimizing the disturbances to the environment by the instrument and its infrastructure.

While our project is very concerned with all of these constraints this summers work has concentrated on the last two elements. The first issue is usually called U-V coverage of the dilute array, instantaneously and under earth rotation (for synthetic aperture construction) or active motion of the elements. Our system will most likely be static, but mobile elements are being designed for flexibility in the future. The second has to do with clean air over the elements. This can have several causes, of which we have only considered one in this study. This is the placing of the infrastructure for the individual elements in such a way as not to produce additional turbulence for elements down wind of the structures. This is accomplished by simply not placing structures along the same wind line. Other considerations in this class are turbulence of the structure on the enclosed telescope and turbulence generated by the telescope itself, either from its construction of heating/cooling properties. We have considered the temperature equilibrium characteristics of the primary mirrors for design purposes but have not considered them in this project.

SYNTHESIS AND CHARACTERIZATION OF METAL-THIOACID AND - DIHYDROGEN PHOSPHATE COMPLEXES USEFUL AS NONLINEAR (NLO) MATERIALS

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Abstract

Several complexes of chromium, copper, zinc, cadmium, mercury and lead were prepared by the reaction of aqueous solutions of the corresponding metal salts with xanthates, dithiocarbamate and dihydrogen phosphate as ligands, and their nonlinear optical properties studied. Attempts were also made to synthesize complexes with mixed xanthate-dithiocarbamate ligand around a single metal center. The synthesis of the complexes were carried out by mixing one equivalent of a metal salt with two equivalents of the ligands at room temperature or at around 80°C. The complexes isolated were characterized mainly by IR-spectroscopy and in few cases by elemental analysis. The nonlinear optical (NLO) properties of these complexes were screened by powder test using Kurtz's method. Complexes obtained from the reaction of mercury salt with xanthate ligands; mercury, cadmium and lead slats with mixed xanthate-dithiocarbamate ligands, and dihydrogen phosphate complexes of chromium, zinc and lead were found to show moderate to intense nonlinearities, although those of mercury and lead showed low damage thresholds by tending to burn under the heat of the laser beam. Most complexes obtained from the reactions of metal salts with dithiocarbamate ligand showed no NLO properties.

ENVIRONMENTALLY-BENIGN SYNTHESIS OF 1,5-HEXADIYNE AND RELATED STUDIES

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Abstract

The compound 1,5-hexadiyne was synthesized from 1,5-hexadiene in two steps by a novel method that eliminated the use of molecular bromine, halogenated solvents, and liquid ammonia. All of these materials are used in the classic method. The initial step is the conversion of the hexadiene to 1,2,5,6-tetrabromohexane using sodium perborate and sodium bromide in glacial acetic acid instead of the standard method of treating the diene with bromine in a halogenated solvent. The final step was the phase-transfer catalyzed elimination of four equivalents of HBr from the tetrabromohexane using a base derived from potassium hydroxide and pinacol, instead of the usual sodium amide in liquid ammonia. The synthesis proved successful in producing 1,5-hexadiyne. However, more work needs to be done to increase the yield and purity of the final product. In addition to the synthetic work, calculations comparing the materials costs for the first step with its traditional counterpart were performed. Finally, theoretical computations of the enthalpy of formation for a number of compounds of interest were performed.

BIOCATALYSIS OF BIPHENYL AND DIPHENYLACETYLENE TO SYNTHESIZE POLYMER PRECURSORS

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ABSTRACT

The U.S. Air Force Material Science directorate has identified the phenolic compounds hydroxybiphenyl (HBP) and hydroxydiphenylacetylene (HDPA) as critical precursors in the production of high performance polymers. Epoxy resins synthesized using HBP or HDPA have exceptional thermal resistance and could be used in a number of important aerospace applications; however, properties vary depending on which phenolic isomer is used as well as the purity of that particular isomer. While *m*-HBP and *m*-HDPA are difficult to produce by normal chemical synthesis, biocatalysis may offer an alternative method. This research demonstrates that two toluene monooxygenase enzymes (Tb2m and Tb4m) are capable of producing either *m*-HBP from biphenyl or *m*-HDPA from diphenylacetylene (DPA). For the enzymatic hydroxylation of biphenyl, specific activities varied between 2.1×10^{-4} and 8.1×10^{-4} μmol/mg protein/min, with the HBP product consisting of 76 to 91% *meta* isomer (remainder *para*). With diphenylacetylene as the substrate, specific hydroxylation activities varied between 0.11×10^{-4} and 2.0×10^{-4} μmol/mg protein/min, and 24 to 30% of the HDPA product was the *para* isomer (remainder most likely *meta*). The addition of glucose to the resting cell systems inhibited the enzyme activity initially, but prevented a drop in activity after 2 h. Tb2m activity was insensitive to medium pH in the range of 5 to 9, while Tb4m activity was maximized at pH 9. While the *meta* regiospecificity of these enzymes was promising, specific activities were only 1 to 3% of the values observed with toluene as the substrate (3 mM). Since the low activities may in part be due to the low aqueous solubility of biphenyl (50 μM) and diphenylacetylene (6 μM), four different surfactants (Triton X-100, Tween 80, Brij 58, and SDS) were evaluated for their effect on biphenyl hydroxylation rates. The specific hydroxylation activity of Tb4m was enhanced by 45% with 500 μg/mL SDS; this surfactant may have increased the effective biphenyl concentration in solution. Future work should further investigate methods for increasing the rate of biocatalysis.

PARTITIONING OF POWER APERATURE PRODUCT OF SPACE BASED RADAR

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Abstract

There may be some operational and cost benefits to be realized by performing space based microwave sensing of surface and air targets with a larger number of smaller satellites than with a fewer number of larger satellites. One way of implementing this concept is by dividing the search space into smaller units and allocating a smaller satellite to each sub space. This is equivalent to partitioning the power aperture product of a large radar into several smaller units. This report analyses power aperture partitioning and quantifies the intuitively expected results. The report concludes that with partitioning there is loss in signal to noise ratio as well as increase in clutter which have to be compensated by increasing the transmitter power or antenna aperture or time on target and additional clutter cancellation to achieve performance equivalent to the unpartitioned case.

Amplitude and Frequency Modulation Characteristics of Stressed Speech

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Abstract

An analysis of stressed speech using its amplitude and frequency modulation (AM and FM) characteristics was carried out. From the preliminary results using actual stressed speech from an operational aviation emergency, stress, in general, appears to increase the modulation behavior in both AM and FM. In particular, the modulation characteristics become significantly more if the analysis (carrier) frequency is centered at one of the resonant frequencies of the vocal tract. Moreover, the spectra of AM envelopes show increasing peak frequencies with stress. The highest peak in the spectrum of the demodulated instantaneous frequency as well as in the AM envelope spectrum, appears to track the fundamental frequency F0. Linear prediction model of the envelope also shows a peak at F0 regardless of the analysis (center) frequency; the peak may not be distinct all center frequencies, however. These features can be used to detect the presence of stress in a speaker.

NEGOTIATION AT A DISTANCE: WHY YOU MIGHT WANT TO USE THE TELEPHONE

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Abstract

Same gender dyads engaged in a 4-issue integrative bargaining task. Negotiator accountability and communication channel (face-to-face, teleconferencing, videoconferencing) were manipulated. Negotiators in the VC condition spent less time negotiating, obtained lower outcomes overall, and engaged in less logrolling that dyads in the other communication conditions. As predicted, negotiators in the TELE condition performed relatively well in the absence of visual access.

COMPUTATIONAL ASPECTS OF THE SPECTRAL THEORY OF PHYSICAL AND CHEMICAL BINDING

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Abstract

We develop the computational infrastructure required for spectral theory calculations of the electronic energy of atomic and molecular aggregates in an arbitrary finite spectral product basis set. We test our approach by performing illustrative calculations of the potential surface of Ar_3 clusters in a spectral product basis set composed of four spectral states on each argon atom. We also investigate the completeness of two finite H_2 spectral product basis sets by computing potential energy curves for H_2 using these basis sets. We find that the two basis sets considered here are far from complete, and produce approximate H_2 electronic wavefunctions that exhibit considerable mixed singlet–triplet character.

Conceptualizing Crew Performance in Dynamic Operational Environments

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ABSTRACT

A conceptual framework is proposed for modeling crew performance in dynamic operational environments. This framework evolves from models of individual performance on dynamic tasks that focus on goal-directed behavior. The conceptual framework also builds upon theoretical developments in control-systems theory and groups as dynamic systems. A series of models are developed that represent (1) the processes of crew members performing their tasks, (2) the processes of interaction among the crew members, and (3) the processes of the crew as a functioning unit. These models form a hierarchy of embedded systems for the dynamic processes in the operational environment. The central concepts for crew performance in these operational environments are the interdependence among the members, and the strategies for coordination and collaboration. An illustration of the use of these models of crew performance is made based on activities of crew members for a Uninhabited Aerial Vehicle ground control station. Subsequently, the models of crew performance are used to highlight a number of research agendas that can contribute to our understanding of crew performance in dynamic operational environments such as Uninhabited Aerial Vehicles.

THERMAL SIGNATURE FOR CIRCUIT CARD FAULT IDENTIFICATION

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Abstract

This research demonstrates that a thermal signature is an effective tool for fault identification in circuit cards. Experimental results indicate that the mean and variance in heating rate over a period of time are two effective discriminating factors for fault detection. Moreover, results from a preliminary study to identify a correction factor for the thermal signature of identical components in different circuitry seems positive.

The research was carried out in eight steps. First, a means for temperature probing was investigated. Second, fixtures for the circuit card and sensor probe were designed. Third, appropriate data acquisition tools were developed or acquired. Fourth, different fault types were designed. Fifth, experiments were designed and conducted. Sixth, the sampling frequency and run time were determined. Seventh, a discriminating factor was identified. Finally, a prototype was developed to implement these findings.

PERFORMANCE MODELING AND SCALABILITY ANALYSIS OF THE NAVIER-STOKES SOLVER FDL3DI ACROSS MULTIPLE PLATFORMS

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A preliminary parallel version of the FDL3DI application from Wright Laboratory was developed using MPI. This report describes the overall design of the parallel code and estimates the performance of the code. For this data-parallel implementation, a single grid is broken into subgrids and each subgrid is assigned to a separate processor. The boundary points are exchanged between processors as necessary.

Scalability analysis was performed to indicate the performance of the code for large data sets and large numbers of processors. Experimental results were obtained on the Cray T3E, IBM SP and SGI Origin 2000. These results demonstrate that parallel systems can provide significant performance improvements for this application.

A STUDY ON ACCELERATING THE RAY/TRIANGULAR-FACET INTERSECTION COMPUTATION IN XPATCH

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Abstract

Xpatch is a software program that uses the ray-tracing technique to model the incident radar signal and generates radar cross section predictions of various objects. The object surfaces are modeled by shape primitives such as boxes, triangular facets, bicubic bezier patches, etc. The heart of the ray-tracing program is to determine if a given ray intersects with some given shape primitives. Despite of its power, the ray-tracing technique suffers from its computational complexity and intensity. This study investigates the possibilities of accelerating the ray/triangular-facet intersection computation, by adopting effective algorithms and developing specially tailored hardware for the execution of the algorithms. Estimated performance and feasibility are discussed. Suggestions on future work are also included.

REACTION OF ELECTRONICALLY-EXCITED NITROGEN ATOMS WITH MOLECULAR OXYGEN

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Abstract

The reaction of O_2 with metastable nitrogen atoms, $N(^2D)$, is a major source of highly-excited NO in the upper atmosphere. We have continued our studies of this reaction at low temperature (80-120 K) in COCHISE, a cryogenic reactor/spectrometer, via the interaction of O_2 and discharge-excited N_2. Reaction products were monitored by infrared and UV/visible chemiluminescence, indicating significant rovibrational excitation of the $NO(X\,^2\Pi)$ product. No emissions from $O(^1D)$ product were detected, however, indicating that the major reaction channel (Φ>0.7) involves formation of ground state $O(^3P)$ atoms. Our experiments provide a new estimate of the rate coefficient for this process, k (100 K)= (2-5) x 10^{-11} cm^3 $molecule^{-1}$ s^{-1}, which is significantly larger than the accepted value at higher temperatures, k (240-370 K)= 6 x 10^{-12} cm^3 $molecule^{-1}s^{-1}$. This finding, together with the inference of a near-statistical nascent population distribution of the $NO(X\,^2\Pi;v,J)$ product, suggest this reaction to proceed via complex-formation without a significant potential energy barrier.

DETERMINISTIC METHODS FOR BLIND RESTORATION OF ADAPTIVE OPTICS IMAGES OF SPACE OBJECTS

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Abstract

The focus of this research program is algorithm development for blind image restoration of multiframe adaptive optics (AO) telescope images. In particular, methods of primary interest are those algorithms capable of removing residual blur in space objects images acquired using the Starfire Optical Range ground based 1.5m and 3.5 m AO telescope systems located at Kirtland Air Force Base, NM. Deterministic, or algebraic methods which can sometimes lead to closed form solutions rather than iterative algorithms are emphasized in this research. New techniques drawn from the literature on blind channel equalization for digital communications were evaluated for adaptation to the blind restoration problem. Three methods were developed to the simulation stage: 1) Homomorphic blind star image restoration, which uses an extremely fast closed form computation to recover blurred points, 2) Direct multiframe solution, which finds the linear algebraic nullspace of the observed data frames, from which the true image is found by subspace matching, and 3) An algebraic cross relationship algorithm which enables estimating the unknown blurs without having to solve for the object image. Adaptation of this method to a previous iterative Bayesian algorithm was also investigated. Ongoing research activities are described.

Using Neural Networks to Control a Tailless Fighter Aircraft

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ABSTRACT

This paper presents the research conducted over a 12 week period during the Summer of 1998 while I was involved in the AFOSR Summer Research Faculty Program. The work was performed at Wright-Patterson Air Force Base in collaboration with Dr. Corey Schumacher of the Air Vehicles Directorate of the Air Force Research Laboratory (office symbol AFRL/VAAD). Dr. Siva Banda was the overall technical leader of the AFRL VAAD effort and Dr. James Buffington also had a significant impact on the effort. I present an application of dynamic inversion control with adaptive neural networks to a tailless fighter aircraft. In the past, this technique has been studied with proportional-derivative desired dynamics, but not with proportional-integral desired dynamics. This paper presents an extension of the method to use with a dynamic inversion controller using proportional-integral desired dynamics. The performance of the PI adaptive dynamic inversion controller is compared to an adaptive dynamic inversion controller using PD desired dynamics. The controller was tested in a 6DOF simulation of the ICE tailless fighter aircraft. Simulation results are given for simultaneous longitudinal and lateral maneuvers performed under nominal conditions and also with the simulated loss of a major control surface. The PI dynamic inversion controller with neural network adaptation outperforms both the baseline PI controller without adaptation and also a PD dynamic inversion controller with neural network adaptation.

SORPTION OF A NON-IONIC SURFACTANT VERSUS A DISSOLVED HUMIC SUBSTANCE TO A LOW ORGANIC CARBON SOIL

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Abstract

The limited ability to remove sorbed and non-aqueous phase contaminants from subsurface materials using simple pump-and-treat technology motivates research into the use of agents to solubilize these contaminants in order to facilitate their removal. Foremost among candidate agents being examined for this purpose are surfactants. In contrast, dissolved humic substances (DHS) have received little attention as potential remediation agents, although they strongly bind hydrophobic organic contaminants (HOC) and are readily available. In this study, a non-ionic octylphenol ethoxylate surfactant mixture was compared to Aldrich humic acid, a terrestrial DHS, with respect to sorption to a natural low organic carbon content sediment and depression of surface tension in high ionic strength and low ionic strength (artificial groundwater solution) conditions.

A comparison of aqueous concentrations of surfactant oligomers in the presence and absence of sediment indicated significant sorption of both small and large ethoxylate chain length oligomers. Sorption isotherms developed of individual surfactant oligomers indicated that surfactant oligomers with smaller ethoxylate (EO) chain lengths were preferentially adsorbed to the sediment. Sorption isotherms for total surfactant mass indicated that the maximum sorbed surfactant concentration 0.5 g/kg. Ionic strength did not appear to significantly affect the surfactant sorption characteristics under the conditions of the study. A comparison of aqueous concentrations of the DHS in the presence and absence of sediment indicated significant sorption of DHS to the sediment, with preferential sorption of the larger molecular weight DHS fraction. Sorption isotherms developed for the DHS indicate that the maximum sorbed DHS concentration equaled approximately 0.05 g/kg. Ionic strength did not appear to affect sorption of the DHS to the sediment, however, at low ionic strength (in the artificial groundwater solutions) a large molecular weight molecule (50,000-60,000 molecular weight), possibly an indication of DHS aggregation, was observed in the aqueous solutions. Further testing will be necessary to resolve this feature.

Surface tension measurements of the surfactant solutions indicated a critical micelle concentration (CMC) occurring at an aqueous surfactant concentration of approximately 0.5 g/L in the absence of sediment and approximately 1.0 g/L in the presence of sediment. The minimum surface tension achieved in the surfactant solution equaled approximately 37 dynes/cm regardless of the solution ionic strength. Only a small decrease in surface tension (~1-2 dynes/cm) was achieved in the presence of DHS even at the highest concentrations under both ionic strength conditions.

STATISTICAL MODELS FOR ALTITUDE DECOMPRESSION SICKNESS

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Abstract

Survival analysis techniques were used to model the phenomenon of altitude decompression sickness. Models based on the loglogistic distribution were developed to predict the probability/ risk of DCS over time. Several risk factors such as exercise, pressure, and preoxygenation times were included in the model to assess their effects on DCS. To account for the effects of exercise at high altitudes, the altitude range was stratified and separate models developed for the different strata. The effects of exercise during preoxygenation were also studied. Using experimental data, maximum likelihood methods were used to estimate the model parameters. The fitted model was then used to predict the probability of DCS for several exposure profiles. These predictions agreed closely with the empirical DCS percentages from the database.

FUEL-AIR HEAT EXCHANGER FOR COOLED COOLING AIR SYSTEMS WITH FUEL-MIST AND AIR-JET IMPINGEMENT

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Abstract

An innovative design of a compact fuel-air heat exchanger with fuel mist and air jet impingement is presented in this report. The new design not only enhances heat exchange through impingement and mist evaporation, but also is expected to reduce, or even eliminate, deposit formation, which is quite typical in a heat exchanger involving liquid fuel. This design should provide light, compact and maintenance-free fuel-air heat exchangers for cooled cooling air systems and other applications. The pre-vaporized fuel, when burnt in the combustor, also helps to eliminate fouling of combustor nozzles.

Different parameters affecting the overall design of such an exchanger are discussed in this report. An analysis of the fuel-side chemistry, flow and heat transfer is presented to compare the different characteristic times of the system. This analysis should help to identify the range of values for different operating parameters under which the heat exchanger is expected to perform satisfactorily.

Spacecraft Formation Flying: A Survey

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Abstract

A novel concept of distributed array of small, low-cost, cooperative, and highly coordinated micro-satellites is vigorously being pursued for several future space missions. Implementation of the distributed coordinating satellite concept will require tight control of the relative distances and phases between the participating satellites. This research is intended to provide a unified treatment of relative satellite position modeling and linear quadratic control that is suitable for further advancement in autonomous multiple spacecraft formation flying technology. Specifically, it provides a complete development of the nonlinear relative satellite position dynamic equations as well as the linearized dynamics. In addition, a control relevant relative satellite position dynamic model is obtained and linear quadratic controllers are designed. Finally, some concluding remarks pointing to the open research problems in multiple spacecraft formation flying are given.

MICRO-SCALE VISUALIZATION OF THIN MENISCUS AND CAPILLARY PORE FLOWS OF CAPILLARY-DRIVEN HEAT TRANSFER DEVICES

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Abstract

Thin meniscus and thermocapillary stress-driven flows were examined to improve the performance of capillary-driven heat transfer devices. The goal of the present study was to develop optical diagnostic techniques to measure the thickness and movement of thin meniscus and to visualize the capillary-driven flows inside capillary pores. Fizeau interferometry was implemented to measure the location, thickness and slope of meniscus. The use of electrohydrodynamic (EHD) phoresis enables the extension of meniscus toward the electrode of higher field density. This unique method of microscale control of the thin film region was fully evidenced by the interferometric visualization. Microscopic particle image velocimetry (MPIV) visualizes the thermocapillary stress-driven flows inside capillary pores under heating. Depending on the relative heater location, with respect to the liquid-vapor interface, the circulation direction of the thermocapillary-driven flows was changed.

STUDIES ON THE AMPHETAMINE DERIVATIVES AND ANALYTICAL STANDARD

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Abstract

Synthesis of amphetamine derivatives are described with retrosynthetic analysis and synthon /disconnection approach. The schemes were studied from economic and technological considerations that take into account the following: The starting material availability, number of steps, technological difficulties and controlled substance regulations. The chemical synthesis in this research were also involved with identification and quantification of chlorobenzorex.

SELF-SENSING TECHNIQUE FOR ACTIVE ACOUSTIC ATTENUATION

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ABSTRACT

A 'self-sensing' technique is developed for actively suppressing acoustic resonances of enclosed cavities. The technique enables the simultaneous measurement of mechanical velocity and acoustic pressure for a speaker driving an acoustic load. The technique is derived from an impedance model of the coupled electrical, mechanical, and acoustic systems. The velocity and pressure signals are obtained by passing the speaker voltage and current through linear filters that model the electrical and mechanical impedance of the speaker. A transfer function analysis of the technique demonstrates that the pressure and velocity measurements are sensitive to estimation of the physical parameters of the speaker, but that the technique is insensitive to variations in the acoustic load. Experimental results for a speaker driving a cylindrical cavity illustrate that accurate estimates of pressure are obtained for frequency ranges on the order of three octaves (20 - 150 Hz). Errors at higher frequencies are attributed to weaker than expected structural-acoustic coupling and inaccurate estimates of the electrical impedance. Active damping of acoustic resonances is demonstrated with second-order feedback compensators that utilize the self-sensing technique derived in the paper. Feedback control increases the damping in the first acoustic resonance from 4.4% critical to 14.9% critical and increases the damping in the second acoustic resonance from 2.4% critical to 3.2% critical. The acoustic response in the 40-60 Hz frequency range is increased due to small phase margins near the mechanical resonance of the speaker.

MANY-BODY THEORY OF QUANTUM-WELL GAIN SPECTRA

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Abstract

The aim of this summer project is to develop a theory and computer code for the group of Dr. John Loehr in the Sensors Directorate to assist them in analyzing fine details of the gain spectra of quantum-well laser diodes being measured. Such an in-house capability should help the Air Force Research Laboratory in developing new types of semiconductor lasers. We have critically studied the different theoretical models of material gain (particularly with respect to the many-body effects) currently available in the literature, developed a computer code for modelling the gain at a level comparable to the most advanced work reported so far, and uncovered deficiencies in current theories.

A STUDY OF REFERENCING ISSUES IN MULTIPLATFORM AND MULTISENSOR BASED OBJECT LOCATION

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Abstract

This report summarizes the result of a two-month research effort in investigation of georeferencing in multiplatform and multisensor based object location. The environment used in this report can be characterized by a set of dynamic platforms such as satellites, aircraft, and terrestrial vehicles with various sensors, for example, GPS, INS, SAR, EO, and FLIR. The sensors may be installed on the platforms separately or combined. It is assumed that communication between the platforms is available, so that real-time applications demanding coordination among the platforms can be carried out. The object to be located is simplified as a point on the ground. Data acquired by this kind of integrated sensor system can be characterized by its vast volume, comprehensive spatial relationships, and associated temporal dynamics.

After a brief introduction, chapter 2 reviews mathematical models of least squares adjustment and gives a comparison between two methods used in modeling sensor uncertainties. A conceptual model of dynamic object location by a multiplatform and multisensor system is introduced in chapter 3. In chapter 4, design of an experiment using optical images, a SAR image, and a terrain model is given to test the concept in chapter 3. Finally, conclusions are drawn in chapter 5.

SENSOR FUSION WITH PASSIVE MILLIMITER WAVE (PMMW) AND LASER RADAR (LADAR) FOR TARGET DETECTION

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Abstract

Advanced sensors and guidance techniques are required in killing mobile offensive and defensive systems. Many different sensors such as radar, video camera, laser radar (LADAR), millimeter wave (MMW) systems, infrared images, acoustic sensors, etc. are available for such usage. However, no single sensor seems to provide completely satisfactory capabilities. While some sensors have complimentary capabilities, integration of multiple sensors for kill can relax the task difficulty and provide more reliable results. The use of multiple sensors can also reduce the possibility of being defeated by countermeasures. In this project, we studied the framework and investigated potential techniques for integration and fusion of information from passive millimeter wave (PMMW) and laser radar (LADAR) systems. The focus has been on target detection. The PMMW is used to detect metal objects and the LADAR checks those regions of interest for other evidence of existence of a target. Advantages obtained by integrating these two sensors include reduction of task complexity and improvement of reliability, both due to efficient localization of regions of interests from the PMMW. Since PMMW possess weather penetration capabilities through fog, cloud, smoke, etc., the combined system has a near all weather capability. A LADAR provides three-dimensional (3-D) information for checking target details. It should be used as the primary sensor for target selection upon target detection. The framework of the fusion is based on the Dempster-Shafer decision method. The fusion may be done in the algorithm level and sensor level. With the Dempster-Shafer method as the framework, new sensors or new decision components can be integrated into the existent system easily.

Boundary Conditions for Direct Numerical Simulation of Turbulent Flow

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Abstract

The computational results of FDL3D flow solver using the high-order compact scheme and high-order filter for some fundamental flows are reported for code verification. The boundary conditions in a curvilinear coordinates for inflow, outflow, far-field, and solid-wall surface is derived and discussed with some computational results.

EFFECT OF MATERIALS AND DESIGN VARIATIONS ON AMTEC CELL LOSSES

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Abstract

This document deals with the improvement of power output and the efficiency of the vapor-anode multi-tube AMTEC cells. In the recent past a number of programs have focused on developing AMTEC technology associated with its fabrication and design. The performance level, however, achieved to-date is hitherto below the theoretical potential of this device. In improving performance characteristics we examined the sources of power loss and proposed some solution by demonstrating with computer calculations. Two kind of losses reduce efficiency are thermal (as a result of thermal conduction and radiation of materials) and electrical (related to the ohmic resistance of material). Each of the losses can, in principle, be reduced separately by varying the current in the load. To reduce the thermal losses, the current must be increased; to reduce the electrical losses, the current in the load must be decreased. In such inversely competitive situation an optimum value is sought by applying the optimization theory. Heat losses due to radiation may be reduced by increasing the current density and by reducing the emissivity of electrodes and other surfaces. Changing the geometry (design) of the cell has proved to be helpful in improving the cell performance. As a result of this overall effort we have been able to demonstrate the improvement in the efficiency of AMTEC cell by 100%.

On a wavelet-based method of watermarking digital images

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Abstract

We present two wavelet-based watermarking methods for digital images. The first method uses the singular value decomposition of the matrix of wavelet coefficients of the image to generate the watermark; the second method uses cellular automaton. Both methods provide a high degree of security and robustness to various image processing operations and both require the original image for detection of the watermark.

FILTERED-RAYLEIGH SCATTERING IN REACTING AND NON-REACTING FLOWS

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Abstract

Investigations into Filtered Rayleigh Scattering for large scale velocity field measurements in AEDC high speed wind tunnels were continued during the summer 1998 program. The injection seeded Nd:YAG laser was optimimized for measurements, refining the alignment and cooling system of the laser and assessing its temperature stability, tunability, mode hopping characteristics and other pertainent optical requirements. An iodine cell used in the collection optics was also constructed and tested in the laboratory. The main accomplishments of the research were the measurement of the one component of the velocity in a seeded laboratory air jet. At the current state, the technique is a qualitative velocity measurement technique. Work will be done in the next few months to design calibration schemes for quantitative measurement. The results indicate that filtered-Rayleigh scattering is a promising technique for tunnel applications and more work will be done in the coming year (1999) in making tunnel measurements feasable as well as improving measurement accuracy. Additionally, it is the PI's intent to apply the technique in reacting flows of fundamental interest.

BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTIONS DESCRIBING FIRST-SURFACE SCATTERING

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Abstract

The bidirectional reflectance distribution function function (BRDF) is a measure of the amount of light scattered by some medium from one direction into another. Integrating it over specified incident and reflected solid angles defines the reflectance, which can be easily related to the absorptance (or emissivity) of a sample. The BRDF can thus be taken as a fundamental quantity for the optical characterization of an object and it correspondingly is important in a large variety of applications. When a beam of electromagnetic radiation (visible, infrared, radar, etc.) strikes a body, it can scatter off the top or first surface, as well as from the volume or subsequent interfaces. However, the total amount of light reflected from the first surface depends primarily on the complex index of refraction of the illuminated medium (relative to that of the incident medium) and is often sufficiently large that this dominates the scattering from the material. On the other hand, the topography of this interface determines the angular distribution of the scattered radiation—smooth surfaces reflect almost entirely into the specular direction, while with increasing roughness the light tends to diffract into all possible directions. Ultimately an object will appear equally bright throughout the outgoing hemisphere if its surface is perfectly diffuse (i.e., Lambertian). Measuring and modeling the BRDF can thus give valuable information about the nature of a target sample.

The paper is organized as follows. The introduction lists some domains of study in which reflectance plays an important role, as well as the relationship between it and other quantities of importance in optics. Next, the nomenclature needed to define and characterize the BRDF is presented, along with some related issues. Following this, a long section reviews the principal analytical and numerical models used to describe first-surface scattering; this comprises the heart of the present paper and considerable effort has been expended to unify the often disparate notations and points of view in the literature. Finally, this report ends with a summary of select experimental measurements, most of which are quite recent and varied in style and purpose; this gives a flavor for the ongoing efforts in this field.

CHARACTERIZATION OF MICROSTRUCTURE EVOLUTION IN PITCH-BASED CARBON FIBERS DURING HEAT TREATMENT

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Abstract

The evolution of structure and mechanical properties with various heat treatment conditions was investigated in this study for pitch-based carbon fibers. AR-mesophase and SCF-mesophase were obtained in the form of pitch fibers. The fibers were first stabilized to render them infusible and then subjected to heat treatment temperatures (HTT) that ranged from 300°C to 3000°C.

The unique aspect of the present study was the characterization of dimensional changes of individual fibers in terms of their length and diameter. The dimensional measurements for AR fibers indicate very clearly that starting from an oxidized state, the length of the fibers shrinks about 8% at a HTT of 900°C. Above 900°C, the length does not reduce any further, instead it increases slightly. The final shrinkage of the length (relative to the oxidized state) is about 6%. The slight increase can be explained by the alignment of the graphene layer planes along the fiber axis that result in the shrinkage of fibers in the transverse direction (diameter) but an expansion along the longitudinal direction. Considerably larger changes are observed in the diameter of the fibers. Starting from the oxidized state, a significant drop of 15% is observed till 900°C HTT. From 900°C till 1500°C, there appears to be a slight increase in the diameter. Beyond 1500°C, there is again a significant reduction of the diameter with the ultimate shrinkage being about 20% at HTT approaching 3000°C.

The fiber microstructure was characterized by scanning electron microscopy (SEM). Consistent with the dimensional measurements, the SEM examinations reveal that the first major change is observed at 900°C, where a radial texture is observed. At higher HTT, the development of radial texture is more pronounced and by 2400°C the graphene-layer planes are seen very clearly. Wide-angle x-ray scattering (WAXS) measurements indicate that at 2875°C HTT, the fibers have a d_{002} spacing of 0.3354 nm indicating that the material is almost fully graphitic. Single-filament testing indicates that the tensile modulus and strength increase with increasing HTT till 2100°C, where a slight drop is observed followed by further increase till the maximum HTT of 2875°C. The maximum modulus was measured to be about 385 GPa whereas the maximum strength was found to be about 1.8 GPa.

The present study establishes that in AR mesophase pitches, the first significant change in dimensions and microstructure occurs at about 900°C. Whereas microstructure and properties continue to evolve over higher heat treatment temperatures, the next significant change is observed above 2400°C. These results should help in the establishment of optimum processing conditions for carbon fiber/carbon matrix composites.

Simulation of the Antenna Pattern of Arbitrarily Oriented Very Large Phase/Time-Delay Scanned Antenna Arrays With Systematic and Random Errors

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Abstract

A computer simulation to determine the field-pattern of arbitrarily oriented very large phase/time delay scanned antennas was developed. The simulation takes into account errors present in antenna arrays. These are systematic and random errors. The systematic errors considered here are the finite quantization of the phase produced by the use of digital N-bits phase/time-delay shifters and the flexing of the array aperture due to its large size and weight. The random errors considered are those caused by variations on the amplitude and phase of the elements current, variations on the radiation pattern of the elements, and missing elements (due to catastrophic failure), and variations in the location of the elements. To validate the simulation a number of patterns were computed. These included patterns of linear arrays, array panels, and arrays of panels. Experience as well as specific examples validated the ideal patterns. The "random-error-patterns" were compared to specific trends noted in earlier studies. The behavior of the computed patterns confirmed such trends.

A Model To Analyze Sensor Data For Detection of Multi-Source Attacks

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Abstract

Sensors at different Air Force operation sites collect information on various network and system parameters and store them in local databases. Data obtained from various are then analyzed to detect any occurrence of attacks. If any indication of an attack is found, necessary course-of-action is taken to recover the system(s) affected by the attack. While copycat types of attacks can be easily detected, more prudent coordinated attacks originating from multiple sites by a group of sophisticated attackers will go unnoticed by sensors. This research presents a model to detect such attacks. It uses Petri Nets to represent the model. We claim that this model will significantly reduce number of false alarms raised by the intrusion detection sensors.

FLUTTER PREDICTION METHODS FOR AEROELASTIC DESIGN OPTIMIZATION

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Abstract

In the design of flight vehicles, dynamic flutter instability is a critical parameter that must be considered in various design phases. Due to the numerically intensive nature of design optimization, accurate and efficient method of flutter prediction is needed. The objective of the report is to review and investigate the flutter prediction methods for realistic examples used in aircraft preliminary design. Specifically, demonstrate the flutter predictions with recently developed method using EigenVector Orientations (EVO). Comparisons of flutter predictions between the popular V-g method and Eigenvector Orientation method are presented. The examples studied include a sweptback untapered wing, jet transport wing/aileron, and intermediate complexity wing. Results presented illustrate that the EVO method can predict the onset of flutter for aircraft wings used in design optimization studies. Based on the results obtained, the EVO method shows the feasibility of automating the flutter prediction process and achieving real time control.

ARCHITECTURES FOR KNOWLEDGE BASES

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Abstract

Potential challenge problems were analyzed to determine the nature of their knowledge/database components. The solution to many of these problems depends on an advanced data knowledge base capability. However, research in not needed on how to build larger data/knowledge bases. Research is needed on how to make knowledge in knowledge bases useful, how to get it to the user over long distances and from multiple sources, how to discover knowledge in unstructured knowledge bases, how to use semi-structured knowledge, how to access data using "conventional communication skills", how to "integrate" knowledge from diverse sources and how to keep knowledge secure. Several current technologies were reviewed to determine their appropriateness for addressing these issues. It was determined that associative techniques combined with processor in memory architecture is the most promising technology.

MODELING AND IMPLEMENTATION OF LOW DATA RATE MODEM USING MATLAB

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Abstract

The report investigates methods of modeling and DSP implementation of the modem used for low data rate multi-media communications over wireless links developed and built at the Air Force Lab, Rome site. Communication Toolbox with MATLAB version of 5.1.0.421 was used in Simulink environment to model the modem based communication system. C-code of the simulated system was generated for targeting the DSP board using Real-time workshop (RTW) of the MATH WORKS Inc. Third party software based on MATLAB for the implementation of DSP was also investigated.

Aircraft and DMT: Modeling and Analysis of Training Effectiveness, Flight Tradeoffs, Costs and Resource Allocations

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Abstract

Distributed Mission Training (DMT) is a revolutionary training paradigm currently evolving at the Department of Defense, especially at the Air force. The fundamental technologies on which DMT is built are: virtual simulation, networked war gaming and intranets. The rationale for DMT is derived from the characteristics of contemporary warfare and the increasing emphasis on creating technology based training environments that realistically capture the complexities and demands of modern military operations. While the dimensions and complexity of modern warfare are expanding, the ability of the defense services to train forces in a realistic environment is being increasingly constrained. The primary constraints arise from limited resources for team skill training using actual equipment such as aircraft, safety limitations of live training events such as air-to-air missiles for instance, and security constraints due to operational conditions. Consequently, DMT is strongly emerging as an alternate but effective mode of team training in the defense services. In this research, we develop models and a spreadsheet decision support system to address the following key questions concerning DMT: (i) *Should DMT be deployed at all, as part of continuation/replacement training programs for F16 crew, (ii) What is the extent to which continuation/replacement training can be conducted using DMT systems, (iii) What are the various system configurations under which DMT can be deployed, (iv) What are the specific costs associated with DMT systems, and (v) Are there specific measures of effectiveness that can they be used to evaluate the potential DMT configurations up front.*

Characterization of BN-Doped SiC Epitaxial Layers

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Abstract

The electrical properties of 4H-SiC epitaxial layers on semi-insulating substrates were studied. The epitaxial layers were grown by the Emerging Materials Research Laboratory (EMRL) using an existing cold-wall chemical vapor deposition (CVD) system. These layers were doped during growth using a solid-phase boron-nitride source, which had previously been shown to dope the layers with boron, nitrogen and aluminum. Capacitance-Voltage (C-V), cathodoluminescence (CL), Hall effect, thermal admittance spectroscopy (TAS) and optical admittance spectroscopy (OAS) were used to characterize these layers. CL data indicated the presence of the boron-related D-center ($E_A = E_V + 0.60 \pm 0.2$ eV), which has a characteristic green luminescence when donor to D-center recombination occurs. TAS showed evidence of a deep level but sample instabilities prevented complete characterization from being performed. OAS data was gathered and compared with semi-insulating substrate material from Cree Research Inc. which permitted a direct comparison between observed optically-active defects in both materials. Finally Hall data indicate the possibility of hopping conduction in slightly p-type layers, while in slightly n-type layers there was a measurable mobility. However, characterization of thin films on insulating substrates using the Hall Effect was inconclusive and will require further study.

AN IMAGE REGISTRATION ALGORITHM BASED ON THE PROJECTIVE TRANSFORMATION MODEL AND AUTOMATED BLOCK MATCHING FEATURE POINT SELECTION WITH APPLICATIONS IN MULTIFRAME INTEGRATION AND CONCEALED WEAPON ENHANCEMENT

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Abstract

A subpixel-resolution image registration algorithm based on the nonlinear projective transformation model is proposed to account for camera translation, rotation, pan, and tilt. Typically, parameter estimation techniques for transformation models require the user to manually select feature point pairs between the images undergoing registration. In this research, the block matching algorithm is used to automatically select correlated feature point pairs between two images, and these features are used to calculate an iterative least squares solution for the nonlinear projective transformation parameters. Since block matching is only capable of estimating accurate translation motion vectors in discontinuous edge regions, inaccurate feature point pairs are statistically eliminated prior to computing the least squares parameter estimate. Convergence of the projective transformation model estimation algorithm is generally achieved in several iterations. Simulations show that the algorithm estimates accurate integer- and subpixel-resolution registration parameters for intensity image sequence frames, dissimilar image slices from the Visible Human Project, and uncalibrated infrared images. Through subpixel-resolution registration, high-resolution video stills are generated by integrating the registered pixels from a short sequence of low-resolution video frames. Experimental results are also shown in utilizing dissimilar data registration followed by vector quantization to segment tissues from multimodality Visible Human Project slices, as well as to enhance concealed weapons imaged by a dual long-wave and short-wave infrared camera.

COMPUTER MODELLING OF NONLINEAR VISCOUS PANEL FLUTTER

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Abstract

Nonlinear viscous panel flutter is reported for the first time in Selvam , Visbal and Morton [1]. Further study on Euler and viscous panel flutter is reported in this work. Divergence occurred when the Mach number M is less than one. There are two equilibrium positions during divergence depending upon the initial perturbations is reported in [3] and similar two equilibrium positions are simulated in this work for both Euler and viscous flows. The viscous flow features are much more complex than Euler flow. Many small vortices are observed during viscous negative divergence. The flow details and pressure contours are reported. Computer model to study the three-dimensional panel flutter is implemented. At this time the nonlinear plate equation is solved by finite difference method in space and Newmark-β method in time. Verification is underway.

A Computational Study of Turbine Blade Interactions with Cylinder Wakes at Various Reynolds Numbers

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ABSTRACT

The cyclic passages of wakes from upstream engine components introduce severe fluctuations into the aerothermal environment of turbine blades. The associated adverse effects are amplified at higher flight altitudes, as the attendant reduction in Reynolds number results in unsteady flow separation on the blades and a corresponding decrease in engine performance. In the present study, computations simulate the unsteady interactions of small cylinder wakes with a cascade of Langston turbine blades in a sequence of Reynolds number cases (660 K - 16.5 K). Vortex shedding from the cylinders produces an unsteady environment for the downstream boundary layers that may have adjustable content in frequency and length scale. Results from the existing VBI2D code are presented concerning the flowfield, pressure distributions, and total pressure loss coefficient. Flow structures are seen that are rich in oscillations and separations, especially at the lower Reynolds numbers. A somewhat surprising structure is seen in the generation of total pressure, which indicates the need for further study. A provisional explanation is offered for the corresponding behavior in pressure loss coefficient by means of a basic analytical model.

DEVELOPMENT OF A PROBABILISTIC ASSESSMENT FRAMEWORK FOR HIGH CYCLE FATIGUE FAILURES OF GAS TURBINE ENGINE BLADES

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Abstract

A framework for the probabilistic analysis of high cycle fatigue is developed. The framework will be useful to U.S. Air Force and aeroengine manufacturers in the design of high cycle fatigue in disk or compressor components fabricated from Ti-6Al-4V under a range of loading conditions that might be encountered during service. The main idea of the framework is to characterize vibratory stresses from random input variables (uncertainties such as initial crack size, crack location, loading, material properties, and manufacturing variability). The characteristics of such vibratory stresses will be portrayed graphically as histograms, or probability density function (PDF). The outcome of the probability measures associated with all the values of a random variable exceeding the material capability is achieved by a failure function $g(\mathbf{X})$ defined by the difference between the vibratory stress and Goodman line or surface such that the probability of HCF failure is $P_f = P[g(\mathbf{X}) \leq 0]$. The framework can be used to facilitate the development design tools for the prediction of inspection schedules and reliability in aeroengine components. Such tools could lead ultimately to improved life extension schemes in aging aircraft, and more reliable methods for the design and inspection of critical components.

A STUDY OF MODELS AND TOOLS FOR PROGRAMMING THE VGI PARALLEL COMPUTER

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Abstract

A recent trend in dataflow architecture design is incorporation of dataflow concept with multithreading concept. The VGI parallel computer is a multithreaded static dataflow computer intended for processing stream data present in video, graphics, and image processing applications. The massively parallel VGI computer consists of a large number of processors connected through reconfigurable communication networks. Two connected processors use a simple handshake protocol for communication and synchronization.

This report focuses on the issues of programming models, tools, and compilation technology for programming the VGI parallel computer. The issues are discussed at three programming levels: machine level, signal flow graph level, and SISAL language level. Future research work is also discussed in the report.

Joule Heating Simulation of Poly-Silicon Thermal Micro-Actuators

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ABSTRACT

Previous studies of surface micro-machined polycrystalline silicon MEMS thermal micro-actuators have established that these simple and compact devices can provide deflections on the order of 10 micrometers at CMOS compatible drive voltages. These thermo-mechanical devices operate by differential thermal expansion caused by ohmic heating in higher resistance regions of the double beam device. Because of thermal conductivity and temperature dependent resistivity in polycrystalline silicon, the temperature profile along the "pusher" section of the beam is not uniform, and motion simulation of the thermal actuator can be complex. This work represents an initial attempt at correlation of experimental near-IR observations of thermal actuator operation to a new commercial Joule-heating MEMS simulation package that integrates pertinent mechanisms into a no parameter fit model.

ALIAS-FREE PROCESSING OF P-3 SAR DATA

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ABSTRACT

This paper is concerned with multidimensional signal processing and image formation with FOliage PENetrating (FOPEN) airborne imaging radar data which were collected by a Navy P-3 ultra wideband (UWB) radar in 1995 [Raw]. A commonly-used assumption for the processing of the P-3 data is that the beamwidth angle of the radar is limited to 35 degrees [Bes], [Goo]; based on this assumption, the PRF of the P-3 SAR system yields alias-free data in the slow-time Doppler domain. However, controlled measurements with the P-3 radar have indicated a beamwidth which exceeds 35 degrees [Raw]; e.g., at the radar frequency of 300 MHz, the beamwidth angle is close to 100 degrees.

In this paper, we examine a method for processing of the P-3 data in which the incorrect assumption that its radar beamwidth angle is limited to 35 degrees is not imposed. In this approach, a SAR processing scheme which enables the user to extract the SAR signature of a specific target area (digital spotlighting) is used to ensure that the resultant reconstructed SAR image is not aliased [S94], [S95], [S99]. The images which are formed via this method with 8192 pulses are shown to be superior in quality to the images which are formed via the conventional P-3 processor with 16386 pulses which was developed at the MIT Lincoln Laboratory [Bes].

In the presentation, we also introduce a method for converting the P-3 deramped data into its alias-free baseband echoed data, and the resultant interpretation of Radio Frequency Interference (RFI) in the measured P-3 data. A two-dimensional spectral domain method for calibration from an in-scene target signature is discussed. Squint-mode image formation with the P-3 data is also examined. The original figures for this report may be obtained by contacting the author.

LIE-ALGEBRAIC REPRESENTATIONS OF PRODUCT INTEGRALS OF VARIABLE MATRICES

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Abstract

Lie algebraic ideas are used to find useful representations of product integrals of variable matrix functions. These representations are then used to construct explicit solutions to variable coefficient differential equations that have applications to transmission-line and wave-launcher problems.

RELIABILITY AND VALIDITY TESTING OF THE STUDENT CHARACTERISTICS SCALE

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Abstract

Stone (1996) proposed that 16 factors underlie the overlapping research areas of engagement, involvement, and self-regulated learning. Based on this information, she developed and preliminarily tested the Student Characteristics Scale (SCS). Initial results indicated that 13 factors might exist (Stone, 1998). Further data were collected to complete the initial analyses. From this more complete set of data, 12 factors, using 83 of original items, were retained and were similar to the preliminary 13 factors identified. Further analyses using the maximum likelihood estimators indicated that another 23 of the original item should be retained. To resolve issues of an insufficient number of items per factor or low alpha reliabilities, 24 new items were generated. This revised form of the SCS was computerized and distributed to 700 enlisted personnel who had completed technical school training within the past 6 months. This project is still in progress and a draft technical report is in progress. This research effort has led to the recent development of collaborative research projects through the Human-Environment Research Center at the United States Air Force Academy.

ENHANCEMENTS TO CUBEWORLD

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Abstract Cubeworld is a 3D Virtual Reality (VR) application under development by the MITRE corporation. A stereoscopic display coupled with 3D input devices and a speech recognition system allows users to navigate and interact within 3D environments using an easy to use interface. Two enhancements were implemented to extend Cubeworld's capabilities, (a) viewpoint manipulation, which permits a user to look at the world from the vicinity of any object within the 3D world, and (2) a computer model of the Deployable Reconfigurable Command Center (DRCC) was imported into Cubeworld, to permit real-time navigation and inspection of the model, both as a complete model, or, in terms of its components.

HIGH VELOCITY PENETRATION OF LAYERED GROUT TARGETS

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Abstract

The continued trend of internal weapons carriage for new manned aircraft designs has focused new weapons development on smaller penetrators. As a result, the interest in high velocity penetration of these smaller penetrators into hardened targets has been piqued. There currently exists a preponderance of data for high velocity penetration of small scale projectiles into concrete and grout targets, however virtually all the data is for monolithic targets. This report summarizes the results of a preliminary analytical study and small scale experimental study on high velocity penetration of layered grout targets. The results of the study indicate that the layered target configurations exhibit increased penetration in comparison to the corresponding monolithic targets. There are several factors which significantly influence penetration into layered targets which are not completely understood. A second phase experimental study and a comprehensive hydrocode parametric study are recommended to address these uncertainties.

PRELIMINARY DECISION ANALYSIS OF THE DATA EXPLOITATION, MISSION PLANNING, AND COMMUNICATION (DEMPC) SYSTEM OF THE PREDATOR UNMANNED AERIAL VEHICLE (UAV)

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Abstract

A decision analysis of the DEMPC mission planning and replanning functions was considered. The DEMPC is a component of one of the three subsystems in a Predator UAV Ground Control Station. The job of this operator is to determine the best path through a region of territory that the Predator UAV will navigate in order to image (i.e, take pictures or radar images of) various locations, or targets, to satisfy reconnaissance objectives. Factors such as relative location, wind direction and speed, cloud cover, forbidden zones, type of target, etc., all influence the decision strategy likely to be employed by this operator. The present paper explores the possible mathematical structure of an optimal strategy to perform this task and discusses the applicability of such analyses to actual human performance. A preliminary empirical investigation is outlined which is designed to reveal decision strategies and sensitivities to the various factors exhibited by individuals faced with mission planning. The long term goal is to develop a cognitive performance model of the DEMPC task that can be integrated into a Predator - like system serving as an intelligent agent.

THE EFFECT OF REPEATED MEASUREMENTS ON THE VARIANCE OF THE ESTIMATE OF THE HALF LIFE OF DIOXIN IN THE AIR FORCE HEALTH STUDY

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Abstract

The half-life of dioxin in the veterans of Operation Ranch Hand depends on its decay rate, denoted by λ. Estimates of the decay rate have been obtained by postulating a log-linear model relating logarithm of dioxin to time since exposure and other covariates of interest and estimating the coefficients by the method of least-squares. So far, four measurements per subject on dioxin, time since exposure, and other covariates are available, with future measurements planned. The postulated model depends on the law of first order kinetics and holds only when the dioxin measurements for each subject are beyond a threshold (taken here as 10 parts per trillion (ppt)). Due to this selection criterion, the least-squares estimate of λ is biased. It can be made unbiased by further selecting the subjects whose dioxin measurements lie above a tilted line. This results in a loss of subjects. As more measurements on each subject become available, the variance of the estimate should decrease, however, that need not be the case. As one obtains more measurements on each subject, those with dioxin measurements lower than the threshold of 10 ppt are excluded from the study. Thus the gain realized by additional measurements may be offset by the loss of subjects. In this report variance of the corrected unbiased estimate of the decay rate is compared for various values of k, the number of repeated measurements. This study will be helpful in policy decisions regarding continuation of the dioxin half-life study.

A DISTRIBUTED CONCURRENT INTRUSION DETECTION SCHEME BASED ON ASSERTIONS

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Abstract

This document describes a new intrusion detection scheme based on concurrent monitoring of user operations. In this scheme, prior to starting a session on a computer, an auxiliary process called watchdog first queries users for a scope file and then generates a table called a sprint-plan. The sprint-plan is composed of carefully derived assertions that can be used as a basis for concurrent monitoring of user commands. The plan is general enough to allow a normal user to perform his task without much interference from the watchdog or system administrator and is specific enough to detect intrusions, both external and internal. A distributed watchdog process architecture based on the notion of verifiable assertions is presented. This scheme is a significant enhancement over the traditional approaches that rely on audit trail analysis in that the intrusion detection latency is much shorter and can help fast recovery from successful break-ins. The issues related to recovery following the on-line detection of intrusions are also discussed.

DETECTING BIDIMENSIONALITY IN RESPONSE DATA: AN EMPIRICAL TASK ANALYSIS TECHNIQUE

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Abstract

There are several common situations in which we might expect test data to exhibit multidimensionality across measurement occasions or between subgroups, and task analysis is often used to uncover the multidimensionality inherent in a set of test items or other cognitive tasks. The purpose of this paper is to describe a method for utilizing knowledge of group differences in task performance for the purpose of performing empirical task analysis. To this end, two-dimensional, dichotomous response data were simulated to portray several situations that might arise in operational settings. The factors manipulated during data generation included (a) the magnitude of the relationship between the two dimensions, (b) the proportion of tasks belonging to each dimension and (c) the number of respondents upon whom the tasks were calibrated. Task dimensionality was recovered using a Rasch standardized fit statistic to measure the difference between task calibrations that were estimated on two groups of simulated examinees. Overall, the technique was successful in recovering task dimensionality with 85% accuracy.

ENHANCEMENTS TO A DIRECT AEROELASTIC STABILITY COMPUTATIONAL MODEL

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Abstract

The ability to accurately and efficiently predict transonic flutter boundaries is investigated using an enhanced direct computational method. Steady characteristic and unsteady approximate non-reflecting characteristic farfield boundary conditions are utilized to more accurately model the aerodynamic flow physics in a direct method. In addition, the aerodynamic model is modified to lock the movement of the farfield grid points while allowing the airfoil surface points to move freely. This is accomplished by introducing a linear weighting function in the grid deformation model. The direct method is based on a discretization of the Euler equations and a coupled set of structural dynamics equations representative of a pitch-and-plunge airfoil with trailing edge flap. The coupled equations are expanded to specify a Hopf-bifurcation point, which defines an incipient flutter state. Since the enhanced farfield boundary conditions improve the modeling of the flow physics, the computational domains can be reduced in size over similar models with simple freestream conditions. A flapped NACA 64A006 airfoil, executing pitching and plunging motion, is utilized to demonstrate the ability of the enhanced direct method to accurately and efficiently calculate flutter boundaries for reduced domain sizes. Both zero and non-zero angle of attack results are shown to highlight the improved accuracy and efficiency of the enhanced model. Each model modification resulted in analysis improvements, with the steady characteristic model demonstrating significant improvements in the nonlinear flow regime. For a 1° static pre-twist analysis at a transonic freestream Mach number of 0.84, the enhanced model resulted in over a 75% decrease in the flutter speed error. Therefore, the capability to more accurately and efficiently model transonic flow conditions with strong shock interaction has been shown.

CO-CHANNEL SPEECH AND SPEAKER IDENTIFICATION STUDY

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Abstract

This study was comprised of two parts. The first was to determine the effectiveness of speaker identification under two different speaker identification degradation conditions, additive noise and speaker interference, using the LPC cepstral coefficient approach. The second part was to develop a method for determination of co-channel speech, i.e., speaker count, and to develop an effective method of either speech extraction or speech suppression to enhance the operation of speaker identification under co-channel conditions. The results of the first part of study indicate that under conditions of the same amount of either noise or corrupting speech, for example 0 dB SNR or TIR (target-to-interference ratio), noise is much more detrimental than corrupting speech to the operation of the speaker identification. For example, with 100% of 0 dB corrupting speech there still occurs a certain number of correct speaker identifications, i.e., about 40% accuracy. Ten (10) dB TIR interfering speech, as well as small amounts of interfering speech, i. e., 40% 0 dB TIR are not as detrimental to speaker identification. The results of the second part of the study indicate that a system for speaker count and speaker separation is possible. The harmonic sampling approach, developed during the study, uses the periodic structure of the fine structure of the frequency characteristics of voiced speech. Successful reconstruction of a single speaker indicates the potential of this approach as a candidate for speech separation. Also, it was shown that detection of co-channel speech is possible using the harmonic sampling approach. Further improvements as well as other possible approaches to the co-channel speech problem are discussed.

A DETAILED STUDY OF THE NUMERICAL PROPERTIES OF FDTD ALGORITHMS FOR DISPERSIVE MEDIA

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Abstract

Numerous finite–difference, time–domain (FDTD) algorithms for dispersive media are presented and studied. To limit the scope of the discussion, only direct integration and recursive convolution techniques are considered in conjunction with the following media types: the isotropic cold plasma and the multi–pole Debye dielectric. The study primarily focuses on the numerical permittivity calculation that results from the discretization procedure. Where appropriate, this permittivity is used to quantify the temporal error mechanisms of the scheme. Discussions are provided that assess the overall strengths and weaknesses of each scheme.

GROWTH AND CHARACTERIZATION OF 3-INCH NITRIDE SEMICONDUCTING EPITAXIAL FILMS

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Abstract

During the period from June 1998 to July 1998, my work was focused on: (1) modification of a MOCVD system located at the US Air Force Research Laboratory/SNHX, Hanscomb AFB to accommodate a new gallium nitride MOCVD reactor. The construction of the MOCVD reactor was completed and leak checking begun. (2) construction of a backup exhaust system for the preexisting vapor phase epitaxy (VPE) system used for gallium nitride (GaN.)

Modified Herriott Cell Interferometry for Pulsed Plasma Neutral Density Measurements

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Abstract

A Modified Herriott Cell was designed, constructed, and implemented into a Heterodyne Quadrature Interferometer. This provided increased resolution of neutral density coming off of Pulsed Plasma Thrusters during firing. Two concave spherical mirrors were used to create a two dimensional plane measurement technique that allowed for large increases in path length by multiplying the number of passes that the laser made across the face of the thruster. Raytracing code was both written and purchased to calculate the possible configurations that could be used with this cell and to optimize solutions found. The solutions identified in the codes were demonstrated in the lab with the intent of making measurements at increased resolution. Lab vibrations were identified as a potentially large source of error and steps were taken to alleviate the error introduced. Final data was not taken on a PPT, as there was not enough time to complete these measurements. Another trip is being scheduled with the intent of taking the final data for demonstration of the validity of this diagnostic as well as using it on various thrusters.

A SIMULATION STUDY OF THE VULNERABILITIES IN COMMERCIAL SATELLITE CONSTELLATIONS

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Abstract

A simulation study of vulnerability in commercial low earth orbit satellite constellation has been conducted. Increasing number of satellite constellations are being set in place in the earth orbit by various companies. Availability of these resources has prompted the study of possible military application during the emergency situation. The simulation is designed to measure the performance drop of Globalstar constellation in a hostile environment. In the presence of jamming transmission, up to 56 percent of transmission per satellite was lost. A method to detect hostile transmission and allow the transmission to hand off from effected satellite to other satellites in the constellation has to be developed if such constellations are to be used in military application.

A STUDY OF OPTIMAL FINITE-THRUST SPACECRAFT TRAJECTORIES FOR THE TECHSAT 21 MISSION

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Abstract

A preliminary study of optimal finite-thrust spacecraft trajectories for the TechSat 21 mission was examined. The study looked only at one satellite orbiting in the ecliptic plane, i.e. two-dimensional motion, with no explicit orbit perturbations included. Optimization of the spacecraft trajectory was accomplished using a direct collocation with nonlinear programming approach. This approach requires that the equations of motion and integrals of the motion for the spacecraft trajectory be calculated from state vector values and then feed into an optimization subroutine. The optimization subroutine changes the state vector values to minimize the objective function, i.e. the thruster firing time, which is subject to constraints dictated by the mission requirements. An example simulation for this mission was performed. The trajectory was divided up into a sequence of twelve thrust arcs separated by twelve coast arcs. Constraints were placed on the objective function to insure that the state vector values yielded results that represented an actual, predetermined trajectory. A general perturbation was incorporated into the problem by including thrust acceleration terms in the equations of motion. The initial conditions used to start the process were chosen to be the state vector values for a pure Keplerian orbit with no perturbations. After only two iterations the code converged to an optimized solution. This solution was very close to the initial condition with only the thrust level and thruster firing times being altered by the program. It is a reasonable solution since the thrusters are only used to maintain the same orbit, hence most of the state vector values would not change. The solution was plugged back into the code as initial conditions and the code yielded the same solution after one iteration. Although this does not guarantee a global minimum was found, it instills confidence that the solution is a valid one. Future work to be done includes expanding the code to three dimensions, including perturbation effects like atmospheric drag, luni-solar, and the Earth's oblateness, and including multiple satellites in the analysis.

MDICE Analysis of an F-18C Wing

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Abstract

In this report, the process of creating a geometric model of an F-18C wing, gridding with structured and unstructured grids, and using the grids in a flow computation is described for a new methodology designed for aeroelastic computations. The new methodology, called MDICE, is a paradigm of distributed processing over a heterogeneous network with all processes controlled by one interface. Through MDICE, the user has control of geometry modeling, grid production, flow solving, and post-process visualization. Successes and failures of a first-time user of MDICE are presented and solutions to encountered problems are given where available. Project limitations resulted in not reaching an aeroelastic computation.

NEAR-OPTIMAL ROUTING OF UNMANNED SURVEILLANCE PLATFORMS

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ABSTRACT

Many issues still need to be explored in the field of sensor management. Real battle scenarios introduce many physical complexities for consideration. In this paper, we begin to explore sensor resource scheduling by looking at the problems involved in routing of surveillance platforms. Unlike many classical routing problems, surveillance platforms must view each target or region of interest rather than visiting it. Terrain obscuration and other similar constraints add many new complexities to this problem. We therefore propose a visibility-constrained routing problem. In general, the solution may be quite different from the problems posed by previous works. The value of the sensor platform may be increased greatly by using a routing scheme which takes visibility into account.

For this study, we use a specific example from the Off-board Augmented Theater Surveillance (OBATS) project at Rome Research Site. An unmanned air vehicle (UAV) may be used for surveillance or target identification purposes. The UAV simulation used in the OBATS lab has been modified to allow for implementation of solutions to an example routing problem. A mathematical model for routing of an independent, self-tasking UAV has been formulated. Final work will include the application of Lagrangian relaxation-based methods to this NP-hard problem. Refinements to the physical model will include multiple UAV's, realistic flight dynamics, threat avoidance, and time constraints.

Stable Controller Design for Deployable Precision Structures Using Perturbation Theory

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ABSTRACT. Perturbation methods for linear operators are commonly used in the analysis of systems that tend to deviate linearly from a given reference model. The construction of an operator with a first order perturbation is investigated and the resulting eigenvalue series is constructed. It is shown that a simplified perturbation series can be obtained for matrix operators with special structure. The given theory is applied to a reduced order model (ROM) control scenario and an algorithm for computing an $O(\varepsilon^3)$ eigenvalue approximation is described.

INTRODUCTION

Modern modeling of large dimensional physical systems primarily employs matrix methods, often via finite elements or partial differential equations. Due to implementation constraints from a control standpoint, however, an adequate model reduction is needed. Model approximations can be used to design controllers, but compensation for observation spillover may be required for stability. It has been shown in [1] that addition of a residual mode filter to the reduced order model controller can stabilize the entire system in modal coordinates. The question now becomes: What components of the spectrum were destabilized? An eigenvalue perturbation method, developed in [3], has been proposed for full rank operators with no multiplicities. In this paper, we have expanded this technique to consider multiple eigenvalues and also provide proof of the order of approximation.

Applied mathematicians, engineers and physicists frequently use perturbation methods to solve a variety of different problems. Even though solutions to intractable nonlinear differential equations can be approximated using perturbation theory, this paper's focus will only encompass linear deviations of finite-dimensional linear operators. The reader is also referred to an "in-depth" treatment of the perturbation theory of linear operators [4], where the subsequent derivations become special cases.

The following definitions lay the groundwork for the construction of an eigenvalue perturbation series. The type of structure imparted upon a matrix operator of interest is illustrated and the corresponding eigenvalue series is given. An example of the application to the control design of a spectral system is explained. A proof and the numerical algorithm for this approach are given in the appendices.

OPERATOR PERTURBATIONS

DETERMINATION OF THE RESIDUAL STRESS PROFILE IN A THIN COMPOSITE PART

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Abstract

Composite materials are advantageous for aerospace applications due to their light weight and high stiffness/weight ratio. However, composite parts which are autoclave cured experience problems associated with cure residual stresses, including a reduction in load carrying capacity and 'spring-in', a permanent deformation due to the residual stresses (Stover, 1993). This paper develops an experimental procedure that can be used to obtain the residual stress profile in a thin composite part. This procedure involves progressive cutting of the composite part (i.e. stress relief) and associated strain gage monitoring. The strain gage data is then combined with a finite element analysis to determine the through-thickness residual stress profile in the composite part. This analysis procedure can be used as a tool in the understanding and prediction of spring-in, or simply for measuring the residual stresses in a composite part.

INTERACTIONS BETWEEN WEAKLY IONIZED GAS PLASMAS AND SHOCK WAVES, A REVIEW

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ABSTRACT

Investigators have observed "anomalous" interaction effects between shock waves and weakly ionized gas plasmas (WIGs). The contribution of thermal inhomogeneities to the phenomena is unclear, but the observed effects exceed those that would occur in the case of simple heat addition. Characteristic phenomena include increased shock velocity, increased shock standoff distance, shock weakening, shock front dispersion, as well as other effects. Several models are presented which may describe mechanisms that could cause the observed "anomalous" effects. Observations of key issues and suggestions for future experiments are also included.

THE PHYSICAL BASIS OF BOID AND CROTALINE INFRARED DETECTION

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Abstract

A hypothesis for the physical basis of neuronal action potential frequency shift due to changes in temperature of vertebrate thermoreceptors is presented. The mechanism of heat generation in the IR receptor organ of pit vipers is shown through finite element modeling of the receptor structure. The adsorption of IR radiation from a mammal is shown to give sufficient heating of the pit organ for supra-threshold stimulation of non-specialized thermoreceptor neurons present in the receptor organ.

PHANToM/MERLIN FORCE-REFLECTING TELEOPERATION: IMPLEMANTATION

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Abstract

This report focuses on implementation of *PHANToM/Merlin* force-reflecting teleoperation. The purpose of the research was to enhance telepresence in human-centered teleoperation of remote manipulators using haptic feedback. The commercially available 3-degree-of-freedom PHANToM haptic interface was used to command translational rates to a 6-degree-of-freedom Merlin robot. A force/torque sensor on the remote manipulator enabled a force/moment accommodation algorithm (FMA), and it also allowed the user to feel the forces that the remote manipulator exerted on the environment. The FMA allowed the Merlin to orient itself so that minimum contact wrench was exerted at the end effector. This allowed for general spatial motion of the Merlin despite the fact that the user could only command translations. This method of rate control and FMA enabled on all axes at all times is unique, and it has been named the Naturally-Transitioning Rate-to-Force Controller (NTRFC). This setup was ideally suited to peg-in-the-hole tasks using the Fitt's Law taskboard in the Human Sensory Feedback Lab. Preliminary data has shown the NTRFC to be an effective method of control.

A STUDY OF THE EFFECTS OF NOVAE ON THE INFRARED CELESTIAL BACKGROUND

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Abstract

The low densities and short timescales involved with dust grain formation in nova outflows imply that the grain size distribution of dust which forms does not conform with thermodynamic equilibrium, and grain growth in these environments should be modeled in terms of kinetic equations (Johnson et. al. 1993). One recent use of kinetic equations to model dust growth in stellar outflows is presented in Egan and Leung (1995.) We present corrections to the equations for kinetic growth presented in Egan and Leung (1995), and compare the method of contracting a large set of kinetic equations by taking moments of the kinetic equation to a method of binning equations.

To determine the effect of novae on the infrared background, and particularly data from the MSX mission, we first calculate the expected rate of nova observations present in the MSX catalog. We find that the expected number of classical novae for any given map in band A (8.28 μm) is of the order of 10, and on the order of 1 in all other bands. We compare 1 known observation in the visual which brightened shortly before MSX measurements of it's location. We report a band A measurement of .322 Jy for Nova V4361 Sgr (Sgr 1996), and discuss the implications of this measurement relative to visual measurements published on this nova.

ISSUES IN STEADY-STATE VISUAL EVOKED RESPONSE BASED CONTROL.

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Abstract

Electroencephalographic (EEG)-based control devices are one of several emerging technologies that will provide operators with a variety of new hands-free control options. In general, EEG-based control translates brain electrical activity into a control signal. This report describes two experimental evaluations of a new steady-state visual evoked response-based control. With this control, the luminance of selectable items on a computer display was modulated at different frequencies. The operator's choice between these items was identified by detecting which frequency pattern was dominant in the visual evoked brain activity. The first study was designed to characterize the performance of this system, in addition to evaluating two candidate control frequencies. The results are encouraging. Participants were able to use this form of EEG-based control and their performance was stable. In fact, participants averaged over 90 percent correct selections.

Having established the efficacy of this type of control, it would be reasonable to develop and test enhancements to the current system. One possible improvement was an automated calibration procedure. Prior to its development, system parameters had to be adjusted manually to tune aspects of the system to particular characteristics of the user's electrical brain activity. With this automated procedure, an algorithm would perform these adjustments. A second experiment was developed to address the usefulness of this procedure. It was found that the automated procedure consistently set the two calibration parameters below where the manual calibrator would have set them. Due to the specific nature of the parameters, this could have resulted in faster selection times (a positive result) and/or an increased false selection rate. Selection times were found to be faster, however, the false selection rate was not increased. Due to the positive benefit and lack of negative consequences associated with its use, the automated calibration procedure was deemed useful.

RESEARCH TECHNIQUES:

A SEARCH FOR CREW RESOURCE MANAGEMENT DOCUMENTS

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Abstract

Technology brings us closer to the information we seek and yet, if not used correctly, this same technology can drive a wedge between the knowledge we seek and us. Not all documents can be found via the traditional methods of academic research. Thus many excellent sources, primarily governmental, are left idle while most researchers settle for older, more easily located documents found in the typical library. The following paper describes the techniques used to uncover documents, via Internet and academic library journal search methods, pertaining to Crew / Cockpit Resource Management (CRM) and any related topics. Also included is an annotated bibliography of the more recent and relevant documents.

A COMPUTATIONAL ANALYSIS OF STACKED BLUMLEINS USED IN PULSED POWER DEVICES

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Abstract

Blumleins are transmission-line structures that allow the formation and propagation of electromagnetic waves. They have existed for decades and their use has been widely documented for a variety of applications. The most common form of the single Blumlein is, perhaps, the three-conductor coaxial line. The widespread use and the coaxial cable's simple geometry lend itself well to today's needs. The tri-plate Blumlein configuration, on the other hand, is not as well known. Due to its more complex geometry, certain aspects must be considered which are not at all relevant in the coaxial case. This work attempts to explore the intricacies of not one triplate Blumlein, but a stack of such devices. A model has been constructed which not only accounts for wave propagation in the time domain, but also Blumlein charging and commutation. Each portion of the model has been compared to modified (existing) analyses of similar structures. The limits of validity for this analysis have also been tested through experimental studies.

WIND VALIDATION:
INCOMPRESSIBLE TURBULENT FLOW PAST A FLAT PLATE

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Abstract

The NPARC alliance has invested considerable resources in developing the WIND code: a robust, user friendly, finite-volume, structured, multi-zone, compressible flow solver with flexible chemistry and turbulence models which can be run on a variety of platforms. A validation effort was undertaken to examine the ability of the WIND code's accuracy and efficiency for incompressible turbulent flat plate flow. The validation work presented herein presents the results obtained upon conducting a grid independence study with and without wall functions and validating the different turbulence models, explicit Euler flux schemes, order of the Euler flux schemes, implicit methods, and time integration schemes. Also, results obtained in conducting 2D simulations were than compared with those obtained for 3D simulations. Overall, the different methods proved quite successful, with only slight problems observed with some of the test configurations.

PERMEABILITY CHARACTERISTICS OF AN ENDOTHELIAL CELL MODEL OF THE BLOOD-BRAIN BARRIER

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Abstract

The purpose of this study was to characterize the permeability characteristics of an in vitro blood-brain barrier (BBB) cell system and relate this information to available in vivo data.. The model was developed by culturing cerebromicrovascular endothelial cells on gelatin-coated polyethylene terphthalate membrane and was thoroughly characterized with regards to morphological appearance, transendothelial electrical resistance (TEER) and the permeability of fluorescein isothiocyanate-dextran (FITC-dextran). The model depicted here bear resemblances to many of the vitro models reported in literature with regards a cobblestone morphology, transendothelial resistance and permeability coefficient for FITC-dextran. However, there appears to be differences in the transendothelial permeability characteristics of this model in comparison to the in vivo BBB. The established cell model was 10-100 times more permeable than that of a continuous BBB endothelium. A possible reason for this increased permeability appeared to be small intermittent gaps between endothelial cells of this model that allowed for leakage of large molecules.

ENHANCEMENTS TO A DIRECT AEROELASTIC STABILITY COMPUTATIONAL MODEL

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Abstract

The ability to accurately and efficiently predict transonic flutter boundaries is investigated using an enhanced direct computational method. Steady characteristic and unsteady approximate non-reflecting characteristic farfield boundary conditions are utilized to more accurately model the aerodynamic flow physics in a direct method. In addition, the aerodynamic model is modified to lock the movement of the farfield grid points while allowing the airfoil surface points to move freely. This is accomplished by introducing a linear weighting function in the grid deformation model. The direct method is based on a discretization of the Euler equations and a coupled set of structural dynamics equations representative of a pitch-and-plunge airfoil with trailing edge flap. The coupled equations are expanded to specify a Hopf-bifurcation point, which defines an incipient flutter state. Since the enhanced farfield boundary conditions improve the modeling of the flow physics, the computational domains can be reduced in size over similar models with simple freestream conditions. A flapped NACA 64A006 airfoil, executing pitching and plunging motion, is utilized to demonstrate the ability of the enhanced direct method to accurately and efficiently calculate flutter boundaries for reduced domain sizes. Both zero and non-zero angle of attack results are shown to highlight the improved accuracy and efficiency of the enhanced model. Each model modification resulted in analysis improvements, with the steady characteristic model demonstrating significant improvements in the nonlinear flow regime. For a 1° static pre-twist analysis at a transonic freestream Mach number of 0.84, the enhanced model resulted in over a 75% decrease in the flutter speed error. Therefore, the capability to more accurately and efficiently model transonic flow conditions with strong shock interaction has been shown.

RELATIONSHIP BETWEEN GROWTH HORMONE AND MYELIN BASIC PROTEIN EXPRESSION *IN VIVO*

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ABSTRACT

Proper functioning of the mammalian nervous system requires myelination of neuronal axons. Myelination of the newborn mouse brain begins shortly after birth and is complete by about 20 days of age. Abnormalities of myelin basic protein (MBP) production have a direct impact on myelination as has been demonstrated in the shiverer mouse. Mice with less than 25% of normal MBP levels have aberrant myelination and brain development and demonstrate a characteristic tremor at 12 days of age. Growth hormone (GH) and insulin-like growth factor I (IGF-1) have been shown *in vitro* and *in vivo* to affect myelination. This project explores the effect of GH deficiency on myelin basic protein expression to determine whether GH deficiency exacerbates MBP haploinsufficiency. These studies grew out of studies undertaken on children with 18q- syndrome who have only a single copy of the MBP gene, are hypomyelinated, and are also shown to suffer growth hormone deficiency or insufficiency. A hybrid mouse model that mimics these deficiencies of 18q- patients was developed to explore the relationship between GH and MBP *in vivo*.

APPROXIMATING MORSE POTENTIALS NUMERICALLY AND ANALYTICALLY

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Abstract

Using the results derived by Akira Matsumoto and Kenichi Iwamoto published in two papers[1,2] studying Morse potentials, we attempted to calculate transition probabilities between vibrational levels. We used two methods for calculating the probabilities, the first method involved numerically evaluating the analytic *eigenfunctions* and the second method was to evaluate the analytic solution to the electric dipole matrix elements, both of which were provided by Matsumoto and Iwamoto's papers.

ANISOTROPIES IN VISUAL SEARCH PERFORMANCE ACROSS THE UPPER AND LOWER VISUAL FIELDS AS A FUNCTION OF EXTRINSIC FEATURES

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Abstract

Previous research examining visual search performance anisotropies across the visual fields utilized stimuli which differed from one another in terms of intrinsic features (e.g. color). These studies yielded an upper and right visual field advantage in performance efficiency and accuracy. Recent research examining the same anisotropies utilizing stimuli which differed from one another based on extrinsic features (e.g. tilt) have yielded conflicting explanations. The current study attempted to resolve this conflict by controlling for a possible confound in previously used stimuli: luminance. Results indicated two major findings when luminance is controlled for: 1) reaction times are slowed drastically and 2) perceived three-dimensionality is not a useful feature during visual search. A discussion of these findings with respect to peripersonal and extrapersonal space and categorical and coordinate processing is included.

A DETAILED STUDY OF THE NUMERICAL PROPERTIES OF FDTD ALGORITHMS FOR DISPERSIVE MEDIA

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Abstract

Numerous finite–difference, time–domain (FDTD) algorithms for dispersive media are presented and studied. To limit the scope of the discussion, only direct integration and recursive convolution techniques are considered in conjunction with the following media types: the isotropic cold plasma and the multi–pole Debye dielectric. The study primarily focuses on the numerical permittivity calculation that results from the discretization procedure. Where appropriate, this permittivity is used to quantify the temporal error mechanisms of the scheme. Discussions are provided that assess the overall strengths and weaknesses of each scheme.

CONDUCTING FLUID REAL-TIME 2-D ELECTRONIC INTERPOLATOR AND SPATIAL FILTER FOR WAVEFRONT SENSOR-TO-CORRECTOR INTERFACING.

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INTRODUCTION

The situation often exist in adaptive optics that the geometry of wavefront sensing is different than that of wavefront correcting. By virtue of Nyquist Theorem, more wavefront sensing elements are usually required than for wavefront correcting, and the geometrical arrangement may differ. In our case, the wavefront sensor has rectangular geometry while the correcting element has hexagonal. Another situation arises when the reconstructed wavefront solution is noisy and must be spatially filtered to the lower order modes. We propose a solution using the **Fluidic Interpolator Module(henceforth called FILM).**

An aqueous solution of $CuSO_4$ provides for a resistive medium which allows for freedom of movement. Electronically driven, etched copper circuit board traces and pads with the input geometry provide for spatially defined potentials in the medium. A receiving plate etched with the field distribution and resulting fluid potentials interpolates and smoothes the output plate data. When the output plate is "close" to the input plate i.e. the separation is much less than the separation between input plate elements, the output plate senses essentially bilinear interpolation. Separating the plates tends toward averaging of the fields, and hence 2-D smoothing and interpolation of the output data.

THE DESIGN OF A DOUBLE STRUT SUPPORT SYSTEM FOR LOW SPEED WIND TUNNEL TESTING OF ROTATING, AXISYMMETRIC LIGHTCRAFT MODEL

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Abstract

An inline, double strut support system and Lightcraft test model were designed, and partially constructed, for use with the Rensselaer Polytechnic Institute Low Speed Wind Tunnel. The support system was designed especially for rotating, axisymmetric bodies, particularly the Lightcraft model.[1,2] By attaching the system to the existing yoke balance system; it is possible to experimentally measure the aerodynamic forces on the rotating model. The apparatus maintains a constant angle of attack, while the yaw angle may be varied.

A GREEDY RANDOMIZED ADAPTIVE SEARCH PROCEDURE FOR THE MULTI-CRITERIA RADIO LINK FREQUENCY ASSIGNMENT PROBLEM

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Abstract

A Greedy Randomized Adaptive Search Procedure (GRASP) is presented for computing approximate solutions to the $\mathcal{NP}$-hard Radio Link Frequency Assignment Problem (RLFAP). The purpose is to allocate a limited number of frequency channels to a given set of transceivers needing to establish communication links. An RLFAP solution is termed feasible if no two frequencies within the network interfere with each other and all other constraints are satisfied. If a feasible solution does exist, the objective would be the minimization of both the order and the span of the solution set. GRASP is shown to be an efficient and robust method for solving the RLFAP. The paper also shows the advantages of solving a multi-criteria function in finding the most beneficial optimal solution.
Keywords: Radio link frequency assignment problem, Combinatorial Optimization, GRASP, heuristics, computational results

NEGOTIATION AT A DISTANCE: WHY YOU MIGHT WANT TO USE THE TELEPHONE

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Abstract

Same gender dyads engaged in a 4-issue integrative bargaining task. Negotiator accountability and communication channel (face-to-face, teleconferencing, videoconferencing) were manipulated. Negotiators in the VC condition spent less time negotiating, obtained lower outcomes overall, and engaged in less logrolling that dyads in the other communication conditions. As predicted, negotiators in the TELE condition performed relatively well in the absence of visual access.

IN-SITU SYNTHESIS OF DISCONTINUOUSLY REINFORCED TITANIUM ALLOY COMPOSITES VIA BLENDED ELEMENTAL POWDER METALLURGY PROCESSING

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Abstract

Discontinuously reinforced titanium (DRTi) matrix composites offer higher specific modulus, specific strength, wear resistance and thermal stability as compared to the unreinforced titanium alloys. The powder processing approach can offer better distribution of the reinforcement particles than conventional casting techniques.

In this study two alloys were selected for investigation: Ti-6Al-4V and Ti-10V-2Fe-3Al, both reinforced with 15 volume percent titanium boride (TiB). The composites were processed via a powder metallurgy technique by in-situ synthesis of the TiB from titanium diboride (TiB_2). The elemental powders were blended, compacted and extruded to obtain a fully dense material. Microstructural characterization of the as-extruded and heat treated specimens was performed to understand the transformation kinetics. The composites were also made using hot isostatic pressing to compare with the extruded material.

EVALUATION OF USING AGENTS FOR FACTORY LAYOUT AFFORDABILITY

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Abstract

The Manufacturing Technology Division of the Air Force Research Laboratories is aiming toward improving the affordability of manufacturing military equipment. Autonomous agents have been used with increasing frequency in the past few years to model various manufacturing theories, such as scheduling and activity based costing.

The goal of this phase of the project was to evaluate the literature and the current state of factory layout methodologies and autonomous agent theories. A case study was performed to evaluate a preliminary model of agents applied to the layout of a helicopter blade manufacturing cell. The goal of the model was to determine a feasible factory layout design by applying agent rules to the entities (workers and machines) existing in the cell.

The long term goal of this research is to develop a tool to evaluate layout affordability which could be an extension for existing manufacturing software. The tool could determine the efficiency of work flow in a manufacturing facility by calculating the effects of overcrowded machines and congested walkways or transport areas vs. low floor space utilization.

SYNTHESIS OF 7-BENZOTHIAZOL-2-YL-9,9-DIDECYLFLUORENE-2-YLAMINE: A VERSATILE INTERMEDIATE FOR A NEW SERIES OF TWO PHOTON ABSORBING MATERIALS & THREE NOVEL TPA DYES

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Abstract

The synthesis of of a new, useful intermediate, 7-benzothiazol-2-yl-9,9-didecylfluorene-2-ylamine, was accomplished starting with fluorene. Regiospecific nitration of fluorene with HNO_3 and CH_3CO_2H at 85 °C led to formation of 2-nitrofluorene in 80% yield. Regiospecific iodonation of 2-nitrofluorene with I_2, $NaNO_2$, H_2SO_4, and CH_3CO_2H at 115 °C afforded 7-iodo-2-nitrofluorene in 79% yield, after recrystallization. Alkylation of 7-iodo-2-nitrofluorene was accomplished with 1-bromodecane and KOH in DMSO at room temperature, yielding 9,9-didecyl-7-iodo-2-nitrofluorene in 77% yield (after column chromatographic purification). 2-(Tri-n-butylstannyl)benzothiazole was synthesized in 90% yield (after distillation) by reaction of benzothiazole with n-BuLi at -78 °C in THF, followed by addition of tri-n-butyltin chloride. 9,9-Didecyl-7-iodo-2-nitrofluorene and 2-(tri-n-butylstannyl)benzothiazole were subjected to Stille coupling with either tetrakis(triphenylphosphine)palladium (0) or dichlorobis(triphenylphosphine)palladium (II) in toluene at 110 °C under Ar, providing 2-(9,9-didecyl-7-nitrofluoren-2-yl)benzothiazole in 61% yield. Quantitative reduction of 2-(9,9-didecyl-7-nitrofluoren-2-yl)benzothiazole with NH_2NH_2 and 10% Pd/C in EtOH/THF at 70 °C produced 7-benzothiazol-2-yl-9,9-didecylfluorene-2-ylamine in 30% overall yield from fluorene.

UNDERSTANDING DISAGREEMENT ACROSS RATING SOURCES: AN ASSESSMENT OF THE MEASUREMENT EQUIVALENCE OF RATERS

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Abstract

Relations among ratings of multiple performance dimensions by multiple rating sources are examined. Confirmatory factor analysis is used to evaluate a series of models representing levels of measurement equivalence across rating sources. Results indicate the relative impact of dimension, rating source, and unique effects on ratings. Implications for practice (e.g., 360° feedback systems) are considered.

THE EFFECT OF SPATIAL SEPARATION AND ONSET ASYNCHRONY ON THE DETECTABILITY AND INTELLIGIBILITY OF A CRITICAL CALL SIGN PHRASE IN A MULTI-TALKER ENVIRONMENT

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Abstract

Two experiments were conducted to examine the detectability and intelligibility of a target call sign and subsequent target speech phrase in the presence of competing messages, were examined. In both experiments, the speech phrases were presented virtually over headphones to a listener whose head position was tracked. In the first experiment, multiple simultaneous talkers were located at virtual positions along the median plane of a listener. The number of competing speech phrases was varied from 2-8 and the spatial separation of the simultaneous phrases was manipulated. In the second experiment, from 2-8 talkers were located at virtual positions along the horizontal plane, and the relative onset times of the individual speech phrases was varied. On half of the trials, the speech stimuli all appeared to originate from the same location, and on the other half of the trials the stimuli appeared to be spatially separated on the horizontal plane. Preliminary results indicate that both detection and intelligibility decrease as the number of speech phrases increases. Furthermore, both detection and intelligibility were improved when the speech phrases were spatially separated over the case in which all speech stimuli appeared to originate from one location. In addition, listener self-reports indicate that longer stimulus onset asynchronies improve one's ability to detect a critical call sign. The results from these experiments have relevance to the design of auditory displays for communications, warning systems, and virtual environments, the development of hearing aids for patients with sensorineural hearing impairments, and to the study of the mechanisms by which the auditory system segregates information associated with a target sound source from information produced by competing sound sources.

SIMULATION OF PLASMA-WALL MIXING IN A MAGNETIZED TARGET FUSION CONCEPT

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Abstract

Magnetized target fusion provides a method to reach fusion ignition conditions that is intermediate to inertially confined and magnetically confined fusion schemes. Although a magnetic field is used to inhibit thermal conduction from the plasma to the confining liner, plasma-wall mixing still poses a problem. When this mixing occurs, increased impurities in the plasma reduce the plasma temperature and prevent the plasma from reaching ignition conditions. Computer simulations studying the effect of plasma-wall mixing due to the Rayleigh-Taylor instability in an imploding cylindrical linear are presented. The simulations are performed using the 2D magnetohydrodynamic code, MACH2.

THE RATE OF SKILL ACQUISITION FOR MALES AND FEMALES ON SPACE FORTRESS

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Abstract

The rate of skill acquisition for male and female participants will be examined using the complex computer game known as Space Fortress. Participants will work in dyads to learn how to play Space Fortress. It is expected that the rate of skill acquisition will be affected by previous experiences with video games. Participants who have more experience with video games should have a faster rate of learning than participants who have less experience with video games. Slopes for individual learning curves will be compared for male and female participants to determine the rate of skill acquisition.

WEIGHING THE IMPORTANCE OF SPATIAL ORGANIZATION AND PRIORITY OF TARGETS ON UAV MISSION PLANNING: WHICH FACTORS CONTRIBUTE MOST TO A TARGET'S ATTRACTIVENESS?

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Abstract

A relatively unstudied member of the UAV crew is the DEMPC, the person in charge of reconnaissance mission planning and preplanning. Part of the reason for that neglect is the difficulty of teasing apart all of the different factors influencing the DEMPC's decisions. The task described here is an initial attempt at such a study that simplifies the process by focusing on just the two most salient factors of those a DEMPC must consider: spatial organization and priority of targets in a ROZ box. The theory is that, when faced with several targets and a paucity of information, DEMPCs will mentally separate those targets into clusters based on Gestalt perceptual and organizational rules. Those clusters will be more or less attractive depending on the conditions of several factors surrounding them. Specifically, I propose that five features will be most salient at the start of a mission and so will also prove most influential in determining a cluster's initial attractiveness: (in order from strongest to weakest) proximity of the cluster to the ROZ box entrance, proximity to the exit, the density of the cluster, the size of the cluster, and the percentage of high-priority targets in the cluster. Preliminary results from a run of a previous version of the task show that at least some of these factors—particularly proximity to entrance and the number of priority targets—do indeed make a cluster more attractive. If a full run of the current version also proves successful, it should be a large step forward in the eventual development of decision-making support and automation systems for the DEMPC position.

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Theory of Envelope-function within 6X6 Luttinger model in holes subband states of Si/Ge quantum wells and superlattices.

Abstract.
We derive the exact envelope-function from the Luttinger-Kohn effective-mass Hamiltonian
including the split-off band to calculate the valence band structure for semiconductor quantum wells and superlattices. A unitary transformation is used to block diagonalize the 6X6 Hamiltonian matrix into two 3X3 blocks.The results are applicable to silicon/germanium. The envelope functions are analytically given as linear combination of Bulk wavefunctions. Boundary conditions imposed on the envelope functions yield a 12X12 matrix for quantum wells,24X24 matrix for superlattices, and from the zeros of its determinant the in plane energy dispersion is obtained as a function of inplane wavevector $k_{//}$. We discuss the mixing between the heavy-holes and light-hole states at finite $k_{//}$.

Introduction

Significant progress in semiconductor physics in recent years has stimulated great interest in the use of high speed electronic and optoelectronics devices such as quantum well lasers, superlattice photodetectors etc...To study the electronic structure of these devices,several theoretical methods such as the envelope function method [1], using the effective mass theory,the tight-binding method [5],and the pseudopotential method [8] have been used.
The envelope function method based on effective-mass theory from Luttinger Hamiltonian is convenient for the description of valence subbands near the center of the Brillouin zone, and expresses the nonparabolicity in k space, causing the mixing of heavy and light holes away from k = 0[2,3].
Our concern in this paper is the valence band structure of Si/Ge semiconductor quantum wells and superlattices,They have recently aroused great interest because of their optoelectronics properties and their compatibility with the mature Si-based integrated circuit fabrication technology. The progress in epitaxy growth technology such as chemical vapor deposition (CVD) and molecular- beam epitaxy(MBE) have made new Si/Ge alloy materials potentially useful optoelectronics properties.
We use six-components envelope function method to study the valence subband structure of semiconductor quantum wells and superlattices.
The Si/Ge semiconductors have a valence band maximum at the Γ point, similar to

EMPIRICAL AND THEORETICAL FOUNDATIONS FOR A TWO-DIMENSIONAL NON-HOMOGENEITY DETECTOR FOR THE RADAR PROBLEM

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Abstract

We are interested in target detection and the radar problem. We looked at i.i.d. data generated by MATLAB and developed a nonparametric test statistic to test for homogeneity in two dimensions. Additional MATLAB programs were written to facilitate this analysis and a method was shown to develop tables for the statistic.

MRF SEGMENTATION FOR FEATURE EXTRACTION IN SAR CHIP CLASSIFICATION

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Abstract

DARPA's Moving and Stationary Target Acquisition and Recognition (MSTAR) program has shown that image segmentation of Synthetic Aperture Radar (SAR) imagery into target, shadow, and background clutter regions can be a powerful tool in the process of recognizing targets in open terrain. Unfortunately, SAR imagery is extremely speckled. This impulsive noise can make traditional, purely intensity-based segmentation techniques fail. Introducing prior information about the segmentation image, such as its expected "smoothness" and anisotropy, in a statistically rational way can improve segmentations dramatically. Moreover, maintaining such statistical rigor throughout the recognition process can make combining multiple sources of information straightfoward.

To this end, I introduce a Bayesian approach to image segmentation of MSTAR target chips based on a statistical observation model and a Markov Random Field (MRF) prior model. I then compare the results of this segmentation approach those from the MSTAR program and from human segmentation. Despite little optimization of the associated parameters, the Bayesian approach compares favorably to the MSTAR approach, opening a host of statistically based options for SAR image segmentation.

Parameter Estimation for the Tailless Advanced Fighter Aircraft (TAFA)

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ABSTRACT

The goal of this summer research was to investigate the implementation of an online parameter estimation methodology for the Tailless Advanced Fighter Aircraft (TAFA). It was determined that the current in-house parameter estimation methodology for reconfigurable flight controls will require modifications in order to obtain reasonable estimates of the longitudinal stability derivative. The crux of the issue is that the longitudinal stability derivative varies rapidly with angle of attack, probably due to the canard influence, which is a unique characteristic of this aircraft. Furthermore, the control law design tends to reduce the stability derivative signature. A proposed modification would use the control law design canard preference to produce an equivalent pitch acceleration model for identification. The focus audience of this report is Air Force personnel who will continue to pursue this research.

CHARACTERIZATION OF SPATIAL LIGHT MODULATOR FOR ABERRATION COMPENSATION OF SEVERELY DISTORTED PRIMARY MIRROR

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Abstract

Spatial light modulators are used in a wide variety of applications ranging from optical computing to display. The application that is of interest for this report is that of real-time holography. A system architecture has been developed that uses a spatial light modulator as a real-time holographic element in a telescope system to perform adaptive optical correction of primary mirror distortions. This allows a less expensive, lightweight primary mirror to be used with little or no degradation of the resulting image. The spatial light modulator is the key element to this system. A phase conjugate projection system is also being investigated for beam collimation/projection applications using a similar inexpensive, lightweight primary mirror.

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

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Abstract

Induced transmittance of laser eye protection served as the research focal point. Twelve samples of Laser Eye Protection (LEP) underwent tests to detect induced transmittance. The laser configuration delivered ultrashort pulses at 800nm to the samples. Energy generally varied from 5.0E-8 to 6.0E-5 Joules and pulses were typically in the 90 - 130 femtosecond range. The experimental results revealed that no samples exhibited induced transmittance with satisfactory certainty. Some examples did show a decreasing pattern of optical density, but the variation in optical density was insignificant.

SUBJECTIVE ASSESSMENT OF DIGITAL INFRARED IMAGES

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Abstract

Several sequences of infrared images taken from an airborne infrared sensor were ranked in order from best to worst by five observers. They were ranked according to erratic noise content. The results were then correlated with an objective assessment of the same sequences of images. This was to observe how similar or how different the quality of a machine vision system is to a human's vision.

GALLIUM DIFFUSION ON THE SURFACE OF GALLIUM ARSENIDE

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Abstract

Gallium diffusion on the surface of Gallium Arsenide was studied. This process is necessary for the useful production of a growth model for Molecular Beam Epitaxy. Crystal growth was studied through Molecular Beam Epitaxy at high temperatures, in near vacuum. The energy of the Beta 2x4 surface was calculated through minimization of the surface and subsequent layers of bulk Gallium Arsenide. Surface structures such as the Beta 2x4 and the C 4x4 were studied using MSI's Cerius 2 program. The electron counting rule was studied, and used to test surface stability. Using the Fortran 90 programming language, an electron counting rule program for Gallium Arsenide structures was created for use by researchers. These methods combined allowed for quick results of structures over long time scales. While not as accurate as time consuming ab-initio calculations, they do allow for reasonable results over time.

My Summer Tour
at the
Air Force Research Laboratory

Jeffrey S. Becknell
Beavercreek High School

Abstract

My summer tour was at the Air Force Research Laboratory, specifically the Air Vehicle Simulation Group. This group was responsible for the simulation of research and development aircraft. When I started to work, they were working to acquire a new visual display system. I performed many tasks while on my tour at the Air Force Research Lab. Among these are working on the new visual display system, the plotting of data, the drawing of simulator diagrams, web authoring, and data cataloging for the reference library.

TRACE METALS ANALYSIS OF SOIL AND WATER AT MUNITIONS TEST SITES

Beth Ann Behr
Niceville High School

Abstract

Over the past 60 years, Eglin Air Force Base has conducted munitions testing not only to test the capabilities of new munitions, but also the longevity of munitions stored in arsenals. When munitions are detonated or fired, various metals from components and casings impact the test range environment. Over time, metal fragments become part of the soil profile. Constant munitions testing at Eglin AFB test sites exposes the environment to different metals it would not normally be exposed to. The possibility exists that these metals could reach very high concentrations and eventually contaminate the soil. In order to prevent unacceptable contamination, test sites are being monitored for high concentrations of metals.

Two test sites (C-64A & C) in the Advanced Warhead Evaluation Facility (AWEF) were chosen as monitoring sites for this project. Water samples were taken from the six wells located around C-64C, and 45 soil samples were taken from site C-64A. The soil and water samples were then analyzed with an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

The results of the analysis show that neither C-64A nor C-64C contain unacceptable amounts of the metals analyzed. The results from this analysis will be used as a base line for comparison for future monitoring programs.

Computer Animation of Global Search Algorithms

Kari Berg (Student Researcher)

Holland Patent High School

Abstract

The assigned summer project was to create animations to demonstrate how the global search algorithm solves the air/sealift scheduling and the quasigroup completion problems (QCP). The air/sealift scheduling problem schedules cargo on planes and ships. Because of the complexity and branching factor of the air/sealift scheduling algorithm, creative ways of representing the steps in the algorithm had to be used. The air/sealift scheduling problem is very significant to the Defense Transportation System for military deployments and employments during the response to a crisis situation.

The quasigroup completion problem is a "N" by "N" Latin square filled with colors (see figures) so each color is not repeated in any row or column for a possible solution. Some of the squares are preassigned colors and the algorithm tries to complete the problem. The quasigroup completion problem was animated as a search tree for a 2 by 2 and 3 by 3 Latin Square. The quasigroup problem has been used to unlock some of the secrets of computation. Macromedia Director was used for the animation and Adobe PhotoShop was used for some of the graphics.

SCANNING AND ORGANIZATION OF REPORTS

Christopher J. Broscious
Mosley High School

Abstract

At the soils lab of AFCESA (Air Force Civil Engineer Support Agency), there has been an increasing need to put their Airfield Pavements Evaluations (APE) onto a computer. These evaluations run back as far as 1944 and as soon as 1996. Once these reports are on a computer they can then be transmitted to others at the click of a button through the Internet and may also be edited without damaging the original document. Also new technology has been brought out that will allow a computer to pick out the words from the pictures and spell check those words also.

VISUALIZATION OF MULTIPATH WITH POV-RAY

Todd S. Burnop
Oriskany High School

Abstract

Using rendering software known as POV-Ray to simulate amounts of multipath that occur at test sights like Newport New York, and Stockbridge New York. By obtaining modeled data of the Newport site and importing said data into POV-Ray; virtual models of the site could be created. By adding actual aircraft data as well as simulated radio signals multipath occurring at the Newport sight could be visualized. This data can then be used to limit the amounts of multipath coming from ground positions by the addition of reflection fences and/or ground resculpting.

COMPARISON OF OBJECTIVE AND SUBJECTIVE ASSESSMENT OF DIGITAL INFRARED IMAGE SEQUENCES

Sarah Childers
Centerville High School

Abstract

Objective and subjective quality assessment of digital infrared image sequences is compared. In order to do this one must choose sequences of infrared images to evaluate as well as a variety of methods for the computer to determine image quality. Then the computer and the observers can start ranking the images. In the end, we can compare and correlate theresults.

The correlation coefficients between pairs of observers show how similarly people rank the same image sequence. The correlation coefficients from the subjective and objective results show how closely objective assessments match subjective assessments.

IMAGE ANALYSIS OF POLYMER DISPERSED LIQUID CRYSTALS

Daniel Cleyrat

Abstract

I was presented with the task of writing specialized macros for Optimas, an image analysis software package. Images of polymer dispersed liquid crystals (PDLCs) needed to be analyzed to measure certain aspects of the liquid crystal regions such as size, diameter and length along the x and y axes. This all needed to be automated so that anyone could come in and pick up the manual and analyze an image in a small amount of time. Because Optimas has such a rich macro language it was an ideal program to use.

TENSILE PROPERTIES OF ALIGNED CHOPPED-FIBER CARBON FIBER REINFORCED POLYMERIC COMPOSITES

Amanda J. Colleary

ABSTRACT

The tensile properties of polymeric composites reinforced with aligned, chopped carbon fiber tows were measured and compared to corresponding composites reinforced with continuous fibers. Panels were created using uni-directional tape and making small incision according to a defined template IM7/977-3 and AS4/APC2 were the two materials used in the study. Specimens were cut from each panel and tested to failure to determine tensile strength and modulus. Significant differences were shown in strength and modulus between the two material systems. Another factor was the fiber alignment - a 0° panel outperformed a ± 5° panel in modulus, and contrary to what we had hypothesized, the ± 5° panel had the greater tensile strength. These experimental results are below the 80% strength translation goal expected based on data from other researchers, but meet or exceed the 90% modulus translation goal.

A STUDY OF PROGRAMMING AND IVIEW 2000

Stefan Enjem

Whitesboro High School

Abstract

I have studied the X-Windows libraries and JavaScript over the summer of 1998. I used X-Windows to manipulate the program IVIEW 2000. IVIEW 2000 is a government program that is used to visualize air engagement simulations and track certain objects within a graphical interface. The intention of this project was to change the original 2-Dimensional view into a 3-Dimensional view, to be used with polarized glasses. Although my time expired before the project was completed, I have gained knowledge in certain subjects of programming that can be used in my future.

A STUDY OF ACOUSTIC AND SONIC FATIGUE

Frank J. Fasano III
Centerville High School
Centerville, OH 45459

Abstract

I studied the results of very high acoustic levels on the structure of airplanes, and I also studied sound waves. To generate high acoustic sound waves, the laboratory used an acoustic chamber where the structure would be put in the chamber. Experimental indicated that large structures (complete missiles) can be tested at continuous sound fields as high as 172 dB (1.2 psi of dynamic pressure), and the experiments also indicate that serious damage can be caused to structures, systems, and components due to the high level of noise. Sometimes the damage is so severe it can cause instantaneous failure in areas that cannot withstand high acoustic structures.

Michael Favata

Abstract

This report details my activities at the Rome Research Site of the Air Force Research Lab to develop web pages. I developed my Web Tools program to aid me in my task of creating web pages more efficiently. Making use of a 3 dimensional rendering program dramatically increased the quality of the graphics I created for the pages. I also expanded my programming knowledge by learning a portion of Java during my tour.

CHARACTERIZATION OF THE CO_2 LASER

Lauren A. Ferguson
Moriarty High School

Abstract

A carbon dioxide laser was characterized. To characterize the laser, a series of tests were run to determine the laser's P- branch wavelength capabilities, power vs. temperature relationship, and overall stability. Experimental results indicated that the laser runs more efficiently at lower temperatures. The laser also seems to be more stable at the P(20) wavelength instead of at P(22). The tests also showed that to use the laser in an experimental setup, the laser needed to be refurbished.

COMPUTER SOFTWARE EXPERIMENTATION AND MODIFICATION

Tracey E. Fitzgerald
Port St. Joe High School

Abstract

My objective is to present the reader with details concerning my experiences as part of the high school apprenticeship program. I worked in Pavements and Facilities for eight weeks, dealing with many computer issues that were new and challenging to me. Among these are: utilizing programs such as Microsoft Access, Visual Basic, and PowerPoint; the entering of data by way of a scanner; the importing and exporting of text, tables, and graphics; database design, including forms, tables, queries, and reports; program design, including actual code writing; PowerPoint presentation preparation; DPlot data modification; and last, a greater familiarity with computers in general.

TWO-DIMENSIONAL MULTIPLE-FRAME IMAGE ANALYSIS

Jeffrey L. Friedman
Niceville High School

Abstract

The purpose of this summer project was to begin work on an algorithm that would effectively locate and track a moving target in a sequence of digital radiance images. At completion, this algorithm is projected to be capable of locating moving targets in a high-clutter environment. It will also be fast enough to be implemented in real time. The developed algorithm uses contrast enhancement, edge detection, image differencing, and pixel masking to analyze its input. It currently can track targets in low-clutter environments, but further work will be needed in order to deal with data obtained from a dynamic source (e.g. a moving camera) in high-clutter environments.

FOLLOWER OF
DAN THE "LAN"MAN

Adria D. Gaitros
A. Crawford Mosley High School

Abstract

This year I shadowed a network administrator. This proved a useful learning experience for when I need to fix my own computer. He mentored me in the skills of troubleshooting and how to find my way around a network. Part of my job here was to set up a network help desk and run it while my mentor left for two weeks. He entrusted me to fix all computer problems while he was away. On the side of learning about computers, I also helped in the Technical Information Center. There I spent my time researching for the scientists in the lab and giving them the needed information for their studies. There also were various other jobs that filled my time. The opportunity came up to learn how to make a web site and create one for the office I worked for. One administrator gave me the task to learn how to use the office's database and create a short cut sheet for those who did not know how to maneuver their way around. This job gave me the experience needed to ready myself for a job in the future.

The Study of United States Cellular Technology

Michael Galime
T. R. Proctor High School

Abstract

Cellular Technology was researched and studied. The three main the three main technologies studied were AMPS (Advanced Mobile Phone Service), GSM (Global System for Mobile Communication), and IS-95, a code division multiple access based standard. The research was done mainly with the use of books, articles via the Internet, and by visiting cellular providers in person. In the research the technologies were compared to see which one had the better advantages and prevail in the long run as the new standard. IS-95 was found to be the best.

In addition to the research I started to explore MATLAB®. I was introduced to the program in the beginning of my research and was taught how to write my own programs and presentations using MATLAB®.

SUMMARY OF SUMMER WORK ON A SEARCHABLE DATABASE THAT CONTAINS THE PRSL'S TECH REPORT LIBRARY

David Greenwald
Oakwood High School

Abstract

A database that contains most (200+) of the tech reports in the PRSL's tech report library was created. This report briefly summarizes what I did and how the database will be used in the future. This report also includes the Procedure Manual for Personal Librarian and the Access Based TR Entry system.

SATELLITE ORBIT DETERMINATION FROM OPTICAL SIGHTINGS

Kevin L. Grimes
Albuquerque Academy

Abstract

An investigation of the nature of satellite orbits was conducted. Based on time-exposures of satellites taken from a remote telescope, and mapped against a star background, angles for the topocentric right ascension and declination system were obtained. An investigation of the methods for analyzing this data was then conducted. Based on the angles, an existing orbit could be improved through a least squares polynomial, or an entirely new orbit could be calculated. In either case, a model for predicting the position of a satellite at a future point is created, affecting applications such as remote signal interaction between the satellite and a point on the surface of the earth.

THE SYNTHESIS OF MONOMER FOR USE IN WATER-SOLUBLE RIGID-ROD POLYMER SYSTEMS

Maneesh K. Gupta
Beavercreek High School

Abstract

2, 5-Disulfoterephthalic acid was synthesized for use as a monomer for elaboration into water-soluble rigid-rod polymer systems. The monomer was synthesized via a four-step methodology. Diethyl 2, 5-dihydroxyterephthalate was converted to 2, 5-dimercaptoterephthalic acid via the formation of the O, O-bisthiocarbamate followed by thermal rearrangement to the corresponding S, S-bisthiocarbamate which was hydrolyzed by alkali to the desired aromatic dithiol dicarboxylic acid after acidification. 2, 5-Dimercaptoterephthalic acid was oxidized to the desired 2, 5-disulfoterephthalic acid monomer using aqueous H_2O_2/HCOOH conditions. All the reactions afforded high yields rendering this a feasible route for the formation and isolation of the desired monomer.

HIGH DENSITY POLY-ETHYLENE "WAFFLE" LINER STUDY

Trenton A. Hamilton
Rocky Bayou Christian Academy

Abstract

In the increasing effort to improve warhead characteristics, the concept of fragmentation control has become an important issue. Conceptually, this technique would be capable of producing a high percent of a specified sized fragment at any given time. This enhances the warhead fragment effectiveness by twofold. Initially, it would help by cutting the large, bulky fragments into more fragments of a medium size. Secondly, it will amplify the performance of the warhead by converting many of the abundance of small fragments into larger, more usable fragments. In this study, a computer simulation using a Hull hydrocode was accomplished followed by sub-scale testing to determine the effectiveness of a High Density Polyethylene (HDPE) warhead case liner. In the fabrication of this liner, a HDPE sheet of specific thickness (τ) is cut into a "waffle" pattern, containing numerous staggered diamond cuts. Variance of the diamond incident angle (ϕ), band length (λ), and band width (β) allow for specified size case fracturing and should optimize the capability of controlling fragmentation. Fragmentation results indicate initial success in controlling case fracture.

DEVELOPMENT OF DVAT:
A DIMENSIONALLY VARYING ANALYTICAL TOOL

Neil N. Harrison
Walton High School

Abstract

A plotting program was created using Visual C++. This program, Dimensionally Varying Analytical Tool (DVAT), plots X-Y data in relation to some other variable, such as time. To display the sets of X-Y pairs as changing in relation to a third variable, each set of X-Y pairs is graphed in succession, creating a moving line.

One or two sets of data can be observed at one time, and the user can control the speed of display and other aspects of the plot. Color of the line can be linked either to Y values, as positive and negative, or to X values, with five variable ranges. An output file option is also available, which provides information such as extrema, integrals, and average y value for each set of X-Y pairs. DVAT can also create derivative files, with respect to X or T, that can then be read back in as input files.

JavaScript Applied to Intranet Documents

William B. Haynal
Spring Valley Academy

Abstract

This summer research program involved creating JavaScript-enhanced intranet documents for the Policies and Procedures section of the expanding ML intranet site. That included studying books based on JavaScript and writing small sample programs to gain a working knowledge for syntax and a feel for style. After a working knowledge of JavaScript had been attained, work commenced on the production of JavaScript-enhanced intranet documents via embedding the JavaScript source code directly into the Hypertext Markup Language (HTML) documents.

REALISTICALLY DUPLICATING THE APPEARANCE AND INTERFACE OF ACTUAL UAV DEMPC EQUIPMENT ON A DESKTOP PC

John T. Hereford
East Central High School

Abstract

Study was focused on the task of duplicating the mission planning interface of the existing Uninhabited Aerial Vehicle (UAV). The controls of the interface were first studied, and then guidelines were drawn out to ensure key elements were maintained. A program was then written on a desktop PC which mimicked the basic behavior of the DEMPC (Data Exploitation Mission Planning Communication) station. This basic model was then expanded to incorporate all aspects of the actual DEMPC station. Each individual element was added so that it closely resembled the actual control interface. The end result was an accurate model of the existing interface which will be used in studies of how to improve both efficiency and ease of use. This task will likely yield excellent results due in part to the efforts made toward maintaining a close resemblance to actual equipment.

OPTIMIZING FORMULATION OF AFFF-EMB USING MIXTURE DESIGNS AND RESPONSE SURFACE METHODS

Jessica L. Hill

Port St. Joe High School

Abstract

Mixture designs and response surface methods can be used to formulate the aqueous film formulation environmentally more benign (AFFF-EMB). A quadratic model was used with four components: water, the organic solvent, hydrocarbon-surfactants, and fluorocarbon-surfactants. The design points were chosen by a software program called Design Expert by Stat Ease, Inc. The program indicated that there was a need of ten mixtures to support a quadratic model plus five replicates and five goodness-of-fit mixtures for a total of twenty.

Each mixture was subjected to six experiments: surface tension, interfacial tension, foam expansion ratio, and a quarter drain time. The results of these experiments lead into the four response surfaces. With the response surfaces optimization can begin and the "sweet spot" can be found. The "sweet spot" is a mixture that will contain what is needed for the correct results. This would be the shorter process of the technique that will be used to compose an AFFF-EMB.

THE DEVELOPMENT OF A GUIDANCE LAW USING OPTIMAL CONTROL THEORY

Taylor L. Hughes
Niceville Senior High School

Abstract

The development of an optimal controller used for missile guidance was studied. Calculus of variations, basic missile guidance, and optimal control theory were all thoroughly researched so that a guidance law could be generated. Design methodology was agreed upon along with the system's complexity. Dynamics equations were produced and tested for controllability in the beginning of the process. The dynamics were linearized and then solved for using the method of linear quadratic regulators and transition matrices. The optimal controller was derived and identified.

MSX-OBSERVED OBJECTS WITH UNUSUAL INFRARED EMISSION

Andrea Hunt
Phillips Academy

Abstract

The MSX measurements of the infrared emission of point sources in the galactic plane were examined. Color-color diagrams were created and used to locate point sources with unusually high infrared emission levels. Point sources possessing unusual infrared emission levels were identified by their abnormal positions on the color-color diagrams. A search of the SIMBAD database was conducted using the MSX-recorded coordinates. The references to each object provided by SIMBAD were researched in an attempt to find an explanation of the unusually high levels of infrared radiation emitted by these objects. These reasons, when found, are discussed.

A STUDY OF WIND TUNNEL TEST PROCEDURES

Joshua B. Jamison
Dixie High School

Abstract

The study of aerodynamics on airplanes is becoming more crucial in design and the methods of testing new models are advancing to meet those needs. I spent most of my research time working with a new method that dealt with the use of pressure sensitive paint. This method allowed us to see millions of pressure points on the model, rather than just a few hundred points, which was a maximum with the older method of using pressure taps to measure atmospheric pressure at certain points on the model.

A Web Page for MNAL

Ryan A. Jones

ABSTRACT

A publicly accessible world wide web page was constructed for the Lethality and Vulnerability Branch. This web page provides the public, as well as the Department of Defense with useful information about the branch. The web page gives MNAL the capability to interact more effetely with the military and public communities. This capability will prove invaluable in today's information age atmosphere.

The site was constructed using several software packages. Netscape Composer was the primary construction tool. The Windows text editor Notepad was used for specific editing of the HTML source code. Paint Shop Pro was used specifically for developing and editing graphics.

The Air Force Research Laboratory has several regulations that all lab web pages must comply with. These regulations include a navigational side bar, a uniform background image, and regulations on the load time of a page. As long as the regulations are met, each web page can have its own look. The purpose of the regulations is to provide a common look and feel among all AFRL web pages.

A Munitions Directorate web page can not be released until it passes a public affairs approval procedure. The purpose of this procedure is to insure that all data being released has been approved for public release. The approval procedure will also insure that no false information is released. Branch approval, division approval, AFRL regulation approval, chief scientist approval, and Public Affairs Office approval are the five main steps in the approval procedure.

After the web page has been approved and is on-line, it must be maintained. The data on the page should reflect any changes taking place inside the branch. As new projects or testing take place, the web page should provide updated information about those programs. A web site with out dated information is virtually useless to the viewer. The web page will be a success if it provides useful information to those who whew it.

A STUDY IN THE SELECTIVE HEATING OF THE RAT ANATOMY

Kathleen Kao
Keystone High School

Abstract

A method by which to selectively heat a specific part of the rat brain, while maintaining a normal core temperature, was studied. The results of this study are to be implemented in an exercise experiment involving rats and the correlation between brain temperature and exhaustion. To accomplish this kind of selective heating, a probe was designed to be inserted into the hypothalamic region of the rat's brain and to heat that area without raising the rat's core temperature. Hot water circulated through the probe provided the necessary heat to raise the brain temperature to 42°C, which had been noted in previous experiments to be the temperature threshold of exhaustion. While maintaining body temperature at normal levels, the sole effect of brain temperature upon fatigue in rats can be observed.

Multiple studies at Wright Patterson Air Force Base

Kevin S. Katerberg
Dayton Christian High School

Abstract

For the first part of my summer here I worked with Jess Underwood on some odd jobs that he had piled up for someone to do. The main project that I did with him was to program an automatic dialer, which in the cause that an alarm for overheating or an alarm for humidity should go off this system would dial numbers of the people of people who would then come in and fix the problem. This project proved to be very tedious since alarms would sound even though there was no reason for the alarms. After two weeks of working on this project I was shifted to a different project.

This project was to test a compressor fan blade to fin its resonance frequency and its modes. On this project I worked as on team with Ailean Gracia so the report on that was written up on her computer so I am just able to put a copy of it in this report. The report for this project starts on page 3.

After completing that project I moved on to a project about the aerodynamics of a cooling fan blade. I tested a fan blade to find how the air circulates after coming off the blade. A short report follows on page 14

The Development of a Search Engine for an Intranet

Joseph M. Kesler
Carroll High School

Abstract

The work done this summer consisted of learning the Perl scripting language and then using it to devise and write a search engine for an intranet currently being developed. The first part of the work this summer was reading and studying books on Perl and CGI scripting. In addition to this, learning the UNIX operating system was a requirement, as was achieving a basic understanding of HTML. Once a basic knowledge of the Perl language was attained, basic programs were written in order to become familiar with syntax, structures, and the like. After a short time, work on a basic skeleton engine was begun, which later developed into the engine now in place.

Campaign Assessment

III. Colin M. Kinsella
Oneida High School

A. Abstract

The beginnings of this project were for me to learn how to do some modern programming in C++. The Microsoft Development Studio was the ideal solution to this by using the Microsoft Foundation Classes. The Microsoft Foundation Classes are Microsoft's own way of adding an easier way to write Windows programs without having to write your own reusable code for objects such as scroll bars. The semi-final product became a usable program across the Windows 95 platform with the look and feel of the Modern User Interface. What came out of this program was a great learning experience that will last a lifetime and greater influence on my motivation towards technology.

AN INTERFACE FOR THE AUTOMATED CONTROL OF HEAT TREATMENT FURNACES

Joshua M. Knopp
Carroll High School

Abstract

A program was written to monitor and control up to nine heat treatment furnaces at a time. The program can run each controller in one of two modes. In setpoint mode the controller utilizes fuzzy logic to approach and maintain a desired temperature. In program mode, the user may specify a set of up to six segments, consisting of a setpoint, ramp time, and dwell time. Each segment is then executed in sequence once the command is given. Graphs and log files were added for extensive monitoring capabilities. The bulk of the program is in linking the interface to the appropriate ASCII codes and floating-point or integer values. The program offers an effective, user-friendly interface for control of the heat treatment furnaces.

RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES AND THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

Peter M. LaMonica
Rome Free Academy

Abstract - RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES

HyperText Markup Language (HTML) is a computer language used to make web pages that is written in a text format, but is graphically shown on the Internet. The appearance of the web pages directly relates to the tags you use. Tags can create different text, colors, images, tables, forms, links, and applets. The structure of an HTML file consists of a head and body.

Abstract - RESEARCH INVESTIGATIONS OF THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

SynTactic Analysis using Reversible Transformations (START) is a natural language processing system. This system originated in 1980 by Prof. Boris Katz at Massachusetts Institute of Technology. (MIT; Katz, Boris; www.ai.mit.edu /people/boris/webaccess/node1.html#00010000000000000000) START was put on the worldwide web in 1993. The user can receive information by entering a query in English. The program takes the query, creates T-expressions from the query, and uses these T-expressions to find information in its knowledge base.

REPORT ON THE PUBLICATION OF RESEARCH PAPERS ON THE INTERNET USING HOT DOG PROFESSIONAL 5 AND MICROSFT FRONT PAGE 98

Lauren M. Lamm
Keystone School

Abstract

With the expanding uses of the Internet, scientists are interested in creating databases in which their work can be published that are accessible through computers. The task given was to create web pages out of bound publications using hypertext markup language (html). Two different programs, Hot Dog Professional 5 and Microsoft Front Page 98 were used for comparison against each other, with the two primary web browsers targeted being Netscape Navigator 4.04 and Microsoft Internet Explorer 2.0. In using the two programs, differences in ease of use, options available, and customization became apparent since Hot Dog seemed more oriented towards experienced page designers and Front Page towards beginners in html. It was important also to test pages on different browsers because of differing interpretations of html which allow certain program commands to be effective on some browsers and ignored on others. Netscape and Explorer were chosen because of their wide usage and popularity.

A STUDY OF THE PREDICTION OF PILOT-INDUCED OSCILLATION

John P. Lightle
Tippecanoe High School

Abstract

The phenomenon known as pilot-induced oscillation (PIO) was studied. Data from flight simulations by four different pilots was collected and analyzed. A pilot's "signature" was established by creating a transfer function relating his longitudinal stick force input to the pitch error between him and the tracking task. The results were compiled and examined for trends with pilot ratings and occurrences of PIO. The data analyzed did not reveal a parameter which would predict a PIO, but it may be useful to ensure that misleading data is not included in future attempts to do so.

Introduction

PIO can lead to severe problems. A recent example is the YF-22 PIO crash, seen on national television. PIO can occur in military or commercial aircraft and at almost any time with little warning. It is a problem that is nearly impossible to prevent, so instead a method of prediction is desired. Ground-based simulators have become an indispensable tool in the development of modern aircraft. Using simulation of tracking tasks, PIO in flight can be studied on a wide scale. The data analysis to be performed was to support the theory that simple pilot "signatures" could be derived from the tracking task. These models would then be used to identify parameters that could be used to predict an impending PIO or to explain what combinations of conditions were necessary for a PIO to exist. Power Spectral Densities of the pilot input and the tracking task and their ratios are the key element in this analysis.

Methodology

On 15 December through 18 December 1997, a series of several flight simulations was conducted using four different pilots. For each pilot, a trial was run for three different configurations and seven rate limits. The pilots would try to track a symbol that follows a specific task. The force they put on the stick, the error from where they are and where they want to be, as well as many other values were recorded onto a database. The database was altered so that a frequency data analyzing program, FREDA, could be run on it. FREDA gave a magnitude, phase, and power spectral density (PSD) for each of several frequencies around the range of interest. Graphs of the pilot's power spectral density were created to see at which frequency each pilot was using the most power, which frequency the pilot's power began to roll off, what was the highest frequency the pilot still had regular inputs, and the maximum amplitude of the PSD. In

NEW METRICS FOR MEASURING SEMANTIC RELATEDNESS USING ROGET'S THESAURUS

Christopher Lipe
Ithaca College

Abstract

New metrics to measure the semantic relatedness of word pairs were tested using Roget's International Thesaurus, Third Edition. The hierarchy of Roget's was turned upside down, and this new view of the hierarchy lent itself well to the new metrics. The large surprise, though was the True / False metric. It gave a one to words who shared a category. This metric performed better than expected because of the nature of the list of word pairs. The first fourteen word pairs were given high marks as to their relatedness; the last fourteen were given low marks. Accordingly, more testing needs to be done with more word pairs.

INFRARED CHARACTERIZATION OF PHOTOVOLTAIC SEMICONDUCTIVE JUNCTION DEVICES

Alex Lippert
Choctawhatchee High School

Abstract

The purpose of this project was to study the electrical properties in response to an IR signal of several different bilayer semiconductive junctions, primarily heterojunctions between indium-tin-oxide and nanoparticulate silicon embedded in a polymer matrix. This was done using a black-body source producing an IR signal. None of the devices except for the amorphous silicon showed any sensitivity to the infrared spectrum. The lack of IR sensitivity is indicative of poor IR transmittance for the clear material attached to the ITO, and the need for an inherently conductive polymer matrix in lieu of the insulating one used in these experiments.

THE CHARGING AND DISCHARGING OF SPACECRAFTS: AN INTRODUCTION

Mary H. Ly
Billerica Memorial High School

Abstract

This report will present an introductory overview pertaining to spacecraft charging and discharging. If an object is subjected to an unequal flux of ions and electrons, it develops a net charge. The surfaces of the spacecraft, if charged to different potentions, result in differential charging. The current balance determines the charging state of the spacecraft in a steady state. Spacecraft in the geosynchronous region are of most concern since there are many satellites in this region where most spacecraft charging occurs. Options exist that can prevent and mitigate the charging of spacecraft. Photoemission and emissions of secondary and backscattered electrons often provide important currents. Beam emissions and other mitigation techniques also reduce the level of charging.

ANALYSIS OF ERROR FREQUENCIES OF AN ON-LINE PEN-INPUT HANDWRITING RECOGNITION SYSTEM

Christina R. Maimone
Chaminade-Julienne High School

Abstract

The performance of an on-line pen-input handwriting recognition system, Communication Intelligence Corporation's Handwriter ® Recognition System, was studied. Input data was developed to test character recognition errors, case errors, word recognition errors, and editing capabilities of the system. Subjects were recruited to enter the data into the computer. The data was then stored, and the errors were calculated. As expected, the error rates for individual characters varied, as did the error rates between subjects. The overall character recognition error frequency rate for individual characters was 6%. The overall word recognition error frequency, including all errors, was 19%. The average error correction time was 11.6 seconds per mistake. The results indicated that both the recognition performance and the editing capabilities of the software were less than desired for use in a current logistics application.

REDUCTIVE DEHALOGENATION OF TCE, CARBON TETRACHLORIDE, AND EDB BY HUMIC-METAL COMPLEX

Lisa A. Mattingley
Mosley High School

Abstract

The reductive dehalogenation of TCE, CT, and EBD by humic-metal complex was studied. These halogenated hydrocarbons have contaminated both aquatic and terrestrial environments. The reduction of these compounds in nature is a very slow reaction. However, with the addition of an electron mediator the reaction is considerably sped up. In this experiment Metal-Humic Complexes were used as the electron mediator. Results indicate that Nickel-humic complex and Copper-humic complex are effective in reducing TCE, CT, and EDB.

SOFTWARE ANALYSIS OF EEG WAVEFORMS AND REAL-TIME MEASUREMENT OF SUBJECT CONSCIOUSNESS

Edwin McKenzie III
Douglas MacArthur High School

Abstract

Research into the effects of high G-forces on rat EEG's led to the discovery of a connection between the power of EEG waves near 40Hz and the level of subject consciousness. This indicator, along with other frequencies present in the brain, was used as the basis for a real-time software consciousness metric. The software was designed using LabVIEW instrument engineering technology. The level of abstraction that is provided by the LabVIEW environment allows the EEG analysis software to be interfaced with a variety of data acquisition boards and vital signs monitors.

A STUDY OF PILOT-INDUCED OSCILLATION TENDENCIES

Daniel B. McMurtry
Northmont High School

Abstract

Longitudinal pilot-induced oscillation (PIO) tendencies were evaluated on ground-based simulators. The results were compared to a model taken from the HAVE PIO flight test program. HAVE PIO tested a variety of aircraft dynamics on the NT-33A variable-stability landing task in both simulation and flight. Comparisons were based on Cooper-Harper ratings (CHR), PIO ratings, and pilot comments. Trends were examined and will be used to formulate concepts to make ground-based simulators a more effective tool for detecting PIO.

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

Charles H. Mims

The University of Texas at Austin

Abstract

Induced transmittance of laser eye protection served as the research focal point. Twelve samples of Laser Eye Protection (LEP) underwent tests to detect induced transmittance. The laser configuration delivered ultrashort pulses at 800nm to the samples. Energy generally varied from 5.0E-8 to 6.0E-5 Joules and pulses were typically in the 90 - 130 femtosecond range. The experimental results revealed that no samples exhibited induced transmittance with satisfactory certainty. Some examples did show a decreasing pattern of optical density, but the variation in optical density was insignificant.

Camden Mullen
Del Norte High School

Abstract

The Radiometric and Radiation Characterizations of Rockwell Science Center Detectors were studied. Two Photovoltaic HgCdTe detectors from the Long-wavelength Low Background Uniform Mercury Cadmium Telluride (LLUM) program were studied. The format of each consisted of several variable area conventional and lateral collection diodes and lateral collection arrays. The devices were identical in structure and format except one had an anti-reflection (AR) coating. The devices were held at a constant temperature and subject to radiometric and electrical characterization in both benign and radiation environments. The measurements performed in a benign environment were spectral and optical response dark and optical current-voltage.

BRL-CAD MODELING OF A HARDENED FACILITY

(The Creation of a MEVA Compatible Model)

John D. Murchison
Fort Walton Beach High School

Abstract

Lethality assessment tests are to be conducted upon a test structure representative of a hardened facility. As part of the pre-test predictions phase of this project, it was necessary to create a model of the facility for use with the Modular Effectiveness/Vulnerability Architecture (MEVA), enabling a variety of possible test parameters to be simulated. The model was constructed in BRL-CAD from blue prints provided. After the model's completion it was tested for compatibility with MEVA and was found to be a compatible target file within MEVA's Target Interaction module. Additionally, a three-dimensional first person model of the facility was created for the purpose of enhancing presentational visualization of the structure and the placement of various explosive charges, instruments, and gauges.

A STUDY IN COMPUTATIONAL CHEMISTRY

Nina Natarajan
Beavercreek High School

Abstract

The basics of computational chemistry were studied and a good understanding of running computational chemistry programs and the models used was gained. To perform computational chemistry calculations, molecular mechanical and quantum mechanical programs were used. Two applications of computational chemistry were examined. Three porphyrins (ethylated (EP), tetra phenyl substituted (TPP), and with both substitutions (ETPP)) were examined in order to understand the effects of substitution on the basic framework. In addition, the molecular geometry and electronic structure of Congo Red, a dye used as a biological stain, was investigated in an effort to understand the dye properties of the material for two different forms.

BIOMIMETICS:
EMULATING THE HUMAN VISUAL SYSTEM FOR MILITARY APPLICATIONS

Joshua B. Nelson

Abstract

The application of biomimetics (the science of mimicking biology) in signal processing was studied. This study looked to further the information available using the knowledge concerning human vision processes that has already been discovered. Using Matlab[c][MAT95] the study constructed many algorithms to test different hypotheses pertaining to biomimetics. The main hypothesis in biomimetics is that models of vision systems can be emulated to our benefit in military systems. Our goal this summer was to work toward proving that a Biomimetics-based algorithm is superior to other systems. This was achieved by first working in different directions and establishing other theories concerning the human visual system and signal processing.

Building a Building Database

Eric C. Nielsen
Xenia Christian High School

Abstract

The building of a database is an important thing. To build my database, I used Microsoft Access and Microstation 95. I used Microstation to do the blue-printing (changing the layout schematics of building 620). I imported portions (sections or sectors) of the floors in building 620 and then in Access I took every room and hallway and put a mslink in them. This was to link them to the other half of the database (which was built by my boss before I came). This database was built to make it easier for people to determine where someone worked, their rank (designation), and other information about the rooms. With this database you would be able to locate anyone's office or any office and who works in it by either clicking on the room or by selecting the person from a list and then the database would bring up where they work. This database is the best way in my mind to locate rooms and the people or items in them.

UPDATING THE INVENTORY AND CREATING HETEROGENEOUS SYSTEM

Bruce Wester Nolte, Jr.
A.C. Mosley High School

Abstract

As a student in the High School Apprentice Program I found it to be a great learning experience. During the summer I took a physical inventory of all the in-house chemicals in all six of the different labs. I was then responsible for updating the inventory in the Microsoft Access database. I also helped create a heterogeneous system of sand, so that DNAPL's can be studied closer.

A STUDY OF DNAPL'S IN A HETEROGENEUOS SYSTEM

Brendan O'Sullivan
Mosley High School

Abstract

The movement of a chlorinated solvent in a heterogeneous system is the object of our study. A sand tank, 2 m x 0.5 m 1.02 m, was filled with three types of sand in two patterns. The two patterns were alternated every other layer to provide a heterogeneous system for the experiment. Each layer is 10cm tall by 20cm wide and varied from 25cm deep to 50cm depending on the pattern. Sample ports were added as the layers were poured into the tank. When all ten layers have been poured into the tank, a chlorinated solvent will be injected into a particular area of the tank. Flooding the tank with a slight current going from left to right with de-ionized water begins the experiment. The tank will remain flooded for 6 to 18 months and the movement of the chlorinated solvent will be monitored. A mathematical model of the movement will be developed.

PROTECTING AIRCRAFT SURFACES: A STUDY OF ABLATIVE MATERIALS AND THEIR PHYSICAL LIMITATIONS

Jeremy Olson

Centerville High School
500 E. Franklin Street
Centerville, OH 45459

Abstract

As part of a larger investigation into the possibilities of protecting aircraft from various high temperature conditions with ablative and intumescent materials, this study has sought to determine the physical limits of these substances. For these tests, several heat-resistant materials from assorted sources were used to coat aluminum, titanium, graphite epoxy and bismaleimide panels. One group of these panels were immersed in water and measured to determine the absorbtion and deformation of the coatings. Another set of panels were subjected to rapid temperature cycles and similar observations were taken. Initial data indicates that several of these materials will be unsuitable for use in high-performance aircraft, and suggests further investigation into the properties of several others. Most materials, however, showed little or no change during the test periods. This study will continue by investigating the effects of several aeronautical fluids and additional physical stresses on these materials.

A STUDY OF HYPERSPECTRAL IMAGING (HSI)

Disha Jayantilal Patel
Kettering Fairmont High School

Abstract

Research was done on hyperspectral imaging (HSI). HSI is a fairly recent, technological advancement in the research and development field. HSI uses hundreds of contiguous, discrete spectral bands at a resolution of 5 to 10 nanometers (nm) in order to identify and discriminate targets from their backgrounds. HSI is commonly used in agricultural and environmental monitoring as well as military target discrimination. The project that was researched dealt mainly with military target discrimination (whether a friend or foe, target typing, mine detection, etc.). The primary purpose of the research was to extract 2x2 pixels from six vehicle targets and from three backgrounds and compare their spectral responses to each other using MATLAB programming. However, before extraction of the pixels could occur, HSI and MATLAB concepts had to be understood. After these concepts were understood, extraction of the pixels and signature matching began. Experimental results indicated that even though everything was performed correctly, the signature matching process did not come out the way it was supposed to. The two remaining pixels from each graph did not match with their corresponding graph mean. For example, target A sample did not match with the target A mean. However, even though errors hindered the research, progress was made in the areas of learning MATLAB, learning how to use HSI imaging, and learning how to do signature matching. Overall, this research will continue to help in the improvement of HSI technique.

THE EFFECTS OF TARGET MOTION ON CRITICAL MOBILE TARGET ALGORITHM PERFORMANCE

Kathleen A. Pirog

Abstract

The purpose of the Critical Mobile Target (CMT) algorithm is to detect and identify targets in laser radar (LADAR) imagery. A study of the effects of target motion on CMT algorithm performance and accuracy was undertaken. Synthetically generated LADAR imagery containing images of nine targets moving at four speeds was run through the CMT algorithm on a UNIX-based workstation. The data was also hand-truthed for comparison purposes. The results of the CMT algorithm runs were evaluated using segmentation quality, probability of detection, probability of correct identification, and probability of correct identification given detection performance metrics calculated on an Excel spreadsheet. These results revealed that target motion had little effect on either the segmentation or detection portions of the CMT algorithm, but that during the classification stage of the algorithm, the probability of correct identification dropped off slightly when target motion increased. However, poor overall classification results indicate underlying problems, possibly stemming from poorly centered reference models. Secondary processing with new models was not completed, making validation of the results of this study impossible at this time.

WEB PAGE DESIGNING AND ASSISTANT IN OTHER FIELDS

Nathan A. Power

Sensors Directorate

Heritage Christian School

Abstract

I was assigned several different projects this summer. My assignments ranged from pricing specialized equipment on the Internet to using HTML (hyper text markup language) and other tools to design a web page. I was introduced to a variety of new computer programs that assisted me with my work during the summer. MATLAB, Excel, Word 7.0, and Power Point were some of the programs that I used to complete the projects assigned to me.

Introduction

This summer I worked for the Sensors Directorate at Wright Patterson Air Force Base. I was given series of projects to complete as the summer progressed. My first project involved locating and pricing computer components. My next project involved the evaluation of a specialized compiler for use with MATLAB, a matrix manipulation and mathematical imaging software tool. The project that took the most time to complete was the creation of a web page for the branch. I also helped develop a new equipment inventory database and I assisted an Ohio State University professor who was hired for the summer to investigate targeting sensitivities associated with sensor image registration.

Discussion of Problem

THE CONFIGURATION OF ANATOMICAL AND SEAT COORDINATE AXIS SYSTEMS

Kavitha K. Reddy
The Miami Valley School

Abstract

In order to configure the Articulated Total Body (ATB) Model for a particular study, two groups of coordinate axis systems were determined. These included anatomical axis systems for the head and neck segments of the subject, and a seat axis system for the various seat planes found on the seat of the Horizontal Accelerator device located at the Wright-Patterson Air Force Base in Dayton, Ohio.

DEVELOPMENT OF A DATABASE FOR MULTI-SENSOR IMAGERY

David S. Revill
Choctawhatchee High School

Abstract

The task of the program was to create a database for multi-sensor imagery, specifically those used with the Irma signature modeling software. This database was created using Microsoft Access. The primary purpose for creating this database was to facilitate the accessibility of the Irma imagery. The database will eventually be pre-approved for public release so that the images in the database can be easily used for distribution to outside organizations and for presentations and reports. A secondary purpose was for the apprentice to gain familiarity with the properties related to multi-sensor imagery.

FINITE ELEMENT ANALYSIS OF LARGE A FRAME USED IN TEST PROGRAM RoCSS

Christopher A. Rice
Southeastern Local Schools
Wright Patterson Air Force Base, Dayton, OH
Thermal Structures Laboratory

Abstract

A finite element model was built of a support structure for the RoCSS (Robust Composite Sandwich Structure, pronounced "Rocks") test program to investigate the likelihood of failure and excessive motion of the structure. The model was constructed and loaded according to actual conditions specified by the initial concept design. The FE equations were solved for displacement and stress. The maximum allowable stress experienced by the structure at any test condition was chosen to be two-thirds of the yield stress. Resulting displacements and stresses were found to be above the acceptable limits, thus the model was altered accordingly and a new finite element analysis done. Stresses in the second model were acceptable, however deflections were still large. Therefore, an alternate configuration was recommended based upon the understanding of the structure gained during this study.

DEVELOPMENT OF VISUALIZATION MODULES FOR ICEPIC

Kim Robinson
Sandia Prep School

Abstract

AVS/Express Developer's edition, by Advanced Visual Systems Inc. is a complex data visualization kit consisting of several hundred different modules, as well as a couple different editors, each serving a somewhat different function. In order to use this program, extensive training is required. In hopes of making things easier by designing a system with which people not familiar with the specifics of AVS can create visuals fairly quickly, an alternate method was developed. Through the custom designing of new modules specified to do certain things simply, graphs and movies are now considerably easier to make and include their own, easy to use, interfaces. This assists the computationalists at the Center for Plasma Theory and Computation by allowing them to view the results of their simulations more easily.

A STUDY OF THE NECESSITY, EFFECTIVENESS, AND CORRELATION OF ANTHROPOMORPHIC MANIKINS TO HUMANS

Anita Roy
Beavercreek High School

Abstract

Anthropomorphic manikins served as human substitutes to better understand the limits of the human body during the ejection process. Their effectiveness could only be measured through their design and correlation to humans. This essential relationship first called on human misfortunes: accidents, injuries, and deaths. In turn, these substitutes, designed to simulate human limits, provided information not feasible for normal human subjects; this gave insight to the betterment of human testing, advancement, and changes required in the ejection seat development.

THE BASIC STUDY AND SEAT STRUCTURE ASSEMBLY OF THE RECLINED EJECTION SEAT

Monica Roy

Abstract

The Reclined Ejection Seat System is designed to fit into Low Profile Cockpits and to provide safe escape during emergencies occurring at airspeeds from 0 to 687 knots at altitudes form sea level to 50,000 feet. In order to comprehend the importance and amazement of the reclined ejection seat system, it is of first priority to learn the seat structure assembly. This necessary equipment is composed of two major subassemblies: a seat bucket structure and a headrest assembly.

A REVIEW OF THE DEVELOPMENT OF EFFICIENT HELICOPTER ESCAPE SYSTEMS

Sanjida S. Saklayen
Centerville High School

Abstract

The development of efficient helicopter escape systems was reviewed. Through a general study of several technical reports, it was learned that rotary wing aircraft escape systems had not been developed until just two or three decades ago, as opposed to fixed wing aircraft escape systems, which were developed much earlier. It was also learned that a main problem considered in the development of helicopter escape systems was the presence of the rotor blades and its potential as an inhibitor to a successful escape. Numerous techniques have been studied, including but not limited to: manual bailout, ejection via ejection seat, extraction, and collective systems, such as total aircraft and capsule systems. In studying these techniques, feasibility, cost effectiveness, repeat success rate, human psychological factors, and other issues were considered. The Russian Ka-50 "Hokum" military helicopter, recently developed, is also reviewed, as it is the only operational military helicopter in the world to employ a fully-functional blade severance ejection system. This paper discusses positive and negative aspects of each type of helicopter escape system studied. The conclusion addresses the future of escape technology as well as a mention of the author's experience in the high school apprenticeship program in which she was involved.

Abstract: The Basics Of My Job Were:

- to update the current Rome Labs web structure to fit a template an thus end up with a universal "look and feel"
- to create any new pages that are requested
- attend web group meetings and offer suggestions

Methodology:

The majority of my summer work time was spent converting web pages to a common template to standardize the navigation method in the different programs represented on the site. The template also offered time and date stamps, webmaster and POC email, PA numbers, and a choice of a white or a pattern background.

These additions were accomplished by using two methods. The first method was a basic Unix shell script to remove the title and body of a page and place them in a predefined template. Barring the successful completion of this script, the pages would have to be updated by hand. The script failed when the original page was lacking any of the previous standards. A page created by a program such as Microsoft Frontpage™ or Microsoft Word 97™ would fail because of the often-inefficient ways that the pages are generated. Seventy-five percent of updates were thus completed by hand.

Either method chosen was implemented on a Macintosh II series computer used as a telnet client to a Sun Ultra 2 running SunOS 5.6. After being updated each page was checked with multiple Netscape Navigator™ versions on MacOS, WindowsNT, and Unix systems.

Appendix A

An example of a template:

```
<HTML>
<HEAD>
<!--IF Division and Branch Template revision C-->
<!------Replace the web page title within the TITLE tags below----->
<!----------**********************************************---------->
<TITLE></TITLE>
<!----------**********************************************---------->
<!---Insert the one-line description for the web page document----->
<!----------------within the CONTENT quotes below---------------->
<!----------**********************************************---------->
<META NAME="description" CONTENT="">
<!----------**********************************************---------->
<!------ Once the page has received Public Affairs approval, ------>
<!--- insert the PA Approval number in the CONTENT quotes below --->
<!----------**********************************************---------->
<META NAME="PA Approval" CONTENT="">
<!----------**********************************************---------->
<!------Insert the keywords for the web page document within the--->
<!--------------------CONTENT quotes below--------------------->
<!----------**********************************************---------->
<META NAME="keywords" CONTENT="">
<!----------**********************************************---------->
<!-- Page expiration interval -->
<!----------**********************************************---------->
<META NAME="expiration-interval" CONTENT="6 months">
<!----------**********************************************---------->
</HEAD>
<BODY BACKGROUND="/Images/background.jpg" TEXT="#000000" LINK="#6633ff"
vLINK="#6633ff">
```

GALLIUM ARSENIDE SURFACES

Jill M. Seger
Archbishop Alter High School

Abstract

Growth of the semi-conductor GaAs was studied. In particular, the surface structure of the substance was examined. Possible structures, including the beta 2x4 and the beta2 2x4, were animated using molecular dynamics. Pashley's electron counting rule was used to determine if a given structure was possible.

INFRARED SMALL CRACK DETECTION SYSTEM

Jonah Shaver
Waynesville High School

Abstract

The purpose of this project was to develop an infrared system that had the ability to take images at given intervals for detection of small crack initiation sites in test specimens. A Raytheon Amber Radiance 1 infrared camera and Dipix XPG-1000 Power Grabber ISA card were set up and tested for this project. Though the camera had the ability of internal calibration, an external calibration source was made out of copper plate and tubing. It was determined that the software packaged with the camera did not fully meet our needs. George Hartman helped with the development of software that would better suit our purposes. In the time allotted for development, the system was set up and software was written to take single images. Further work is required to get the software to take multiple images at different intervals.

AN IN-DEPTH STUDY OF SYNTHETIC APERTURE RADAR (SAR) IMAGERY

Douglas E. Smith II
Tippecanoe High School

Abstract

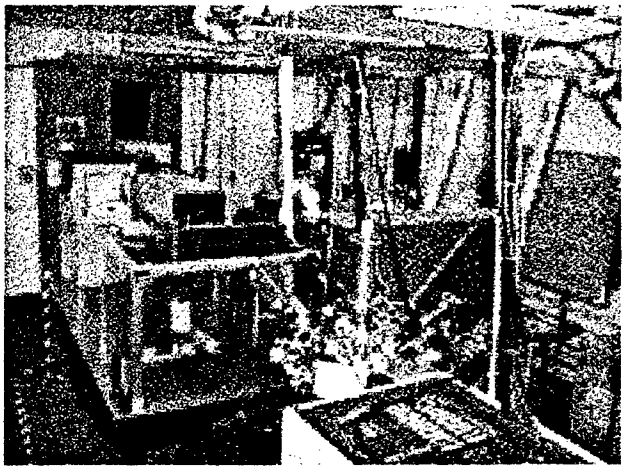
Research was done on Synthetic Aperature Radar (SAR) imagery. The images were produced by the Moving & Stationary Targer Acquisition and Recognition (MSTAR) project from Defense Advance Research Projects Agency (DARPA). A couple of weeks were spend on getting familar with the UNIX operating system and gaining background information on SAR and MSTAR. Then several weeks were needed to write and develop computer programs to view and manipulate the SAR imagery. The SAR images consist of a target, followed by its shadow, and the background is called clutter. Our main focus was on the target and the shadow. We wrote our programs to perform the function of cutting out the polygonal regions of the target and shadow in the images. These cutouts are used to find a more accurate target to clutter ratio and also as data for furthur analysis by the Model Based Vision researchers and developers at Wright Patterson Air Force Base.

STUDY OF THE POTENTIAL FOR THE GROWTH OF POTASSIUM CARBON THIN FILMS

Andrew T. Snow
Kettering Fairmont High School

Abstract

The potential for the growth of potassium and carbon thin films was studied. To grow these films, a high-powered excimer laser was used to create a plume of excited potassium and carbon atoms that coated a silicon substrate. To determine the bonding in the film created, an XPS (x-ray photoelectron spectroscopy analysis) was run on the films. The ability of the two elements to bond was very low. Initial results of the analysis indicate that these films are too unstable for practical use. The initial film oxidized when exposed to air. Further testing revealed that the film was very soft. The film was also very inconsistent, consisting of patches of diamond-like carbon, potassium, and some film of an unknown type.



HIGH SCHOOL APPRENTICE SUMMER RESEARCH STUDIES

Matthew J. Spriggs

Archbishop Alter High School

Abstract

Over the summer I worked in the Wright Patterson Power Systems Branch Research lab. I was assigned three main tasks during the course of my tour: data reduction, C-coding for instrumentation, and computer upgrading. This report will explain the tasks and their value to the Research lab.

HYPERTEXT MARKUP LANGUAGE: AN INSTRUCTIONAL GUIDE FOR WEB PAGE DESIGN

William J. Squicciarini
Floresville High School

Abstract

The programming language, HyperText Markup Language (HTML), was studied along with web page design. HTML, one of the major languages of the Internet's World Wide Web, is a user friendly, text based language that is used to create and modify web pages. After learning and studying the language, several web pages were designed to test the language and the Internet browsers. When the results of these tests were gathered, the findings were put into a simplified guide. The purpose of this guide is to instruct and guide the non-technical person who wants an easy tutorial on the HyperText Markup Language.

Creation of the MNAC Webpage and Software Verification of *Moments* '96

Meredith Stegall
Walton High School

Abstract

My first project for the summer was to create a webpage for the Computational Mechanics Branch of the US Air Force Research Laboratory Munitions Directorate (AFRL/MNAC). This project was accomplished through utilization of several web-building programs including *Netscape Composer* and *AOL Press*. Microsoft's *Word Pad* was also used for more advanced HTML markups. The purpose of the webpage is to give the general public a knowledge of what the MNAC and of research opportunities and also to give the Department of Defense easy access to web based information.

Additionally, I was to cooperatively create a webpage for the High School Apprenticeship Program (HSAP). This page will serve as an informant to the public about the HSAP program. It will also be a point where former apprentices can look up old friends and newer apprentices. Interested parties and schools can download a job application from this website.

My primary project for my two-year apprenticeship is to verify and improve the *Moments* '96 code. *Moments* was originally written in FORTRAN in the 1980's. The current version of *Moments* is written in Visual Basic. *Moments* calculates the weight, center of gravity locations, and polar and transverse moment of inertia for axisymetric projectiles.

WHAT I DID ON MY SUMMER VACATION

Lydia Ruth Strickland
Mosley High School

Abstract

As a High School Apprentice student my summer project consisted of many small projects, instead of one main one. I was assigned the task to help publicize the projects done at our laboratories. This included updating and duplicating our reports, as well as making a web page to help people get to our software and reports. I also helped get many needed reference documents for our scientists, sort mail, and shelve books for the Technical Information Center. I created a trouble desk for the network users and kept in running. In addition I updated receiving files for the lab, database files of reports, and the Technical Summary Sheets. Perhaps the most challenging project was to make a "cheat sheet" for all users of the program database. What made the task so difficult was that I had never seen the database before. I was given access to the database familiarized myself with it well enough to make a sheet for all project managers to use as a quick reference guide.

STUDY OF PAINT WASTE DECOMPOSTION

Rachel J. Strickland
Mosley High School

Abstract

Analytical and microbiological research was done on a paint waste sample from Tinker Air Force Base. Five chemicals were established to be present in the paint waste sample. Each chemical was individually mixed with different amounts of pure water to establish three different concentrations of each chemical. SPME and gas chromatograph techniques were used to run tests on each separate chemical. These same instruments were used to test a combined solution that made up the same concentrations as the paint waste sample. The paint waste was then cultured to grow bacteria, this being the microbiological portion of the experiment. The results proved that there were several types of bacteria present in the paint waste. It was theorized that the paint waste contained bacteria that could decompose the chemicals present in the paint waste.

INVESTIGATING INTERFERENCE PATTERNS IN CELESTIAL IMAGES

Timothy Swierzbin
Chelmsford High School

Abstract

Research was conducted to characterize band C noise pattern interference in celestial images. Initial investigations focussed on the possibility of using one-dimensional fractals, such as the Cantor set, which appeared to be related to the observed interference pattern. However, because of certain restrictions to the boundaries of a Cantor set, the investigation did not yield desired results. Further studies using multi-fractals also did not produce useful results, but appeared to be a promising area for further examination. A mathematical approach was then applied in an alternative attempt to reproduce the pattern.

THE STUDY OF THE CHANGE IN STRENGTH OF UNREINFORCED ALUMINUM 7093 ALLOY AND ALUMINUM 15 VOLUME% SiCp/7093 DRA

Robert L. Todd
Carroll High School

Abstract

The effect of heat treatment on unreinforced aluminum 7093 alloy and aluminum 15 volume% SiCp/7093 DRA was studied. In order to study this effect, the unreinforced and DRA alloys were precipitation strengthened by solutionizing, water quenching, and aging. After being heated, the alloys were cut and polished. The alloys were examined with a scanning electron microscope (SEM). With the SEM excess amounts of carbon was found and the size of the precipitates increased as aging did. Using a macro-hardness testing machine, the hardness of the alloys were found to be weaker as the aging increased. This data indicates that the excess amounts of carbon played a major role in the strengthening of the alloys.

DAMAGE STUDIES ON INERTS AND EXPLOSIVES USING ROD-ON-ROD IMPACT AND SPLIT-HOPKINSON PRESSURE BAR TECHNIQUES

My V. Tran

Choctawhatchee High School

Abstract

Damage to inerts and explosives caused by impacts was studied in this investigation. The inert studied was sand (SiO_2, silicon dioxide), while the explosives studied were 1, 3, 5- trinitro-1, 3, 5- triazocyclohexane (RDX) and the plastic bonded explosive, PBXN-109. PBXN-109 is composed of 64% RDX, 20% aluminum, and 16% hydroxy terminated polybutadiene (HTPB), a rubbery binder. Analyses were conducted on previously tested samples and samples tested specifically for this study. The previously tested PBXN-109 samples were shot by rod-on-rod impact. Scanning Electron Microscope (SEM) images of these samples were used to map out the damage done to the sample and to determine their respective particle size distributions. New tests were conducted on wet sand and dry sand of one particle fit using Split-Hopkinson Pressure Bar (SHPB) Technique. The particle size distribution of these sand samples were determined using the Coulter LS 100Q Particle Size Analyzer. SEM images of these samples were also taken to be studied.

Posttest analysis of the PBXN-109 showed that the particle size distribution was altered by the rod-on-rod impact. None of the largest RDX particles remained after the impact, while the number of smaller particles (0-100) increased. The study of the damage paths resulted in no definitive conclusions. The damage appeared to be random in some parts, while in other parts there appeared to be definite patterns. More studies on rod-on-rod impacted PBXN-109 specimens must be conducted in order to make an absolute statement on the presence of or lack of damage patterns. The analysis of the SHPB tested sand samples showed that the wet sand was damaged much less than the dry samples even though they were tested at much higher stress levels. Exactly how much less is still not known. There was no data on samples with binders to which the water data could be compared to quantify the effects of the water.

THE PROCESS OF TRAPPING CARBON AND BORON ATOMS IN AN ARGON MATRIX

Danielle D. Turner
Tehachapi High School

Abstract

Powder mixtures containing either carbon or boron carbide, were vaporized from a resistively heated tantalum cell at 2900K and co-condensed with argon onto a 10K barium fluoride window. The species trapped in the matrix were detected by Fourier Transform Infrared Spectroscopy (FTIR). The vibrational spectra of the carbon and boron species were then analyzed, which led to the identification of the trapped species. The sticking coefficient of argon that built up on the substrate window was found.

COMMERCIAL POWER INTERFACE FOR THE ISACC ALARM SYSTEM

Arun K. Wahi
Albuquerque Academy

Abstract

An interface to monitor commercial power operation for the Sensaphone® Intelligent System for Automatic Control and Communication (ISACC) was developed. ISACC was already in place in the Cryogenic Technology lab to monitor experiments on the coolers and to notify a technician if conditions were out of bounds. ISACC could be programmed to delay notification until a given alarm had existed long enough for concern. OR Box Interfaces had been developed to combine alarm signals from five coolers into one of ISACC's limited alarm inputs. No system existed previously to notify a technician if commercial power failed; but because such a failure could cause expensive systems to terminate or operate out of bounds, the new interface replaced the existing relay box between the OR Interface and ISACC. In other words, the interface connected the existing systems and allowed either a power failure or an experimental condition to alarm ISACC. A one-hour delay of notification in which commercial power could be restored was delegated to ISACC's programming capability (rather than complicating the interface). Tests with a Fluke Digital Multimeter and ISACC alarm simulations indicated that the wiring was correct and that the interface functioned as intended. This paper illustrates the logic behind the circuitry of the interface.

A STUDY OF THE INFLUENCE OF PARTICLE REINFORCEMENT ON THE AGING BEHAVIOR OF ALUMINUM ALLOYS

Donald S. Weaver
Centerville High School

Abstract

The aging behavior exhibited by two similar aluminum alloys was studied. The first of the two alloys was the unreinforced Aluminum 7093 alloy. The second was the Discontinuously Reinforced Aluminum (DRA) sample, which is 15 vol.% SiCp/7093 DRA. Approximately 30 samples of each alloy were obtained and after being solutionized were heat treated at three different temperatures for multiple time spans. The samples were prepared and both Micro Hardness testing and Macro Hardness testing were done to investigate and document the differences between the matrix microstructures of the different stages in aging of both the unreinforced and DRA alloy. The original concept was that the aging curve for the DRA alloy would be much higher (stronger) in the beginning than the unreinforced alloy but then would reach a certain height ("peak age") and then would become increasingly lower (weaker) over time than the unreinforced alloy. Due to circumstances beyond our control we were unable to either prove or disprove this concept.

MODTRAN VALIDATION

Jeremy Wertheimer
Buckingham Browne & Nichols School

Abstract

The objective was to test the accuracy of the computer model MODTRAN3.5 that predicted atmospheric transmittance and radiance. For each set of interferometer data, the recorded radiance, spectrally degraded to intervals between 525 cm^{-1} and 1795 cm^{-1}, was compared to the respective predictions from MODTRAN. The overall mean percent error was 0.22% and the overall average standard deviation of the percent error was 4.29%. The results indicated that MODTRAN was accurate enough to give a fairly good representation of atmospheric transmittance and radiance.

Summer Work Projects

Jeremy L. White
Sandia Preparatory School

Abstract

During my tenure at Phillips Laboratory as part of the High School Apprenticeship Program I worked on a series of projects. The first of these projects was designing a web page for the Component Characterization Group of the Space Electronics and Protection Branch. The next project on which I worked was using computer programming to aide in the operation of an Aracor irradiation device. I also learned of some of the effects of high energy electron irradiation on plexiglass.

DEVELOPMENT OF ENVIRONMENTAL CHAMBER AND CONTROLS TO STUDY THE EFFECT OF ENVIRONMENT ON INTERFACE TRIBOLOGY

Ming Xia
Kettering Fairmont High School

Abstract

The development of the environmental chamber for a friction tester and how to control the humidity in the environmental chamber was studied. In order to measure friction between a ball and a disc in a given humidity condition, the dry nitrogen gas was used for lower the humidity in the chamber. The water vapor from a large flask was used to supply more humidity to the environmental chamber. Experimental result indicate that the flow rate of the gas has direct effect on the humidity in the chamber. After the humidity in the environmental chamber can be controlled very easily, then there are many materials in tribology can be tested in a given humidity in this chamber