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AD-A252 543



Bibliography of In-House and Contract Reports, Supplement 17

Jean R. Diaz
E. James Books
Karen Carroll



September 1991

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U.S. Army Corps of Engineers
Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060-5546

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PREFACE

This is Supplement 17 to the report titled, "Bibliography of In-House and Contract Reports" AD-877 653L; Supplement 1, AD-890 066L; Supplement 2, AD-905 548L; Supplement 3, AD-B005 275L; Supplement 4, AD-B010 642L; Supplement 5, AD-B019 966L; Supplement 6, AD-055 468; Supplement 7, AD-A068 744; Supplement 8, AD-A084 111; Supplement 9, AD-A099 803; Supplement 10, AD-A113 006; Supplement 11, AD-A128 400; Supplement 12, AD-A141 778; Supplement 13, AD-A160 607; Supplement 14, AD-A173 750; Supplement 15, AD-A195 953; and Supplement 16, AD-A215 154. It is a continuing bibliography of reports prepared by and for the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. This bibliography includes reports that were published from 1 October 1989 through 1 October 1991.

Reports with AD numbers can be purchased by Department of Defense agencies from the Defense Technical Information Center; other agencies and individuals can purchase copies from the National Technical Information Service, Springfield, Virginia 22161-2171. Reports with a "B" in the AD number are limited in distribution to U.S. Government agencies unless permission for release is granted from the controlling office. Reports are available on an interlibrary loan from the Scientific and Technical Information Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia 22060-5546.

Colonel David F. Maune, EN, was Commander and Director, and Mr. Walter E. Boge was Technical Director of the Engineer Topographic Laboratories during the report preparation.

ETL-0496

AD B158 326L

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM
SEVENTH QUARTERLY REPORT
March 1988**

Edited by:
Gustav R. Hoyer

Martin Marietta Astronautics Group

DACA76-84-C-0005

Keywords: Autonomous Land Vehicle, Image Understanding, Computer Vision, Unmanned Vehicles, Artificial Intelligence, Robotic Combat Vehicles, Robotics

During this quarter, we finalized our hardware and software testing and integration activities in preparation for the November 5, 1987 Autonomous Land Vehicle (ALV) demonstration. In hardware integration developments, we completed the installation and check out of the Warp systolic array processor and the Local Attitude Reference System (LARS). In software development activities, we finalized the integration of all software components that, in totality, comprise the 1987 ALV Computer Software Configuration Item (CSCI), which is, in Department of Defense software requirements specification terminology, the formal name for our 1987 computer software architecture. After fine-tuning the demonstration software configuration, we performed a series of pre-demonstration test runs to verify our readiness for the November 5 performance date. Following this, we placed the demonstration software CSCI under formal configuration management control.

ETL-0498

AD A240 746

**HOURLY AND DAILY PRECIPITATION FREQUENCIES
FOR THE UNITED STATES
December 1988**

Ruth L. Wexler

Keywords: Hourly Precipitation, Daily Precipitation, Short-Term Rainfall, Precipitation Models, Computer Programs

This report presents daily and hourly precipitation probabilities for an extensive network of stations throughout the United States, from special summaries of observations obtained over the decade 1951-1960. When data are in the format of cumulative percent frequency per precipitation rate, the daily and hourly distributions each form a fairly regular progression, per P/D or P/H, respectively (P = total precipitation, D = days, H = hours). The resultant models, in the form of succinct tables, graphs, or computer programs, provide a ready means for recovering the original observations, or estimating any selected precipitation rate for a wide spectrum of precipitation regimes in the United States, or elsewhere. The models, which serve as a check on data errors, or weather modification, also indicate to the engineer preferred areas for testing particular equipment. The methodology for the comparison among stations (or countries) of the actual short-term precipitation distributions, given only routine climatic data, should be highly useful for assessing more accurately a host of factors, as: soil moisture, trafficability, water supply crop yields, or possible malfunction of electronic equipment. The greatest advantage of the result is that they may be utilized for estimating short-term precipitation in data sparse localities.

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM PHASE II
FIRST QUARTERLY SCIENTIFIC AND TECHNICAL REPORT
August 1988**

Edited by:
Gustav R. Hoyer

Martin Marietta I&CS

Defense Advanced Research Projects Agency

DACA76-84-C-0005

Keywords: Autonomous Land Vehicle, Unmanned Vehicles, Expert Systems, Mobile Robots, Artificial Intelligence, Image Understanding, Computer Vision

Phase II of the program shifted away from annual system demonstrations to the use of the ALV as a "national testbed" for the purpose of hosting various experiments in autonomous land navigation technology. In hardware installation, integration and test activities, minor modifications were made to the vehicle's on-board computer hardware. We developed a new LNS navigation processor interface board, continued testing the Local Attitude Reference System (LARS), acquired a doppler radar ground speed sensor, developed a new architecture plan for real-time system development and sensor integration, introduced improved hardware documentation, and made mechanical improvements to the vehicle's mobility platform. In software developments, we continued to develop and test our prototype perception and reasoning (planning) software configuration for offroad navigation and finding the road from offroad. Our test activities on the ALV were primarily focused on documenting our vehicle hardware configuration; acceptance tests of the RF communications system; road checks of the vehicles handling characteristics following the installation of new automotive components; experimenting with our prototype perception and reasoning offroad software; validating our evolving concepts for offroad navigation; and perfecting our vehicle teleoperation hardware and software components and procedures. We also conducted several nighttime tests in preparation for future nighttime on and offroad experiments.

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM PHASE II
SECOND QUARTERLY SCIENTIFIC AND TECHNICAL REPORT
January 1989**

Edited by:
Gustav R. Hoyer

Martin Marietta I&CS Defense Advanced Research Projects Agency

DACA76-84-C-0005

Keywords: Autonomous Land Vehicle, Artificial Intelligence, Image Understanding, Unmanned Ground Vehicles, Mobile Robots, Machine Intelligence

During this quarter, our activities primarily focused on validating our evolving concepts for off-road navigation; continued experiments with our prototype off-road software architecture; correcting performance problems in our off-road software; and perfecting our vehicle teleoperation hardware and software components and procedures. In hardware installation and integration activities, minor modifications were made to the vehicle's on-board hardware. We installed a more capable video switch, modified the vehicle's control unit board, modified the Bendix LNS, and installed a new stereo camera system to support the Mars Rover program. In software developments, activities centered on the continued testing and refinement of our prototype perception and reasoning (planning) software configuration for off-road navigation and finding the road from off-road. We performed a number of software development tasks needed to support various hosted experiments on the ALV. We continued our research in video/range sensor fusion and inverse perspective algorithm comparison, developed a perception processing approach based on a 3-D vehicle model using the Warp, and developed a prototype multispectral image classification methodology using neural networks on the Warp. Our test activities concentrated on performance testing of the hardware installations made and supporting various experiments on the ALV testbed. These included our own off-road autonomous navigation tests, data collection for Advanced Decision Systems and Carnegie-Mellon University (CMU), and experiments by CMU and the Martin Marietta Mars Rover program. Our program staff representative made a coordination visit to the Jet Propulsion Laboratory (JPL) to determine their intentions and requirements regarding future experiments.

**RESEARCH IN KNOWLEDGE-BASED VISION TECHNIQUES FOR THE
AUTONOMOUS LAND VEHICLE PROGRAM
FINAL ANNUAL REPORT
August 1989**

Editors:	Contributions by:
R. Nevatia	W. Franzen G. Medioni
K. Price	S. Gazit S. Peng
	P. Saint-Marc

University of Southern California

DACA76-85-C-0009

Keywords: Autonomous Land Vehicle, Motion Analysis, Target Detection and Description, Knowledge-Based Vision

This report describes our research activities for the period of June 1, 1988 through May 31, 1989, and along with the previous annual reports it constitutes the "Final Technical Report." The researchers basic approach to detecting and tracking motion is to extract and match features, such as lines and regions, from a sequence and to generate motion estimates from these. Presented are: one report on spatio-temporal analysis for tracking edges through very closely spaced sequences; a report on matching edge-based contours using edges from multiple scales with low resolution guiding high resolution matches; and an analysis of estimating 3-D motion and structure of moving objects with uniform acceleration.

**DEVELOPMENT OF AN INTEGRATED MOBILE ROBOT SYSTEM
AT CARNEGIE MELLON UNIVERSITY
July 1989**

Steven Shafer
William Whittaker

Carnegie Mellon University

DACA76-86-C-0019

Keywords: Strategic Computing, Machine Vision, Autonomous Land Vehicle

This report describes progress in development of an integrated mobile robot system at the Carnegie Mellon Robotics Institute from July 1987 to June 1988. The program includes a broad agenda of research in the development of mobile robot vehicles, focused on the NAVLAB computer-controlled van. In the year covered by this report, we addressed major issues in both hardware and software for autonomous mobile robots.

* **Evolution of NAVLAB Vehicle.** We built the NAVLAB mobile robot vehicle in our previous work under this contract, by outfitting a commercial truck chassis with computer-controlled drive and steering controls and a set of on-board computer workstations. The NAVLAB serves as a mobile navigation laboratory that allows researchers to interact intensively with the system during testing and execution. This year has seen a continued evolution and improvement of the NAVLAB mechanism, sensors, controller, and Virtual Vehicle interface to higher-level planning and perception software.

* **Evolution of the CODGER Blackboard.** Last year, as part of this research program, we designed and implemented the CODGER Blackboard system for robot perception and reasoning on a distributed collection of processors. This year, in response to our experience in using CODGER for mobile robot control, we have upgraded it to deal with geometric models and uncertainty in perception and map data.

* **Experiments With the Driving Pipeline.** To control the NAVLAB and Terregator mobile robot vehicles, we developed the Driving Pipeline architecture last year for coordinating road following, obstacle avoidance, and vehicle motion control. In our ongoing research, we have performed numerous experiments with this system that demonstrates its value.

This hardware and software is the basis for the New Generation System (NGS) for robot vision and navigation, which integrates many independent technologies to produce an integrated mobile robot system.

**FEASIBILITY OF A REDUCED POWER-CONSUMPTION MAGNETOMETER
FOR USE IN A DIGICOMP LENSATIC COMPASS
August 1989**

George Hsu
Timothy Joel Hawks

Precision Navigation Incorporated

DACA72-88-C-0001

Keywords: DIGICOMP, Digital Compass

This report summarizes the Small Business Innovative Research (SBIR) Phase I research effort performed by Precision Navigation, Incorporated, for the U.S. Army Engineer Topographic Laboratories' DIGICOMP project. The feasibility of using Precision Navigation's proprietary magnetometer and clinometer technologies in a battery-powered, handheld, tilt-compensated digital compass replacement for the standard issue Army M2 compass has been successfully assessed. The magnetometer and clinometer technologies have proven to be low-power and accurate enough for use in a battery-powered, tilt-compensated compass system. During the research effort, the magnetometer sensor was extensively characterized and optimized for linearity, zero-drift, and power consumption.

**VISION-BASED NAVIGATION AND PARALLEL COMPUTING
FIRST ANNUAL REPORT
August 1989**

Larry S. Davis
Daniel DeMenthon
Thor Bestul
David Harwood

University of Maryland

DACA76-88-C-0008

Keywords: Autonomous Navigation, Computer Vision, Parallel Processing, Search

This report describes research performed during the period May 1988-May 1989 under DARPA support. The report contains discussion of four main topics:

1. On-going research on visual navigation, focusing on a system named RAMBO, for the study of robots acting on moving bodies.
2. Development and implementation of parallel algorithms for image processing and computer vision on the Connection Machine and the Butterfly.
3. Development of parallel heuristic search algorithms on the Butterfly that have linear speedup properties over a wide range of problem sizes and machine sizes.
4. Development of Connection Machine algorithms for matrix operations that are key computational steps in many image processing and computer vision algorithms.

This research has resulted in twelve technical reports, and several publications in conferences and workshops.

ETL-0549

AD A213 172

**DYNAMIC IMAGE INTERPRETATION FOR AUTONOMOUS VEHICLE NAVIGATION
FINAL REPORT
August 1989**

Edward M. Riseman
Allen R. Hanson

University of Massachusetts

DACA76-85-C-0008

Keywords: Scene Interpretation, Spatial Reasoning, Sensor Motion

This report presents the results of the Dynamic Image Interpretation for the Autonomous Vehicle Navigation project for the time period February 26, 1985 through July 12, 1989. The purpose of the project is to develop algorithms and tools to enable a robotic ground vehicle to navigate autonomously through realistic landscapes. In this final annual report, we summarize our accomplishments in constructing robust algorithms used for vehicle navigation as well as tools that have been developed to more efficiently utilize these algorithms.

ETL-0550

AD A215 154

**BIBLIOGRAPHY OF IN-HOUSE AND CONTRACT REPORTS
SUPPLEMENT 16
October 1989**

Annemarie Black
E. James Books
Karen Carroll

Keywords: Bibliography, Scientific Reports

This is Supplement 16 to the ETL *Bibliography of In-House and Contract Reports*. This supplement provides author and title indexes, abstracts, and AD numbers for the 1987, 1988 and 1989 additions to the continuing bibliography. It also contains a complete title index designed to be used in conjunction with the 16 published bibliographies and refers to them by year and number.

ETL-0551

AD B139 032L

**DIGITAL MULTICOLOR RECORDERS AND SCANNER
THE TECHNOLOGY AND THE EQUIPMENT**

December 1989

Stephen P. Hollandsworth

James W. Gladden

Keywords: Ink Jet, Laser Xerography, Electrostatic Recording, Thermal Transfer, Ion Deposition, Cycolor, Laser Photography, Halftone Dot, Photomultipliers, Photodiode, CCD's, Scanners

State-of-the-art, electronic, non-impact digital multicolor printers and recorders and scanners are reviewed in this technical note. A review of the various non-impact technologies (ink jet, laser xerography, electrostatic, thermal transfer, ion deposition, Cycolor, and laser color photography) are also presented. Also discussed are three types of radiant energy sensors (photomultipliers, photodiodes and CCD's) used for scanning full color imagery. In addition, halftone dot and continuous tone reproduction are explained and discussed.

ETL-0552

AD A216 516

EXPERT SYSTEM FOR MINEFIELD SITE PREDICTION — PHASE III

November 1989

Jonathan W. Doughty

Anne L. Downs

PAR Government Systems Corporation

DACA72-86-C-0017

Keywords: Expert System, Minefield Site Prediction, GIS (Geographic Information System), Quadtree, Window System, Terrain Analysis, Minefield Doctrine

This report reviews the major system components of the Minefield Site Prediction Expert System (MSPES) and discusses enhancements made to the systems under Phase III of this contract. Phase III extended the knowledge base and significantly enhanced the operation of the system, both in the processing methods and analyst interaction with the system. Additional detailed descriptions of the MSPES and its architecture may be found in Phase I and Phase II Reports (ETL-0492 and ETL-0534). Phase III MSPES development continued on the Sun 3/160, using the Sun operating system and the X Window System graphics software package. A knowledge base was implemented which incorporates enemy location factors.

**AN EVALUATION OF THE ERDAS IMAGE PROCESSING SYSTEM AND
ITS POTENTIAL ROLE IN THE DIGITAL TOPOGRAPHIC SUPPORT SYSTEM
December 1989**

John E. Anderson

Keywords: Image Processing, Remote Sensing, Geographic Information Systems (GIS), Multispectral Imagery

The evaluation of the Earth Resource Data Analysis System (ERDAS) image processing system was initiated as part of the softcopy exploitation work unit in the Data Base Development Branch of the Topographic Developments Laboratory at ETL. The work unit's main goal is to advise on the feasibility of integrating an image processing capability into the Digital Topographic Support System (DTSS). ERDAS is a commercially available image processing package which was selected as the test-bed for the evaluation. ERDAS was selected based upon three major criteria formulated at the beginning of the project: (1) Semi-powerful, user-friendly, interactive image processing capability, (2) Compatibility with the ARC/INFO geographic information system chosen by DTSS, and (3) VAX/VMS host compatibility. A fourth element, not cited, was cost.

The test-bed system consists of a 386/20 personal computer, Mitsubishi color monitor, polygon digitizing tablet, and ERDAS 7.3 version software running under a DOS 3.31 host. All image processing functions relevant to military terrain analysis were explored using acquired SPOT panchromatic and multi-spectral imagery over Fort Hood, Texas. These functions included image display, correction, spectral and spatial enhancement, roam/zoom, training field selection, supported supervised and unsupervised classification algorithms, and annotation and colorization of final images. Other features explored were special image algebraic routines including IHS to RGB, image warping or "geo-referencing", and 3-D image capabilities using elevation data.

The results of this evaluation have demonstrated that with few inexpensive upgrades to the DTSS PAWS configuration, an ERDAS or ERDAS-like image processing capability will greatly enhance the detail and accuracy of terrain and mobility products. This improvement will enable battlefield commanders to "see" the battlefield and to make more timely and accurate tactical decisions.

ETL-0554

AD A221 096

**AUTOMATED SEGMENTATION AND EXTRACTION OF AREA TERRAIN FEATURES
FROM RADAR IMAGERY**

January 1990

Pi-Fuay Chen
Richard A. Hevenor

Keywords: Radar Image, Feature Extraction, Texture, Segmentation, Bayes Classifier, Region Growing, Edge Enhancement

An automated method for segmenting and extracting certain area terrain features from Synthetic Aperture Radar (SAR) imagery is presented. First, the input radar image is edge-enhanced by passing it through a Sobel operator in order to obtain the required edges for further processing. The unwanted noise, both from the original image source and from the edge operation, is reduced with a low-pass filter. The next step is a region growing process in which pixels of similar gray values in the filtered image are grouped and merged together. A method of selecting an optimum threshold that is essential for region growing is described. The pixels in the image after the region growing operation are further grouped into exactly four different categories, each with its own gray value. The four categories of pixels are then finally classified as water, fields, forests, or urban areas depending upon their gray values. A texture measurement scheme and a Bayes classifier are also incorporated into this effort for verifying the classification results.

ETL-0555

AD A220 093

FRACTURES IN ROCK: AN ANNOTATED BIBLIOGRAPHY

January 1990

Judy Ehlen

Keywords: Bibliography, Fractures, Data Analysis, Engineering, Rock Mechanics, Geology, Joint Propagation

This bibliography lists many papers concerned with fractures. Subjects addressed include: descriptive and quantitative characteristics of fractures, mechanisms of fracture initiation and propagation, methods for obtaining information on fractures in the field, and procedures for analyzing and interpreting the data in the laboratory. Papers on engineering applications are also included. Each entry is annotated and key words are given.

ETL-0556

AD A220 380

**THREE APPROXIMATE METHODS FOR ESTIMATING THE BEST SUBSET
OF GPS SATELLITES FOR SATELLITE POSITION CALCULATIONS
February 1990**

Michael A. Crombie

Keywords: Spatial Position Accuracy, Global Positioning System (GPS), Position Dilution of Precision (PDOP)

Three methods approximating the best subset of four or five of N observable GPS satellites to be used for calculating spatial positions are evaluated. Position Dilution of Precision (PDOP) is used as the measure of effectiveness. Three GPS constellations are considered. The user spatial positions are taken from circular orbits ranging from 100 to 2400 nautical miles above the earth and from orbital inclinations ranging from 0 degrees to 90 degrees in 15 degree increments.

ETL-0557

AD B142 339L

**KNOWLEDGE-BASED VISION TECHNIQUES TASK B: TERRAIN AND
OBJECT MODELING RECOGNITION - EXECUTIVE SUMMARY
February 1990**

Daryl T. Lawton, et. al.

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Model Based Vision Systems, Landmark Recognition, Perceptual Processing, Spatial Reasoning, Navigation, Autonomous Land Vehicle Systems, Image Understanding, Image Understanding Software Environments, Object-oriented Programming.

This report describes the Knowledge-Based Vision Techniques Task B: Terrain and Object Modeling Recognition project. Its primary objective has been to develop terrain and object autonomous land vehicle. This is fundamental for the eventual operation of concealed autonomous robots in complex outdoor environments. Our work has been organized into three major areas which correspond to the three volumes of this report. "Autonomous Systems for Navigation and Terrain Recognition" (Volume I) is concerned with terrain recognition and map building for an outdoor robot. This involves using limited a priori terrain maps to interpret imagery obtained from a vehicle and also how to build a usable representation of terrain from a freely moving vehicle with no a priori terrain information and also possessing limited recognition capabilities. "Tech Base Vision Research" (Volume II) involves basic research and development in several areas critical for eventual incorporation on an outdoor robot. This includes new approaches to perceptual processing, geometric modeling, inference, and the architecture of model-based vision systems. "Image Understanding Software Environments" (Volume III) concerns the software environments we have developed to support image understanding research and technical transfer to integrative applications such as the autonomous land vehicle project. This executive summary presents an overview and critical processing results for the work in all three volumes.

**KNOWLEDGE-BASED VISION TECHNIQUES TASK B:
TERRAIN AND OBJECT MODELING RECOGNITION - VOLUME I:
AUTONOMOUS SYSTEMS FOR NAVIGATION AND TERRAIN RECOGNITION
February 1990**

Daryl T. Lawton, et. al.

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Landmark Recognition, Qualitative Reasoning, Navigation, Spatial Representation, Model Based Vision Systems, Perceptual Grouping and Organization, Path Planning, Road Following, Object Recognition, Autonomous Land Vehicle Systems

This volume, "Autonomous Systems for Navigation and Terrain Recognition", presents a model-based vision system and a theory of spatial representation for navigation and terrain recognition by an autonomous land vehicle. This first involves techniques to generate and match predicted image structures from a priori terrain grid data. These predictions are used to direct perceptual processes to find structures such as road regions, horizon lines, terrain patch discontinuities, and anomalies using object models. This has been successfully applied to data from the Martin Marietta ALV Test Site. We then present a new theory of spatial representation called Qualitative Navigation. This allows for navigation using locally coupled scene descriptions called viewframes without use of a global coordinate system. An exploring robot can then build maps and navigate without a priori terrain information while utilizing limited object recognition capabilities and landmarks with potentially very large positional uncertainty. We extensively tested qualitative navigation in simulations of a mobile robot and developed techniques for viewframe extraction and matching. These techniques used a generic terrestrial scene model which includes several constraints on the formation of perceptual structures based upon the relative direction of gravity, the horizon line determined by the orientation to the immediate ground plane, and the projected egocentric directions from the observer on this plane.

**KNOWLEDGE-BASED VISION TECHNIQUES TASK B: TERRAIN AND OBJECT MODELING
RECOGNITION - VOLUME II: TECH BASE VISION RESEARCH
February 1990**

Daryl T. Lawton, et. al.

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Segmentation, Perceptual Grouping and Organization, Image Understanding, Shape Representation, Generalized Cylinders, Bayesian Inference Nets, Model-Based Vision Systems

This volume, "Tech Base Vision Research", describes research in several areas of computer vision necessary for the development of autonomous vehicles and general machine vision systems. The volume is organized into the areas of (1) perceptual processing, (2) shape and object representations, and (3) prototype image understanding systems. The research in perceptual processing has been organized into three areas: perceptual organization of extracted image structures; segmentation using texture and color to form environmentally meaningful image regions; and multi-level stereo. The work in shape descriptions and object representations is part of an integrated attempt to combine generalized cylinder representations, which are used to describe complex objects, with perceptually based predictions and model-based inference for an integrated machine vision system. Two particular model-based vision systems have been developed using these representations. MOBI was created early in the project as a vision system for a robot which could successfully navigate and build maps, in real-time, of indoor environments consisting of walls, hallways, doors and rooms. It served as a catalyst to develop the SUCCESSOR system which combines all of the research described in this volume in modeling, perceptual organization, and inference in the framework of a general and extendible model based vision system.

**KNOWLEDGE-BASED VISION TECHNIQUES TASK B: TERRAIN AND OBJECT MODELING
RECOGNITION - VOLUME III: IMAGE UNDERSTANDING
SOFTWARE ENVIRONMENTS
February 1990**

Daryl T. Lawton, et al.

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Object-oriented Programming, Image Understanding Environments, Programming Languages, SYMBOLICS Lisp Machine, Apple Macintosh II Computer, Common Lisp Object System

This volume, "Image Understanding Software Environments," presents our work in developing software environments for image understanding research and applications. This work was initially motivated to support internal developments and to expedite technical transfer from ADS to the autonomous land vehicle system integrators. We have developed two different image understanding (IU) environments, Power Vision and View/Shark, and an exploratory prototype on the MAC II. The Power Vision environment was developed on the Symbolics LISP machine. It defines a basic architecture for IU software environments in terms of a small number of modular components and programming constructs which are built around objects commonly used in image understanding such as images, curves, regions, junctions, and groups. Algorithms are developed using these objects and a language called DEFIU for writing code and manipulating defined objects in terms of local neighborhood-level operations. Shark and View were developed to produce a machine independent image understanding environment. Shark is a CommonLISP/CLOS-based toolkit for building user interfaces. View is a CLOS-based set of image understanding constructs which is completely object-oriented and makes extensive use of the inheritance of CLOS to achieve abstraction and user-specific extendibility. We ported the CommonLISP-based IU environment onto the Apple Mac II series of personal computer workstations. *Note: This abstract was summarized for this bibliography.*

ETL-0561

AD A220 005

**BUILT-UP AREA FEATURE EXTRACTION:
FIRST YEAR REPORT
February 1990**

David M. McKeown, Jr.
Aviad Zlotnick

Carnegie Mellon University

DACA72-87-C-0001

Keywords: Feature Extraction, Road Networks, Scene Interpretation, Built-up Area

This report describes research performed by the Digital Mapping Laboratory at Carnegie Mellon University on the analysis of aerial images of built-up areas during the first year of the Contract. This research can be divided into three major parts: (1) extracting road networks from images; (2) detecting and delineating buildings; and (3) basic research to support extraction of the above features. Previous work in large-scale spatial databases and in knowledge-based systems for scene interpretation is described. Research results performed under this Built-Up Area Feature Extraction contract are described. New research in road network extraction is discussed. New work in the use of structural analysis to hypothesize and verify buildings using monocular cues in complex imagery is also discussed. Finally, the current state of research including successes, failures, and goals for the second year continuation are described.

ETL-0562

AD A220 006

**BUILT-UP AREA FEATURE EXTRACTION
SECOND YEAR TECHNICAL PROGRESS REPORT
February 1990**

David M. McKeown, Jr.

Carnegie Mellon University

DACA72-87-C-0001

Keywords: Feature Extraction, Scene Interpretation, Monocular Analysis, Built-up Area

This report describes research performed by the Digital Mapping Laboratory at Carnegie Mellon University on the analysis of aerial images of built-up areas during the second year of the Contract. During this year we have built on previous research, in road network extraction and in the detection and delineation of buildings using monocular analysis, accomplished during the first year of this research contract. We have expanded our research in monocular analysis to include the detailed analysis of shadows. Our shadow analysis research has resulted in three techniques for the interpretation of monocular imagery: building prediction, grouping of related building hypotheses, and building hypothesis verification. In addition, we have implemented a technique to acquire estimates of building heights using the length of cast shadows.

**A PROGRAMMING ENVIRONMENT FOR PARALLEL VISION ALGORITHMS
FINAL TECHNICAL REPORT
April 1990**

Christopher Brown

University of Rochester

DACA76-85-C-0001

Keywords: Butterfly Computer, Parallel Processors, Computer Vision

Under this contract, the University of Rochester developed and disseminated papers, ideas, algorithms, analysis, software, applications, and implementations for parallel programming environments for computer vision and for vision applications. The work has been widely reported and highly influential. The most significant work centered on the Butterfly Parallel Processor, the MaxVideo pipelined parallel image processor, and the development of the real-time computer vision laboratory. For the Butterfly, the Psyche multi-model operating system was developed and the CONSUL autoparallelizing compiler was designed. Much basic and influential performance monitoring and debugging work was completed, resulting in working systems and novel algorithms. There was also significant research in systems and applications using other parallel architectures in the laboratory, such as the MaxVideo parallel pipelined image processor. The University of Rochester developed a heterogeneous parallel architecture involving pipelined and MIND parallelism and integrated it with a robot head.

**PARALLEL ALGORITHMS FOR COMPUTER VISION
FINAL REPORT
April 1990**

Tomaso Poggio

Massachusetts Institute of Technology

DACA76-85-C-0010

Keywords: Computer Vision, Parallel Algorithms, Connection Machine

The main effort in this project has been directed towards the development of an integrated vision system - the Vision Machine - based on a parallel super computer. The core of the vision Machine is in fact a set of parallel algorithms for visual recognition and navigation in an unstructured environment. The present version of the Vision Machine has been demonstrated to process images in close to real time by: (1) computing first several low-level cues, such as edges, stereo disparity, optical flow, color and texture; (2) integrating them to extract a cartoon-like description of the scene in terms of the physical discontinuities of surfaces; and (3) using this cartoon in a recognition stage, based on parallel model matching. In addition to the development of the parallel algorithms, their implementation and testing, we have also done substantial work in several areas that are very closely related. These include: (1) design and fabrication of VLSI circuits to transfer some of the software algorithms to potentially cheap and fast hardware; (2) initial development of techniques to synthesize by learning vision algorithms; and (3) several projects involving autonomous navigation of small robots.

ETL-0565

AD A222 494

**DEVELOPMENT OF AN INTEGRATED MOBILE ROBOT SYSTEM
AT CARNEGIE MELLON UNIVERSITY
DECEMBER 1989 FINAL REPORT
May 1990**

Steve Shafer
William Whittaker

Carnegie Mellon University

DACA76-86-C-0019

Keywords: Mobile Robot System

This report describes progress in development of an integrated mobile robot system at the Robotics Institute at Carnegie Mellon University from July 1988 to December 1989. This research was sponsored by the Defense Advanced Research Projects Agency and monitored by the US Army Engineer Topographic Laboratories. This program pursued a broad agenda of research in the development of mobile robot vehicles, and focused on the NAVLAB computer-controlled van. In the period covered by this report, July 1988 to December 1989, we addressed major software issues for mobile robot vehicles:

- * Evolution of the CODGER Blackboard and the Driving Pipeline Architecture
- * Kinematic Path Planning for Wheeled Vehicles.

This software is central to the New Generation System (NGS) for robot vision and navigation, which combines many independent technologies to produce an integrated mobile robot system.

ETL-0566

AD A223 749

**THE LANDFORMS OF GRANITIC ROCKS: AN ANNOTATED BIBLIOGRAPHY
May 1990**

Judy Ehlen

Keywords: Granite, Landforms, Process, Fractures, Weathering

This bibliography addresses the study of granite landforms throughout the world from a variety of different perspectives. It summarizes the content of more than 150 papers and books. The subjects addressed include theories of origin for the respective landforms, the weathering processes acting upon these landforms, and the composition, texture and structure (mainly jointing) of granitic rocks as they relate to landform development.

**AUTOMATED EXTRACTION OF AIRPORT RUNWAY PATTERNS
FROM RADAR IMAGERY
June 1990**

Richard A. Hevenor
Pi-Fuay Chen

Keywords: Radar Image Feature Extraction, Computer Vision, Edge Enhancement, Connected Component

A method is presented to extract linear terrain features from Synthetic Aperture Radar imagery. An input radar image is smoothed with an edge-preserving smoothing operation. Edge detection is performed using a Sobel operator, and both the magnitude and directional images are computed. The edges are then strengthened using several iterations of a relaxation operation in which both the magnitude image and the directional image are updated with each iteration. The output of the relaxation operation is a binary edge image, which is then thinned. A connected components routine is then run in which two passes through the image are used to provide a unique label for each connected component. The connected components related only to the runway pattern are then extracted by computing certain properties of each component. A border-following algorithm is then used to follow only the outermost borders and give each of the pixels on an outermost border a maximum brightness value. A tracking algorithm is used to change the binary image array into a set of Freeman chain codes, which serve as the input to a line-forming routine that uses a standard polygon approximation algorithm. Experimental results on a real synthetic aperture radar image are presented.

**AUTOMATIC LINE NETWORK EXTRACTION FROM AERIAL IMAGERY OF URBAN
AREAS THROUGH KNOWLEDGE BASED IMAGE ANALYSIS
August 1989**

Dr. H. Kazmierczak

Forschungsinstitut für Informationsverarbeitung/Mustererkennung

DAJA45-86-C-0049

Keywords: Image Processing, Structural Pattern Recognition, Blackboard Oriented Symbolic Processing, Knowledge Based Image Analysis, Image Understanding, Aerial Imagery, Urban Areas

Different methods for automatic detection of line objects applied to aerial images to extract streets from urban scenes are investigated. First, test results achieved from two existing methods of low level iconic image processing by stream following (line tracking) and structured parallel operations (image filtering, feature extraction) are given. Second, a medium level iconic image processing method developed for edge and area segmentation is described and results from image segmentation are presented symbolically. Then two preliminary approaches of high level symbolic processing by knowledge based blackboard oriented structure analysis are tested. One is originating with preprocessing by low level edge filtering, the other by medium level area segmentation. First results from the image understanding method for street network extraction are presented.

ETL-0569

AD A238 937

ETAK NAVIGATOR MODIFICATION FINAL REPORT
October 1990

Dr. Walter B. Zavoli
Gene E. Bloch

Etak, Inc.

DACA72-89-C-0007

Keywords: Etak Navigator; Dead Reckoning; Electronic Map Display; Digital Map Display; Vehicle Navigation; Off-Road Navigation; UTM Conversion

Etak modified its land vehicle navigation device, the Navigator, for test and evaluation by the U.S. Army Engineer Topographic Laboratories. The Navigator is a low-cost off-the-shelf commercial device that exhibits accurate navigation along with a highly useful electronic map display. The device uses a combination of dead reckoning and map matching. As part of this contract, Etak found that it could create the necessary maps from DMA 1:50,000 scale source material, to an accuracy of 50 meters, and that the Navigator could input and display vehicle positions and waypoints in UTM coordinates. In almost 1400 km of drive testing in Fort Hood, Texas, the modified Navigator showed that as a dead-reckoning device it is accurate to 2% of distance traveled, while its map-matching algorithms gives the Navigator performance comparable to that of an absolute navigation device with an average error of 50 meters. This navigation device demonstrates useful performance for certain classes of Army vehicles. Other vehicles may require more robust and hence more costly devices. It is suggested that digital map displays like that of the Navigator could be a useful standard presentation device for all Army vehicle navigation.

ETL-0570

AD B157 709L

ASSISTANT FOR SCIENCE AND TECHNOLOGY ANALYSIS (ASTA)
August 1990

Thomas L. Adams

Advanced Decision Systems

DACA76-86-C-0010

Keywords: Radar User Interface, Model-Based Reasoning

ASTA (Assistant for Science and Technology Analysis) provides analytical support for the S&T radar analyst. ASTA automates many of the typical calculations the analyst must perform, maintains consistency, integrates external databases and radar models and provides an easy to use graphical user interface. ASTA provides expert guidance in the analysis of radar systems, accepting values for system attributes, either directly from analyst entry or from the integrated databases, and incrementally infers high-level operational system attributes. The ASTA knowledge base is comprised of hundreds of radar facts, fundamental properties, and heuristic rules used by the rule-based inference engine. The basic inference capability is augmented by many information management tools including a graphical explanation system. ASTA employs a graphical, window-based user interface designed to present radar information in a form familiar to radar analysts.

ETL-0571

AD A239 718

**COOPERATIVE AUTONOMOUS AGENTS TESTBED
FIRST ANNUAL REPORT
August 1990**

Charles Dolan
David Payton
Karel Zikan

Hughes Research Laboratories

DACA76-89-C-0002

Keywords: Planning, Autonomous Agents, Transportation Planning

Efforts during the first year of the contract were concentrated on developing a mathematical formalism for resupply planning. The formalism not only allows efficient plans to be constructed, but also allows those plans to be internalized plans (i.e., flexible plans). Internalized plans allow re-supply agents to be opportunistic in a changing environment. The formalism is based on expressing the re-supply problem as a flow of commodities on a graph. An economic analogy allows the re-supply agents to act as if they were self-serving agents while still accomplishing the global goals.

ETL-0572

AD A238 570

**VISION-BASED NAVIGATION AND PARALLEL COMPUTING
SECOND ANNUAL REPORT
August 1990**

Larry S. Davis
Daniel DeMenthon
Thor Bestul

University of Maryland

DACA76-88-C-0008

Keywords: Autonomous Navigation, Artificial Intelligence, Computer Vision, Search, Parallel Processing

This report summarizes the research performed during the period May 1989 through May 1990, the first year of the contract period. The focus of the research program is visual navigation, with an emphasis on the use of massively parallel algorithms to support basic navigational tasks in vision and planning. The first section describes research performed on a project called RAMBO. (RAMBO is an acronym for Robot Acting on Moving BOdies). The project attempts to develop and integrate Connection Machine algorithms for low-level vision, intermediate level vision and visual planning to allow a mobile robot to pursue (in simulation) a moving three dimensional target through space in order to maintain visual contact with points on the surface of the target. The next section describes our past year's work on cross-country navigation. We first describe massively parallel algorithms for route planning in digital terrain maps. Then we describe our research on the problem, and present new methods. The last section presents brief descriptions of other research projects whose results were reported under this contract during the past year.

ETL-0573

AD A239 496

**HYPERSPECTRAL SIGNATURES (400 to 2500 nm) OF VEGETATION, MINERALS,
SOILS, ROCKS, AND CULTURAL FEATURES:**

I. LABORATORY AND FIELD MEASUREMENTS

December 1990

Melvin B. Satterwhite

J. Ponder Henley

Keywords: Reflectance, Hyperspectral, Spectra, Vegetation, Soil Rocks, Catalog, Spectroradiometric, Arid, Semiarid

The objective of this catalog was to document the visible near-infrared reflectance spectra (400-2500 nm) of vegetation, soils, rocks, and man-made materials, and to provide information about their unique physical and chemical properties. Spectra were taken of representative samples of a particular plant species of soil type and selected conditions so that a specific feature could be evaluated. Seasonal differences in vegetation spectra were measured for tree, shrub, herbaceous, and grass species. Soils having different textures and moisture potentials were measured. These spectra summarize results of ongoing research in different environments, although many of the field spectra were taken in semiarid and arid environments.

ETL-0574

AD B156 709L

AUTOMATED SAR CHANGE DETECTION FOR COMBAT SUPPORT PHASE I (U)

December 1990

Tim Patterson

Advanced Decision Systems (ADS)

DACA76-90-C-0012

Keywords: Synthetic Aperture Radar (SAR), Morphological Filtering, Image Registration, Change Detection

The objective of this project is to design and develop a computer system for automatic change detection using synthetic aperture radar (SAR) to support the timely collection of tactical battlefield intelligence. The system will also report significant changes in the terrain with an emphasis on obstructions to vehicle movement. This Phase I effort has built a breadboard change detection system that has been tested on operational battlefield imagery. Preliminary test results show improvement over current vehicle detection techniques by more than an order of magnitude.

WHAT IS A HILL? AN ANALYSIS OF THE MEANING OF GENERIC TOPOGRAPHIC TERMS

January 1991

Robert R. Hoffman

Keywords: Aerial Photo Interpretation, Psychology of Perception, Artificial Intelligence, Terrain Description

This report is part of the effort to generate artificial intelligence systems for aerial photo interpretation. Such a system requires symbolic definitions of generic topographic terms, especially if the system is to interact with a human operator. The author analyzes the meanings of terms such as "hill," "plain," and "terrace," and adjectival descriptors such as "blocky," "rugged," and "large." A review of literature on topography, geomorphology, and terrain analysis reveals that generic topographic terms occur frequently in descriptions of terrain, especially those intended to communicate the perceptual form of terrain. Yet such concepts--rooted in perception, judgement, and experience--are rarely defined. A terrain analysis data base of over 1,000 propositions about the knowledge of expert aerial photo interpreters was analyzed to extract and categorize approximately 100 generic terms and 250 generic descriptors. The author's approach to defining these terms is based on concepts from ecological optics and the psychology of perception. The definitions themselves are built on concepts from the literature of terrain analysis and topography. This study has implications for practicing terrain analysts and aerial photo interpreters, as well as for the field of artificial intelligence. It suggests some new methods for describing terrain and some clarifications of traditional terminology.

ETL-0577

AD B157 337L

ADRIES PROTOTYPE SYSTEM DEVELOPMENT PROGRAM (1986-1990)

June 1990

Gil Ettinger Rick Chester Tom Shaffer
Tod Levitt Tom Esselman Mike Black

Advanced Decision Systems

DACA76-86-C-0010

Keywords: Synthetic Aperture Radar (SAR), Signal Processing, Knowledge-Based Systems, Artificial Intelligence, Parallel Computer Processing, Distributed Computer Processing

The Advanced Digital Radar Imagery Exploitation System (ADRIES) program has undertaken the design and development of automated techniques to aid in the interpretation and analysis of multiple resolution synthetic aperture radar (SAR) imagery of military land scenes. This report summarizes the accomplishments achieved during the four years of the program. The program culminated in the development of the Intelligent Tactical Screener (INTACTS) system, and end-to-end image exploitation prototype system that integrates contextual and terrain reasoning to identify complex military forces in viewed scenes. It is the first system to define means of using and combining multiple knowledge sources supporting image exploitation in a uniform and coherent paradigm that achieves high efficiency and accuracy through a hierarchical reasoning process.

**ADVANCED DIGITAL RADAR IMAGERY
EXPLOITATION SYSTEM (ADRIES) ANNUAL REPORT
November 1990**

Science Applications International Corporation

Keywords: Synthetic Aperture Radar, Artificial Intelligence, Signal Processing, Parallel Computer Processing, Knowledge-Based Systems, Distributed Computer Processing

The ADRIES program is a three-year, multiple contractor research effort aimed at the development and demonstration of technology to support the automation of tasks required to effectively exploit multiple resolution digital radar imagery. The research focuses on techniques for exploiting Advanced Synthetic Aperture Radar (ASARS) imagery. ADRIES has three major objectives: First, to develop technology in support of automating the image exploitation process. This objective is not limited to image processing, but includes knowledge engineering, distributed processing, and other applicable areas. Second, to develop the Sensor National Testbed (SNTB). The SNTB is a collection of sequential and parallel computer architectures, and associated software, providing a research environment for exploring parallel processing for image understanding. Third, to demonstrate the applicability of the ADRIES program to a real world problem. This final report describes only the latest version of the SAIC contribution to the ADRIES software/hardware system. These contributions include: Spot Mode Detection, Other Source Analysis, Region Database, Image Database, Communication and System Services, and the Executive Controller software components. During this second year, the work at SAIC fell into three general areas: software and integration support for the INTACTS demonstration; continued development of the SNTB; and test and evaluation planning on the completed INTACTS system.

**ADVANCED DIGITAL RADAR IMAGERY EXPLOITATION SYSTEM
(ADRIES) FINAL REPORT (1986-1990)
December 1990**

Science Applications International Corporation

Keywords: Synthetic Aperture Radar, Artificial Intelligence, Signal Processing, Parallel Computer Processing, Knowledge-Based Systems, Distributed Computer Processing

The ADRIES program is a three-year, multiple contractor research effort aimed at the development and demonstration of technology to support the automation of tasks to effectively exploit multiple resolution digital radar imagery. The research focuses on techniques for exploiting Advanced Synthetic Aperture Radar (ASARS) imagery. ADRIES has three major objectives: First, to develop technology in support of automating the image processing exploitation process. This objective is not limited to image processing, but includes knowledge engineering, distributed processing, and other applicable areas. Second, to develop the Sensor National Testbed (SNTB). The SNTB is a collection of sequential and parallel computer architectures, and associated software, providing a research environment for exploring parallel processing for image understanding. Third, to demonstrate the applicability of the ADRIES program to a real world problem. This final report describes only the latest version of the SAIC contribution to the ADRIES software/hardware system. These contributions include: Spot Mode Detection, Other Source Analysis, Region Database, Image Database, Communication and System Services, and the Executive Controller software components.

ETL-0580

AD A238 571

**ROBUST IMAGE UNDERSTANDING - TECHNIQUES AND
APPLICATIONS - FIRST ANNUAL REPORT
December 1990**

Azriel Rosenfeld

University of Maryland

DACA76-89-C-0019

Keywords: Image Understanding, Navigation, Vision, Edge Detection, Path Planning

The research on the contract dealt with image understanding applications to both navigation and recognition. Thirteen technical reports were issued on the contract during this period referred to by numbers in brackets in the remainder of the report. Research on navigation was concerned with the following specific topics which are discussed in further detail in this report: (a) analysis of superimposed moving patterns [1,2]; (b) path and motion planning [5,13]; (c) structure from motion [6]; (d) motion uncertainty [8]; (e) motion illusions [11]; and (f) motion recovery in the presence of discontinuities [12]. Recognition research was concerned with: (g) recognition of compact shapes by energy function minimization [3]; (h) learning of invariant shape properties [4]; (i) slant-insensitive shape descriptors [7]; and (j) edge detection [9] and line fitting [10].

ETL-0581

AD A238 678

**PERCEPTION FOR OUTDOOR NAVIGATION
FIRST YEAR REPORT
December 1990**

**Charles Thorpe
Takeo Kanade**

Carnegie Mellon University

DACA76-89-C-0014

Keywords: Autonomous Navigation, 3-D Perception, Road Following, Obstacle Detection, Terrain Modeling

Research supported by this contract includes perception for road following, terrain mapping for off-road navigation, and systems software for building integrated mobile robots. We overview our efforts for the year, and list our publications and personnel, then provide further detail on several of our sub-projects. During the past year, this contract has supported research on color vision for road following; 3-D perception for terrain mapping and cross-country mobility; and system building for autonomous navigation. We have demonstrated autonomous navigation on a variety of roads, including single lane dirt, gravel, and paved; and multi-lane roads with and without lane markings. Our perception modules use a variety of techniques for video processing (clustering theory, symbolic feature detection, neural nets), and for range data analysis (landmark navigation, reflectance processing). We have also integrated position-based navigation (JNS and GPS), and combinations of all these techniques into mobile robot systems and demonstrations. Our scientific papers this year include a book (Vision and Navigation: the CMU Navlab), three PhD dissertations, and an MS thesis.

ETL-0582

AD B156 491L

**KNOWLEDGE-BASED VISION TECHNIQUES FOR THE AUTONOMOUS
LAND VEHICLE PROGRAM - FOURTH ANNUAL REPORT
December 1990**

Martin A. Fischler
Robert C. Bolles

SRI International

DACA76-85-C-0004

The goal of this research is to develop techniques for automatically acquiring and representing knowledge about complex cultural and natural environments for such purposes as intelligence analysis, planning, navigation, and manipulation. Our research strategy is to (1) develop representations and techniques for storing (or incrementally learning) semantic and geographic information about a specific geographic areas to permit both mission planning and knowledge-based interpretation of sensed data, (2) develop representations for natural and manmade objects, (3) develop techniques to predict distinctive features of these objects that can be used to identify them, and (4) develop techniques for building three-dimensional descriptions of an environment from data gathered by range or intensity sensors moving through this environment. In this report we describe our progress and plans in these areas.

ETL-0583

AD A238 681

**A COMPARISON OF SOILS FROM TWENTYNINE PALMS, CALIFORNIA
AND SAUDI ARABIA
January 1991**

Judy Ehlen
J. Ponder Henley

Keywords: Soils: Twentynine Palms, CA and eastern Saudi Arabia, Sieve Analysis, Soil Moisture, Spectral Reflectance, Soil Color

Soil samples collected at Twentynine Palms, California, and eastern Saudi Arabia were analyzed for particle size distribution, moisture content, spectral reflectance characteristics and soil color. The results of the comparison show that, overall, the Twentynine Palms samples are finer grained than the eastern Saudi Arabian samples. Soil moisture in both sets of samples is low. The samples from eastern Saudi Arabia contain quantities of calcite and gypsum not found in the Twentynine Palms samples. The spectral reflectance of the soils from eastern Saudi Arabia is overall higher than that for the Twentynine Palms soils, and shows variations in infrared reflectance due to chemical differences that are not seen in the Twentynine Palms soils.

**AN AUTOMATED SOFTWARE SYSTEM FOR UPDATING DIGITAL TERRAIN
DATABASES FROM ALL-SOURCE IMAGERY, PHASE I SBIR**
February 1991

J. Curlander A. Stocker
W. Kober J. Thomas

Vexcel Corporation Space Computer Corporation

DACA76-90-C-0013

VEXCEL Corporation's Phase I SBIR research effort for ETL concentrated on the feasibility of creating the primary tools for the prototype development in Phase II of a digital change detection work station. This system is intended to be capable of detecting long-term (6 months to 1 year) and/or seasonal changes from all-source imagery. The system is intended to be hosted on a SUN-4 platform operating under a UNIX/C software environment. The emphasis of the present Phase I effort was on the two major technical challenges for the development of such a system: precision image registration and robust change detection and analysis. Most of this effort was directed toward automated SAR-optical image registration and automated change cuing experiments. Change cuing is an initial step in change detection for identifying regions where possible change events may have occurred. The automated registration and cuing efforts were successful over the data sets tested. The data sets did not contain appreciable terrain-induced distortions. Theoretical improvements for algorithms are recommended for addressing such terrain-induced registration complications in Phase II.

ETL-0585

AD B155 495L

**NEURAL NETWORKS FOR OBJECT DETECTION
USING ALL-SOURCE IMAGERY**
February 1991

David Lavine
Srinivasan Rahavan
Naresh C. Gupta
Barbara A. Lambird

LNK Corporation

Keywords: Multi-Sensor Fusion, Image Analysis, Neural Networks, Gabor Transform, Automated Feature Extraction

Fusion of information from multiple sources is a key ingredient in many decision-making processes. This fusion often benefits from hierarchical decision-making which analyzed the data at various levels of abstraction. This report describes a system for performing fusion with a hierarchy of neural networks to provide this abstraction capability. The fusion system is demonstrated by extracting natural and man-made features from synthetic aperture radar (SAR) and optical imagery. The system is designed to be extensible to a much wider range of feature types and to other types of input data, including data from other types of sensors and collateral data. The uniqueness of the sensor fusion system lies in the efficient use of appropriately tailored neural networks, combining different paradigms to perform different tasks.

**NEW METHODS OF CHANGE DETECTION USING
MULTISPECTRAL DATA
May 1991**

Charles Sheffield
Gil Richardson

Earth Satellite Corporation

This report discusses the final phase of a project to develop multispectral change detection methods with emphasis on human activities. Two new algorithms were developed and tested: a Spectral/Spatial Classifier and a Feature Vector Spectral Classifier. The Spectral/Spatial method appears to be a powerful new tool. The Feature Vector results were inconclusive.

**THERMAL INFRARED SPECTRA OF NATURAL AND MAN-MADE
MATERIALS: IMPLICATIONS FOR REMOTE SENSING**

John Eastes

Keywords: Thermal Infrared Spectra, Spectra of Natural Materials, Spectra of Manmade Materials, Remote Sensing

This report is a compilation of laboratory thermal infrared reflectance spectra recorded over various spectral ranges between 4000 and 400 cm^{-1} (2.5 - 25.0 micrometers) for natural and manmade materials of potential interest to both military and civilian sectors. Knowledge of the position and shape of significant spectral features as detected by remote spectrometers or spectral radiometers is necessary to discriminate between targets on the basis of either spectral emittance or reflectance. Many of the samples in this study display spectral features in either, or both of the 3- to 5- micrometer or the 8- to 14- micrometer regions of the spectrum in which terrestrial remote sensing is possible. Such information can be used to devise image enhancement strategies for data in hand or to design new instruments or experiments utilizing thermal multispectral data.

ETL-0588

AD A244 855

REMOTE SENSING FIELD GUIDE - DESERT
September 1991

The Desert Processes Working Group:

Jack N. Rinker

Carol S. Breed

John F. McCauley (Emeritus)

Phyllis A. Corl

Keywords: In support of military operations, Army terrain analysts are frequently required to provide terrain information about an area, and to do so quickly. Examples of needed information include: location of engineering materials, potential ground water drilling sites, influence of the terrain on cross-country movement, potential for dust generation, potential for cover and concealment, and sites suitable for ambush and defilade. The task is not easy because of the lack of sources for detailed and reliable information. Such information is not yet available in data bases, nor in existing maps, and neither can it be obtained by computer analysis of digital imagery. It can, however, be derived by the manual, or "eyeball," evaluation of image patterns. Although airborne or satellite imagery is now available for most of the world, the translation of these image patterns into forms usable by the terrain analysts has not been done. To bridge this gap, for at least one climatic zone, the Desert Processes Working Group has developed this Remote Sensing Field Guide directed towards desert operations. Although developed for military uses, this guide can serve all who travel and work in desert regions.

ETL-0589

AD A240 454

**A HYBRID METHODOLOGY FOR DETECTING CARTOGRAPHICALLY
SIGNIFICANT FEATURES USING LANDSAT TM IMAGERY**
September 1991

Robert S. Rand

Keywords: A general Change Detection (CD) methodology is investigated that involves a hybrid mix of image processing, spectral transformation, and statistical pattern recognition techniques. The Hybrid Methodology attempts to combine various forms of supporting and conflicting evidence for change into a resulting change map. The approach involves differencing registered multiband scene pairs that have undergone a spectral transformation, generating threshold masks, and applying a classifier to the masked multiband scene pairs.

**MULTISPECTRAL IMAGE MAPS FROM
LANDSAT THEMATIC MAPPER DATA
September 1991**

Robert S. Rand
John E. Anderson
Donald A. Davis

Keywords: This report describes a capability to produce prototype 1:50,000 scale multispectral image maps using Landsat TM data. These image maps are in the standard UTM projection, contain imbedded 1,000 meter grid lines with labeled UTM coordinates, and can easily be used in conjunction with conventional military maps of the same scale. Annotation that gives the title of the standard DMA map of the area, the Landsat TM band combinations, as well as a bar scale and compass were also imbedded into the product.

ETL-SR-4

AD B157 293L

**U.S. ARMY AVIATION DIGITAL TOPOGRAPHIC
DATA REQUIREMENTS FORECAST**

May 1989

W. Craig Dubishar
Christian P. Moscoso

Keywords: Digital Terrain Data (DTD), Army Aviation, Data Requirements Forecast, Helicopters

This forecast consolidates information on the Digital Terrain Data requirements of the U.S. Army aviation community, assesses and analyzes the requirements, and identifies emerging issues. Special Operations Aircraft (SOA) is the primary near-term user of DTD, but the LHX program and simulation efforts will be the drivers for future requirements. It is anticipated that the majority of DTD manipulation and use will occur at the Ground Mission Planning System (GMPS), although DTD will also be used operationally for navigation and map display. Existing and planned DTD products from the Defense Mapping Agency (DMA) will satisfy the majority of aviation requirements. However, the aviation community has a need for additional Vertical Obstruction Data (VOD).

ETL-SR-5

AD B157 299L

Appendix A AD B157 300L

Appendix B AD B157 301L

Appendix C-I AD B157 302L

**PHASE I TACTICAL TERRAIN DATA (TTD)
PROTOTYPE EVALUATION**

Jeffrey A. Messmore
Louis A. Fatale

Keywords: Digital Terrain Data, TTD Prototype, Terrain Analysis, Digital Topographic Data, ISO 8211, MiniTopo

This report documents the results of DoD's Phase 1 Tactical Terrain Data (TTD) Prototype Evaluation. The concept of Tactical Terrain Data as the data base to support joint land combat evolved from an initial Army requirement for digital topographic data (DTD) forwarded to DMA in October 1984. The evaluation community consisted of the respective Army, Navy and Air Force laboratories; the U.S. Army Engineer Topographic Laboratories (USAETL), the Naval Ocean Research and Development Activity (NORDA), and the Rome Air Development Center (RADC), as well as many tactical, test, training, and simulation systems and programs. The key aspects of the data set that were evaluated were: accuracy, resolution, content, and data structure. The report presents a set of conclusions and makes recommendations to the Defense Mapping Agency concerning the future direction of TTD production.

**DIGITAL TERRAIN ELEVATION DATA RESOLUTION AND
REQUIREMENTS STUDY - INTERIM REPORT
November 1990**

James R. Ackeret

Keywords: Digital Terrain Elevation Data (DTED), Digital Terrain Data (DTD) requirements, Computer Image Generation (CIG), Resolution, Terrain Visualization, Terrain Classification, Threat Analysis, Line of Sight (LOS)

The DTED resolution requirement has been a controversial subject for many years among users of U.S. Army battlefield and simulator systems. The controversy has focused on the higher cost of producing high resolution DTED and the additional time required to produce a world-wide database at this resolution. The purpose of this study is to report the influence of DTED resolution on various terrain elevation applications. TRADOC Analysis Command, White Sands Missile Range, (TRAC-WSMR), also participated in this study by conducting an in-depth threat analysis. This interim report documents the results of the USAETL DTED resolution analysis and the TRAC-WSMR threat analysis for the determination of the most desirable DTED resolution for various Army tactical and simulation applications.

**PDEF: A STANDARD FILE FORMAT FOR DATA INTERCHANGE
January 1991**

Michael M. McDonnell

Keywords: Geographic Information System, Data Interchange, Spatial Data Storage, Data Exchange, Reformatting

This report explains a new method of encoding data in a set of files that allows advantages over current formats and methods. A new format is necessary because all current widely-available file formats retain restrictions (such as fixed field lengths) that are no longer necessary with modern programming languages. In particular, the ability to be parsed by FORTRAN programs was formerly an important requirements. The limitations of FORTRAN lead to file formats that are clumsy and difficult to work with. The proposed format has a simple syntax and flexible semantics. The format is efficient both for computers and people. It is efficient for computers because it makes use of the powerful parsing tools available for the C programming language. It is efficient for people because data descriptions are in a human-readable form and the content of a data file can be understood without a user's manual. The bulk of this report is in appendixes which give illustrative examples. Examples are presented for raster, quadtree, and vector data formats since these formats are especially prevalent in spatial data systems, a specialty of the U.S. Army Engineer Topographic Laboratories. PDEF stands for Protean Data Exchange Format.

PAPERS

Ackeret, James R. See Lambert, Robin B.

Anderson, John E., and Donald A. Davis. "Using Remote Sensing and GIS to Enforce Corps Wetlands Policy." U.S. Army Corps of Engineers (USACE), Seventh Sensing Symposium, Portland, Oregon, 7-9 May 1990.

Barr, Samuel. See Rinker, Jack N., Dr.

Benton, John, and Anne Brink. "A Hierarchical Route Planner." 1990 Army Science Conference, Durham, North Carolina, 12-15 June 1990.

Boge, Walter E. "U. S. Army Terrain Management Activities." International Conference of Nations Developing Computer Assisted Combat Command Systems, Munich, Germany, 18-19 February 1991.

Bradley, John P. See Lambert, Robin B.

Breen, Jerry M. "Airland Battlefield Environment Tactical Decision Aids." American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping 1990 Conference, Denver, Colorado, 18-23 March 1990.

Brink, Anne. See Benton, John.

Brink, Anne, and John Benton. "Quadrees, X Windows and Predicting Minefields." National Computer Graphics Association Mapping and Geographic Information Systems '89, Los Angeles, California, 12-15 November 1989.

Cox, Thomas M., Jr. See Fosburgh, Bryn.

Davis, Donald A. See Anderson, John E.

Desmond, Gregory B. "Design and Development of the Terrain Information Extraction System." USACE Seventh Remote Sensing Symposium, Portland, Oregon, 7-9 May 1990.

Ehlen, Judy. "Significant Geomorphic and Petrographic Relations with Joint Spacing in the Dartmoor Granite, Southwest England." Second International Conference on Geomorphology, Frankfurt, Germany, 3-9 September 1989.

Fatale, Louis A. See Lambert, Robin B.

Fosburgh, Bryn A., and Thomas M. Cox, Jr. "Absolute Positioning Using the Global Positioning System." U.S. Army Corps of Engineers Surveying Conference, Louisville, Kentucky, 16-19 July 1991.

PAPERS (continued)

Frodge, Sally L. See Lanigan, Carl A.

Gomez, Richard B., Dr. "The Corps and the Space Program." Army Space Symposium, Bethesda, Maryland, 16 May 1990.

Gomez, Richard B., Dr. "A Green Wars Challenge to EOSAEL." Eleventh Annual Electro Optical Sensor Atmospheric Effects Library/Tactical Weather Intelligence (OSAEL/TWI), Las Cruces, New Mexico, 27-30 November 1990.

Gomez, Richard B., Dr. "Space Based Lidar." DOD Environmental Technical Exchange Conference on Mesoscale Phenomena, Laurel, Maryland, 23-27 January 1989.

Greczy, Laslo. "Terrain Visualization." Mapping, Charting & Geodasy Officers' Course (MC&GOC), Conference, Humphreys Engineer Center, Ft. Belvoir, Virginia, 7-9 November 1989.

Greczy, Laslo. "Terrain Visualization." National Computer Graphics Association Mapping and Geographic Information Systems '89, Los Angeles, California, 12-15 November 1989.

Greczy, Laslo. "Computer Image Generation (CIG)." American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping 1990 Conference, Denver, Colorado, 18-23 March 1990.

Henley, J. Ponder. "Spectral Characteristics of Some Saline Playa Surfaces and their Application to Multispectral Imagery Analysis." American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping 1990 Conference, Denver, Colorado, 18-23 March 1990.

Joy, Richard T. See Lambert, Robin B.

Kershner, C. Mark. "ALBE Tech Demo Program." DoD Joint Services Decision Aids Working Group NDU (DAWG) Conference, Fort McNair, Washington, D. C., 24-27 June 1991.

Lambert, Robin J.; John P. Bradley; Barbara G. Rose; James R. Ackeret; Louis A. Fatale; and Richard T. Joy. "Digital Topographic Data Support for Smart Weapons." Army Materiel Command Smart Weapons Conference, Adelphi, Maryland, 14-16 August 1990.

Lanigan, Carl A. "Real Time Differential (DGPS) GPS Data Line Alternatives." ION GPS-90 3rd International Technical Meeting, Colorado Springs, Colorado, 19-21 September 1990.

Lanigan, Carl A. "Continuous Deformation Monitoring with GPS." American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) 1990 Conference, Denver, Colorado, 18-23 March 1990.

Lanigan, Carl A., and Sally L. Frodge. "GPS for the Hydrographic Surveyor: Meters Today, Centimeters Tomorrow." U.S. Army Corps of Engineers Surveying Conference, Louisville, Kentucky, 16-19 July 1991.

PAPERS (continued)

Logan, Kevin P. "Real-Time Decimeter-Level Positioning System Using Global Positioning System (GPS)." U. S. Hydrographic Conference '90, Norfolk, Virginia, 1-4 May 1990.

Logan, Paul G. "Terrain Information Extraction System Support to Planning." Automated Mission Planning Society Symposium, Reston, Virginia, 16-18 July 1991.

Marth, Richard B., Sr. "Project 39, Terrain Analysis Center Modernization, Garrison Topographic Support." 12th Annual U.S. Army Topographic Conference, Humphreys Engineer Center, Ft. Belvoir, Virginia, 11-13 October 1989.

Maune, David F., Colonel. "Digital Topographic Support System (DTSS)." Symposium on Geographical Information Systems for Command and Control (Geo-89), The Hague, The Netherlands, 2-6 October 1989.

Maune, David F., Colonel. "Topographic Engineer Support of Operation Desert Storm (U)." (Classified). DoD Joint Services Decision Aids Working Group (DAWG) Conference, Fort McNair, Washington, D. C., 24-27 June 1991.

McDonnell, Michael. "Scan-Line Methods in Spatial Data Systems." International Symposium of Spatial Data Handling, Zurich, Switzerland, 23-27 July 1990.

Niles, Anthony R. "Computer-Aided Navigation and Drafting Sytem for Revetment Construction Floating Plant." U.S. Army Corps of Engineers Surveying Conference, Louisville, Kentucky, 16-19 July 1991.

Olesak, John F., Lieutenant Colonel. "Managing the Digital Topographical Revolution." DoD Joint Services Decision Aids Working Group (DAWG) Conference, Fort McNair, Washington, D. C., 24-27 June 1991.

Rinker, Jack N., Dr. "Hyperspectral Imagery - What Is It? - What Can It Do?" U. S. Army Corps of Engineers Seventh Remote Sensing Symposium, Portland, Oregon, 7-9 May 1990.

Rinker, Jack N., Dr., and Samuel Barr. "Hyperspectral Imagery - A New Technique for Targeting and Intelligence." 1990 Army Science Conference, Durham, North Carolina, 12-15 June 1990.

Rose, Barbara G. See Lambert, Robin B.

Satterwhite, Melvin B. "Spectral Luminescence of Plant Pollen." IEEE Geosciences and Remote Sensing Society/URSI 1990 International Symposium, College Park, Maryland, 20-24 May 1990.

Satterwhite, Melvin B. "Spectral Luminescence of Some Camouflage Fabrics and Paints." 1990 Army Science Conference, Durham, North Carolina, 12-15 June 1990.

Sither, Mark A. "Spatial Data Transformation: Future Attribute Conversion Issues and Practical Experience." 1991 American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference, Baltimore, Maryland, 25-29 March 1991.

PAPERS (continued)

Shannon, Brian F. "Hydrographic Surveying Equipment Used Today for Dredged Volume Measurement." U.S. Army Corps of Engineers Surveying Conference, Louisville, Kentucky, 16-19 July 1991.

Simcox, George. "Digital Terrain Data: Terrain Visualization and the Space Component." Special Operations Forces Mission Area Planning (SOFMAP) Conference, U.S. SOCOM, Tampa, Florida, 22-23 May 1990.

Smith, Harold L. See Niles, Anthony R.

Werkheiser, Anne. "The Terrain Analysis System 'Carat'." 28th U.S. Army Operations Research Symposium, Ft. Lee, Virginia, 10-12 October 1989.

Werkheiser, Anne. "Automated Terrain Reasoning." U.S. Army Research Office Conference on Simulation of Artificial Intelligence, Falls Church, Virginia, 31 July - 2 August 1991.

Wilhelm, Stanton, "Use of a GIS to Automate the Water Resources Data Base." 12th Annual U.S. Army Topographical Conference, Fort Belvoir, Virginia, 11-13 October 1989.

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Accuracy of Cartometric Data	AD 810 496	1966
Accurate Ephemeris Time Determination and Geocentric Stations Position from Photographs of the Moon Against Stellar Background	ETL-RN-72-4	1972
Acousto-Optic Technology for Topographic Feature Extraction and Image Analysis	ETL-0256	1981
Adjunct Development Test II (DT II) of Position and Azimuth Determining System AN/USQ-70	ETL-0217	1980
Acquisition and Evaluation of Thermal Standard Data	ETL-0218	1980
ADRIES Prototype System Development Program (1986-1990)	ETL-0577	1990
Advanced Continuous Tone Plate and Process Compatible with Present Military Lithographic Reproduction Equipment and Practices	ETL-0056	1975
Advanced Digital Radar Imagery Exploitation Robust System (ADRIES) Annual Report	ETL-0578	1990
Advanced Digital Radar Imagery Exploitation System (ADRIES) Final Report (1986-1990)	ETL-0579	1990
Advanced Edit System	ETL-0295	1983
Advanced Development Prototype (ADP) for the Quick Response Multicolor Printer (QRMP)	ETL-0392	1987
Advanced Feature Symbolization for Three Dimensional Views	ETL-0223	1980
Advanced Methods for the Calibration of Metric Cameras	AD 706 870	1968
Advanced Radar Topographic Application	ETL-CR-73-2	1973
Advanced Satellite Hardware/Software System Study	ETL-0225	1980
Advanced Satellite Tracking Instrumentation Study	AD 882 2546	1968
Advanced Study of a Position and Azimuth Determining System (Final)	AD 844 930L	1968
Advanced Study of a Position and Azimuth Determining System (Addendum)	AD 848 369L	1968
Advanced Study of a Position and Azimuth Determining System (Supplement)	AD 861 446L	1969
Advanced Techniques for the Reduction of Geodetic SECOR Observation (Final)	AD 640 238	1966
Advanced Techniques for the Reduction of Geodetic SECOR Observation (Supplement)	AD 664 744	1967
Aerial Triangulation by Least Squares, Final Report	AD 140 062	1957
AGFA Contour Film	ETL-TR-73-1	1973
Airborne Positioning and Attitude Data Application Study, Phase I	AD 815 525L	1967
Airborne Positioning and Attitude Data Applications Study, Phase II	AD 815 526L	1967

Air Photo Analysis, Photo Interpretation Logic, and Feature Extraction	ETL-0329	1984
Algorithms for Digital Terrain Data Modeling	ETL-0302	1982
All-Weather Mapping Contour Plotting Program		1965
Alternative Theories of Inference in Expert Systems for Image Analysis	ETL-0382	1985
Altimeter, Surveying, 4500 Meters, 2-Meter Divisions	1350-TR	1954
Analog Graphic Processing for 3-D Terrain Displays, Profiles, and Elevation Layer Tints	ETL-0026	1975
Analog to Digital Converter to Digital Magnetic Recorder Interface	ETL-CR-71-4	1971
Analysis and Development of Digital Mapping System Software	ETL-CR-74-5	1974
Analysis and Development of Image Statistics and Redundancy Removal	ETL-0239	1980
Analysis and Simulation of Discrete Digital Image Matching	ETL-0278	1981
Analysis and Test Results of a Gyrocompass With Reduced Susceptibility to Shock, Vibration, and Motion	ETL-0501	1988
Analysis and Tests of Environmental Effects on Gyrocompassing Accuracy	ETL-0378	1984
Analysis of Air Photo and Radar Imagery of Barro Colorado Island, Panama, An	ETL-0540	1989
Analysis of a Relaxation Scheme to Improve Terrain Elevation Data, An	ETL-0298	1982
Analysis of Edge Detection Algorithms on DIAL	ETL-0371	1985
Analysis of GEOS PC-1000 and SECOR Data	AD 882 165L	1967
Analysis of Interactive Image Cleansing Via Raster-Processing Techniques	ETL-0347	1983
Analysis of LANDSAT Systems for Cartographic and Terrain Information (Report No. 9 in the ETL Series on Remote Sensing)	ETL-0103	1977
Analysis of Multispectral Scanner Data for Location of Sand and Gravel Deposits	AD 705 673	1970
Analysis of Radar Calibration Data (Final)	AD 827 858L	1967
Analysis of Radar Calibration Data (Supplement)	AD 836 943L	1968
Analysis of SECOR Data — Vol. I	AD 865 488L	1968
Analysis of SECOR Data — Vol. II	AD 865 489L	1969
Analysis of the Max-Min Texture Measure, An	ETL-0280	1982
Analysis, Storage and Retrieval of Elevation Data with Applications to Improve Penetration	ETL-0179	1979
Analytic Aerotriangulation: Triplets and Sub-Blocks Including Use of Auxiliary Data	AD 631 072	1965
Analytical Aerial Triangulation	1510-TR	1958

TITLE	REPORT NO.	YEAR
Analytical Aerial Triangulation Error Analysis and Application of Compensating Equations to the General Block Triangulation and Adjustment Program (Interim)	AD 271 442	1961
Analytical Aerial Triangulation Error Analysis and Application of Compensating Equations to the General Block Triangulation and Adjustment Program (Final)	AD 401-689	1962
Analytical Aerial Triangulation with Large Computer (Analytical Simultaneous Block Triangulation Technique)	34-TR	1966
Analytical Aerial Triangulation with Small Computer	13-TR	1963
Analytical Aerotriangulation Using Triplets in Strips	AD 668 683	1965
Analytical Photogrammetric Position System (APPS)	ETL-TR-74-2	1973
Analytical Photogrammetric Position System (APPS) to Support the Field Army	ETL-TR-74-4	1974
Apparent Temperature and Emissivity of Natural Surfaces at Microwave Frequencies	AD 872 878L	1970
Appendix III Narrative Report for Geoscience Overlays		1968
Application of a Feature Selection Technique to Samples of High Resolution Synthetic Aperture Radar Imagery	ETL-0330	1983
Application of a Phase Comparison Radiolocation System to Distance and Position Measurement over Mountainous and Desert Terrain		1957
Application of Artificial Intelligence to Radar Image Understanding	ETL-0387	1985
Application of Biorthogonal Filter Functions to Pattern Recognition and Feature Extraction	ETL-0222	1980
Application of Coriolis Force to Geodetic Measurements	AD 477 136	1965
Application of Hierarchical Data Structures to Geographical Information Systems	ETL-0301	1982
Application of Hierarchical Data Structures to Geographical Information Systems (Phase II)	ETL-0337	1983
Application of Hierarchical Data Structures to Geographical Information Systems (Phase III)	ETL-0376	1984
Application of Hierarchical Data Structures to Geographical Information Systems (Phase IV)	ETL-0411	1985
Application of Inertial Techniques to Surveying	AD 805 156	1966
Application of Image Sensing Arrays to Metrology, Detection and Instrumentation	ETL-CR-71-6	1970
Application of Image Sensing Arrays to Metrology, Detection and Instrumentation	ETL-CR-72-5	1972

TITLE	REPORT NO.	YEAR
Application of Image Sensing Arrays to Metrology, Detection and Mapping, Interim	ETL-CR-74-9	1974
Application of LORAC to Precision Terrestrial Line-Length Measurement and Position Fixing	AD 232 015	no date
Application of Scalar Renormalization to the Scattering of Electromagnetic Waves from a Three-Dimensionally Inhomogeneous Medium with Strong Dielectric Fluctuations	ETL-0020	1975
Applications of Advanced Accelerometers to Surveying and Geodesy I	AD 429 324L	1963
Applications of Advanced Accelerometers to Surveying and Geodesy II	AD 439 969L	1964
Applying Photogrammetry to Real Time Collection of Digital Image Data	ETL-0275	1981
Approach to Model Formation Based on Formal Geometric Reasoning, An	ETL-0493	1988
Approach to the Evaluation of Strategies in Insurgency, An	AD 722 787	1968
APPS-IV Civil Works Data Extraction/Data Base Application Study (Phase I)	ETL-0310	1982
APPS-IV Civil Works Data Extraction/Data Base Application Study (Phase II)	ETL-0336	1983
APPS-IV Remote Sensing Applications Guide	ETL-0333	1983
ARK-1 Gyro Aiming Circle (Wild Heerbrugg Instruments, Inc.)	49-TR	1969
ARMIDOP/ZERO-DOP Positioning Technique	ETL-RN-71-2	1971
Army Tactical Terrain Data Requirements Forecast (FY87-FY93)	ETL-SR-1	1987
Army Terrain Information System	ETL-0050	1976
Artifact Removal in Frequency Domain Compressed Imagery	ETL-0233	1980
Artillery Survey System, Phase 1 — Study of Methods	AD 883 288L	1958
Aspects and Methods of Nonisotropic Land Navigation Error Control Including Consideration of Topography	ETL-RN-71-4	1971
Assessment of Inertial Technology for Gravity Survey Applications	ETL-0291-1	1982
Assessment of Means for Determining Deflection of the Vertical	ETL-0303	1982
Assistant for Science and Technology Analyst (ASTA)	ETL-0570	1990
Associative Array Processing of Raster Scanned Data for Automated Cartography	ETL-0046	1976
Associative Array Processing of Raster Scanned Data for Automated Cartography II (Improved Resolution and Data Handling)	ETL-0132	1977

TITLE	REPORT NO.	YEAR
Associative Array Processing for Topographic Data Reduction	ETL-CR-74-1	1974
Associative Array Processing for Topographic Data Reduction, Final Report	ETL-CR-74-20	1974
Astrogeodetic-Inertial Methods for Vertical Deflection Determination	ETL-0414	1985
Astronomical Attachment Azimuth Determination, Reflecting, for Transit or Theodolite	1374-TR	1954
ATF-Hadego Photocompositor Photolettering Machine	1414-TR	1955
Atmospheric Refraction	TR-61-505	no date
Atmospheric Refraction for Satellite Photography	56-8B-1	1962
Autocorrelation of Control Points on 11-Band Multispectral Imagery	ETL-0473	1987
Autonomous Land Vehicle (ALV) Program - Seventh Quarterly Report, The	ETL-0496	1988
Approach to Model Formation Based on Formal Geometric Reasoning, Second Annual Report, An	ETL-0527	1989
Automated Extraction of Airport Runway Patterns From Radar Imagery	ETL-0567	1990
Automated Feature Attribute Accessing From Map Text	ETL-0517	1988
Automated Industrial Feature Extraction from Synthetic Aperture Radar Imagery	ETL-0459	1987
Automated Processing of Geographic Information in Image Data Forms	ETL-0114	1977
Automated Route Finder for Multiple Tank Columns	ETL-0480	1987
Automated SAR Change Detection for Combat Support Phase I	ETL-0574	1990
Automated Segmentation and Extraction of Area Terrain Features From Radar Imagery	ETL-0554	1990
Automated Software System for Updating Digital Terrain Databases From All-Source Imagery, Phase I SBIR	ETL-0584	1991
Automated Technique for Measuring Built-Up Urban Areas from Map Graphics through Analog Image Processing	ETL-0012	1975
Automatic Contour Digitizer (ACD)	ETL-ETR-71-2	1971
Automatic Contouring Instrumentation	1488-TR	1957
Automatic Control of Digital Stereo Correlation Methods	ETL-0356	1984
Automatic Correlation of USGS Digital Line Graph Geographic Features to GNIS Names Data	ETL-0426	1986
Automatic-electro Optical Satellite Triangulation System	RN-23	1967
Automatic Feature Extraction/Algorithm Testing	ETL-0410	1985

TITLE	REPORT NO.	YEAR
Automatic Feature Extraction: An Annotated Bibliography	ETL-0189	1979
Automatic Line Network Extraction From Aerial Imagery of Urban Areas Through Knowledge Based Image Analysis	ETL-0568	1989
Automatic Map Compilation System	AD 277 456	1962
Automatic Point Marking Measuring and Recording Instrument	AD 610 044	1964
Automatic Point Transfer Instrument	AD 834 230L	1968
Automatic Reseau Measuring Equipment (ARME)	ETL-0099	1976
Automatic Stereo Perception of Aerial Photography by Means of Optical Correlation	AD 406 363	1962
Automatic Radar Feature Extraction System Using Descriptors	ETL-0533	1989
Automatic Type/Symbol-Placement Developments	ETL-TR-74-9	1975
Automation of Airborne Profile Recorder Data Reduction (Interim)	AD 805 562L	1966
Automation of Airborne Profile Recorder Data Reduction (Final)	AD 825 545L	1967
Autonomous Ground Vehicles: Control System Technology Development	ETL-0375	1984
Autonomous Land Vehicle	ETL-0413	1986
Autonomous Land Vehicle (ALV) Planning and Navigation System	ETL-0465	1987
Autonomous Land Vehicle (ALV) Program Phase II - First Quarterly Scientific and Technical Report, The	ETL-0515	1988
Autonomous Land Vehicle (ALV) Program Phase II - Second Quarterly Scientific and Technical Report, The	ETL-0526	1988
Autonomous Land Vehicle 1st Quarterly Report, The	ETL-0430	1986
Autonomous Land Vehicle 2nd Quarterly Report, The	ETL-0436	1986
Autonomous Land Vehicle (ALV) Program, Third Quarterly Report, The	ETL-0450	1986
Autonomous Land Vehicle (ALV) Program, Fourth Quarterly Report, The	ETL-0460	1987
Autonomous Land Vehicle (ALV) Program, Fifth Quarterly Report, The	ETL-0468	1987
Autonomous Land Vehicle (ALV) Program, Sixth Quarterly Report, The	ETL-0483	1987
Autonomous Land Vehicle (ALV) Program, Seventh Quarterly Report, The	ETL-0496	1988
Autonomous Land Vehicle (ALV) Program Phase I, Final Report	ETL-0506	1988
Autonomous Land Vehicle (ALV) Planning and Navigation, Second Annual Report	ETL-0511	1988
Autonomous Land Vehicle (ALV) Planning and Navigation System, Final Annual Report	ETL-0539	1989

TITLE	REPORT NO.	YEAR
Background Study and Selection Criteria Analysis of MIL-STD-810C: Environmental Test Methods	ETL-0154	1978
Backscattering of Electromagnetic Waves from a Slightly Rough Surface with a Lossy Layer	ETL-TR-74-10	1974
Backscattering of Electromagnetic Waves from a Surface Composed of Two Types of Surface Roughness	ETL-TR-71-4	1971
Backscattering of Radar Waves by Vegetated Terrain	ETL-0105	1977
Backscattering of Radar Waves from a Tilted, Slightly Rough Surface	ETL-0124	1977
Base Plant Correlator	ETL-CR-71-15	1971
Base Plant Correlator (Final)	ETL-CR-73-3	1973
Basic Factors Limiting the Accuracy of Mapping and Aerotriangulation by Photogrammetric Procedures	AD 77 390	1955
Bayesian Approach to Identification of a Remotely Sensed Environment	AD 860 060	1969
Bibliographic Literature Search Concerning the Relationship Between Soils and Plants in Arid and Semi-Arid Regions in North America	ETL-0171	1978
Bibliography and Abstracts of Analytical Photogrammetry	1487-TR	1957
Bibliography of In-House and Contract Reports	ETL-SR-70-1	1970
Bibliography of In-House and Contract Reports, Supplement 1	ETL-SR-71-3	1971
Bibliography of In-House and Contract Reports, Supplement 2	ETL-SR-72-3	1972
Bibliography of In-House and Contract Reports, Supplement 3	ETL-0013	1975
Bibliography of In-House and Contract Reports, Supplement 4	ETL-0042	1976
Bibliography of In-House and Contract Reports, Supplement 5	ETL-0104	1977
Bibliography of In-House and Contract Reports, Supplement 6	ETL-0143	1978
Bibliography of In-House and Contract Reports, Supplement 7	ETL-0180	1979
Bibliography of In-House and Contract Reports, Supplement 8	ETL-0216	1980
Bibliography of In-House and Contract Reports, Supplement 9	ETL-0255	1981
Bibliography of In-House and Contract Reports, Supplement 10	ETL-0282	1982

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Bibliography of In-House and Contract Reports, Supplement 11	ETL-0320	1983
Bibliography of In-House and Contract Reports, Supplement 12	ETL-0353	1984
Bibliography of In-House and Contract Reports, Supplement 13	ETL-0395	1985
Bibliography of In-House and Contract Reports, Supplement 14	ETL-0434	1986
Bibliography of In-House and Contract Reports, Supplement 15	ETL-0500	1988
Bibliography of In-House and Contract Reports, Supplement 16	ETL-0550	1989
Bibliography on the Chemical Weathering of Granitic Rocks, A	ETL-0505	1988
Bimodal Display	ETL-0110	197
Blue Laser	ETL-0412	1985
Broad-Spectrum Electromagnetic Spectrum Backscatter	AD 878 341L	1970
Brush Surfaced Lithographic Press Plates	1452-TR	1956
Building a 3-D World Model for a Mobile Robot from Sensory Data	ETL-0490	1988
Built-Up Area Feature Extraction: First Year Report	ETL-0561	1990
Built-Up Area Feature Extraction: Second Year Technical Progress Report	ETL-0562	1990
Camera Calibration Study		no date
Capabilities of Remote Sensors to Determine Environmental Information for Combat	ETL-0081	1976
Cartographic Application of Conflex I	AD 882 789L	1964
Cartographic Design Standards — A Preliminary Investigation		1967
Cartographic Drafting Methods and Equipment	1305-TR	1953
Cartographic Drafting Methods and Equipment (Plastic Scribing Process) Second Interim Report	1339-TR	1954
Cartographic Electron Beam Recorder (EBR) System	ETL-0111	1977
Cartographic Electron Beam Scanner Design Study	ETL-0257	1981
Cartographic Scanner Plotter	ETL-CR-72-12	1972
Change Detector Maintenance Instructions		1966
Change Detector Operation Manual		1965
Change Detector Studies		1961
Characterization and Optimization of an Electro-Optic Imaging Device for Real-Time Map Profiling	ETL-CR-74-18	1974

TITLE	REPORT NO.	YEAR
Characterization of the PROM for Coherent Optical Processing Applications	ETL-0053	1976
Charging Equipment, Mobile (CEM)	ETL-0089	1976
Chemical Array Studies	ETL-0130	1977
Circularly Polarized Measurements of Radar Backscatter from Terrain	ETL-0199	1980
Circularly Polarized Measurements of Radar Backscatter from Terrain and Snow Covered Terrain	ETL-0234	1980
Circumpolar Method for Determining Azimuth	ETL-0317	1983
Classification and World Distribution of Vegetation Relative to V/STOL Aircraft Operations	ETL-SR-74-4	1973
Classification of Cartographic Features Through Walsh Transforms	ETL-0290	1982
Classification of Metamorphic Rocks and Their Applications to Air Photo Interpretation Procedures, The	ETL-0341	1983
Classification of Selected Radar Imagery Patterns Using a Binary Tree Classifier	ETL-0442	1986
Climatic Information for Application in Designing and Testing U.S. Army Materiel	ETL-0474	1987
CMU (Carnegie-Mellon University) Strategic Computing Vision Project Report: 1984 to 1985	ETL-0466	1987
Coated Paper and Developer for Continuous Tone Electrophotography	AD 674 241	1968
Cold Weather Testing of 10-Second Direction Theodolite, 1-Minute Direction Theodolite (Foreign Model), Astronomical Attachment, and Winterization Kit	1288-TR	1953
Color Contact Printer Mark III	ETL-ETR-70-9	1970
Color Ink-Jet Demonstration Program	ETL-0196	1979
Color Orthophotomaps	ETL-ETR-72-2	1972
Color Separation System Evaluation	AD 672 078	1968
Combination Map Reproduction Van Body	1536-TR	1958
Combined Engineering and Service Tests of the Copy and Supply Van Section of the Motorized Photomapping Train	1444-TR	1956
Combined Engineering and Service Tests of the Map Revision Van Section of the Motorized Photomapping Train	1447-TR	1956
Combined Engineering and Service Tests of the Multiplex Van Section of the Motorized Photomapping Train	1520-TR	1958

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Combined Engineering and Service Tests of the Photomapping Van Section of the Motorized Photomapping Train	1428-TR	1955
Combined Engineering and Service Tests of the Rectifier Van Section of the Motorized Photomapping Train	1544-TR	1958
Command Retrieval Information System/Direct Input (CRIS/DI)	42-TR	1968
Comparative Aerotriangulation Tests of the Multiplex Kelsh Plotter, Stereoplanigraph, Wild Autograph Model A-5, and Wild Stereoplotter Model A-6	1349-TR	1954
Comparative Study of Photography for Soils and Terrain Data	38-TR	1968
Comparison of Soils from Twentynine Palms, CA and Saudi Arabia, A	ETL-0583	1991
Comprehensive Summary of Project Trend	ETL-0041	1975
Computer-Assisted Likely Minesite Prediction Model and Estimated Electromagnetic and Thermal Soil Properties	ETL-0391	1985
Computer for Army Artillery Inertial Survey System (GEISHA)	AD 814 052	1963
Computer Generation of Fractal Terrains	ETL-0504	1988
Computer Program to Simulate Scenario Functions	ETL-0025	1975
Computer Strategy for Detecting Line Features on Simulated Binary Arrays in Support of Radar Feature Extraction	ETL-0478	1988
Computing a Line-of-Sight Using Digital Image Matching and Analytical Photogrammetry	ETL-0027	1975
Consensus Theory in Expert Systems: An Adaptive Inference Framework and Application to Image Understanding	ETL-0524	1988
Concept Development of Automated Image Analysis	ETL-0194	1979
Concept Development of Automatic Instrumentation for Monitoring Movement of Dams	ETL-0187	1979
Concept for an Ultraprecise Geodetic Baseline	RN-24	1967
CONPLOT I — A Contour Generating Program	ETL-CR-70-2	1970
CONPLOT II — A Contour Generating Program	ETL-CR-71-1	1971
CONRAD — A Program to Contour Radar Data	ETL-CR-73-20	1973
Continuous-Tone Electrophotography	AD 673 881	1968
Contour Digitizing and Tagging Software (CONTAGRID)	ETL-0228	1980
Contour-to-Grid Interpolation with Nonlinear Finite Elements: A Feasibility Study	ETL-0472	1987

TITLE	REPORT NO.	YEAR
Contribution to the Philosophy of Climatic Design Limits for Army Materiel: Extreme Hot-Desert Conditions	ETL-TR-72-5	1972
Control Unit for Army Artillery Inertial Survey System (GEISHA)	AD 814 068	1968
Controlled Color for Contact Printing Aerial Imagery	ETL-TR-72-4	1972
Conversion of the CALAP Program from FORTRAN to DUCK. Final Report	ETL-0419	1986
Cooperative Autonomous Agents Testbed - First Annual Report	ETL-0571	1990
Coordinate Measurement Research: Basic and Applied Experiments with the Negative- Reticle Concept	ETL-CR-72-14	1972
Corona Study Relevant to Electrostatic Printing Process	ETL-CR-71-22	1971
Corps of Engineers Maintenance Package for Inertial Survey Equipment	AD 847 498	1963
Correlation of Noisy Images	ETL-0230	1980
Cultural Data Base Implementation Study and Computer-Aided Scene Modeling System Users Manual	ETL-0380	1984
Cumulative Probability Tables for Testing Consensus in Ranking Experiments	ETL-0418	1986
Data Base Sizing Methodology Applied to the Army Terrain Information System (ARTINS)	ETL-0150	1978
Data Integrity Factors Affecting the Construction of the Mapping, Charting, and Geodesy Data Base	ETL-0357	1983
Data Weighing Analysis	AD 672 101	1968
Decision Path Approach to Guidance for Climatic Environmental Test Planning (MIL-STD-810C)	ETL-0183	1979
Defense Mapping Agency Advanced Raster-to-Vector Benchmark Testing	ETL-0420	1986
Defense Mapping Agency (DMA) Raster-to-Vector Analysis	ETL-0383	1984
Defense Mapping Agency (DMA) Raster-to-Vector Analysis — Appendix	ETL-0383A	1984
Defense Mapping Agency (DMA) Raster-to-Vector Benchmark Testing	ETL-0384	1984
Delta Pulse Code Modulation Compression Relative to Stereo Image Matching	ETL-0157	1978
Demonstration and Evaluation of the Utilization of Side-Looking Airborne Radar for Military Terrain Analysis	ETL-0023	1975

TITLE	REPORT NO.	YEAR
Derivation and Potential of New Filter Equations for Numerical Weather Prediction	ETL-RN-71-3	1971
Description of Instrumentation Data Analysis and Reduction for an Atmospheric Seeing Monitor	AD 701 124	1969
Design and Analysis of a High-Production Mini-Computer System for Regridding Digital Terrain Elevation Matrices	ETL-0240	1980
Design and Development of a Position and Azimuth Determining System (PADS)	ETL-CR-71-18	1971
Design and Development of an Advanced Electron Beam Control System	ETL-0032	1975
Design and Development of Power Package for Surveying Instrument: Azimuth, Gyro, Lightweight	ETL-CR-71-5A	1971
Design and Development of Surveying Instrument: Azimuth, Gyro, Lightweight (SIAGL)	ETL-CR-71-5	1971
Design and Fabrication of a 70 Millimeter Interference Imaging System	ETL-CR-71-8	1971
Design and Fabrication of an Experimental Multiband Camera	ETL-CR-71-28	1971
Design and Feasibility Study of an Off-Line Digital Orthoprinter for Field Use	ETL-0149	1978
Design and Feasibility Study of HOC as a Van Mounted Stereo Model Digitizer	ETL-0109	1977
Design, Fabrication, and Test of a Position and Azimuth Determining System (PADS)	ETL-CR-73-6	1973
Design Issues in Video Disc Map Display	ETL-0362	1984
Design, Modification, Fabrication, and Test of a Prototype Miniaturized North Reference Unit (MINRU)	ETL-0276	1979
Design of a Laser Experiment for the Verification of the Inverse Scattering Theory	AD 463 012L	1965
Design of a Map Update Capability for Engineer Topographic Units	ETL-0107	1977
Design of an Experimental Program for Evaluation of LBR Systems	ETL-0182	1979
Design of Engineering Test Model, Topographic Data System		
Volume 1	AD 270 216L	1961
Volume 2	AD 270 205L	1961
Volume 3	AD 270 207L	1961
Volume 4	AD 270 210L	1961
Volume 5	AD 270 209L	1961

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Design Studies and Prototype Model Development of a Small North Orienting Device (Miniaturized Gyrocompass)	ETL-CR-70-4	1970
Design Study of a Large Format Printer (LFP)	ETL-0368	1984
Desk Model Fotosetter Photo-Lettering Machine	1329-TR	1953
Detecting Line-Road and Road-Intersection Patterns at Various Angles	ETL-0274	1981
Determination of Height Differences from Gravity and Gravity Gradients	ETL-71-CR-10	1971
Determination of Level Sensitivity (Field Calibration with the Level on the Instrument)	ETL-RN-74-4	1974
Determination of the Anomalous Gravity Potential from Satellite and Terrestrial Data Under Utilization of Modern Gravimetric Theory	ETL-RN-73-2	1973
Determination of the Geometrical Quality of Comparators for Image Coordinate Measurements	RN-3	1962
Determinations and Statistical Studies of Gravimetric Deflections	ETL-CR-74-8	1973
Determinations and Statistical Studies of Gravimetric Deflections, Final Report	ETL-0017	1975
Determinations of Direct and Inverse Azimuths, Zenith Distance, Hour Angle, Declination and Distance Between Two Points on Normal Sections	RN-19	1967
Determining an Azimuth with a Gyrotheodolite	ETL-0440	1986
Determining the Translation of a Rigidly Moving Surface, Without Correspondence	ETL-0475	1986
Developing a Data Base for Predicting Soviet Tactical Behavior	ETL-0015	1975
Development of a High Precision Capability for Monitoring Structural Movements of Locks and Dams	ETL-0121	1977
Development of an Integrated Mobile Robot System at Carnegie Mellon University	ETL-0546	1989
Development of an Integrated Mobile Robot System at Carnegie Mellon University	ETL-0565	1990
Development of a Prototype Family of Military Geographic Intelligence Products to Support Airmobile Operations	ETL-ETR-70-7	1970
Development of a Small North Orienting Device	AD 869 896L	1970
Development of a Terrain Profile Recorder Image Point Transfer Instrument	AD 649 830	1967
Development of Automatic Names Placement Software	ETL-0484	1987
Development of a Variscale Stereo Point Marking Instrument	AD 643 722	1966

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Development of an Evaluation Model-Change Detector		1965
Development of an Experimental Family of Military Geographic Intelligence (MGI) Products to Support Battlefield Sensor Activities	ETL-TR-72-3	1972
Development of an Integrated Mobile Robot System at Carnegie Mellon University	ETL-0565	1990
Development of an Integrated Mobile Robot System at Carnegie Mellon University	ETL-0546	1989
Development of an Integrated Mobile Robot System at CMU, June 1987 Annual Report	ETL-0508	1988
Development of Computer Vision Techniques for Automatic Feature Extraction	ETL-0451	1987
Development of Descriptor Sets for the Unambiguous Characterization of Geographic Features on SAR Imagery	ETL-0369	1984
Development of Electronic Control of a Superconducting Gravity Gradiometer	ETL-0397	1985
Development of Electronic Control of a Superconducting Gravity Gradiometer — Phase II	ETL-0447	1986
Development of Finite Element Models for the Earth's Gravity Field Phase I: Macro Gravity Model for Satellite Orbit Integration	ETL-0096	1977
Development of Finite Element Models for the Earth's Gravity Field Phase II: Fine Structure Disturbance Gravity Representations	ETL-0097	1977
Development of Height Finder Oblique, Topographic	1383-TR	1954
Development of High Speed CRT Print Head Systems for Cartographic Applications	ETL-0213	1980
Development of Improved Area Correlation Techniques	ETL-CR-73-19	1973
Development of Lightweight Long-Range Survey System (LRSS)	AD 477 042	1965
Development of Spherical Map Sections and Transparent Conforming Overlays	1440-TR	1956
Development, Service Tests, and Production Model Tests, Autofocusing Rectifier	1307-TR	1953
Development, Test, Preparation, Delivery, and Installation of Algorithms for Optimal Adjustment of Inertial Survey Data	ETL-1307	1982
Developmental Optical Correlator	ETL-0033	1975
Digest of High Temperature Storage Literature	ETL-0152	1978
Digital Automatic Map Compilation System	AD 285 258	1962
Digital Cartographic Study and Benchmark	ETL-0168	1978

TITLE	REPORT NO.	YEAR
Digital Cartographic Study and Benchmark — First Interim Technical Report	ETL-0090	1975
Digital Cartographic Study and Benchmark — Second Interim Technical Report	ETL-0091	1975
Digital Cartographic Study and Benchmark — Third Interim Technical Report	ETL-0092	1976
Digital Cartographic Study and Benchmark — Fourth Interim Technical Report	ETL-0093	1977
Digital Computer Program for the Solution of a Photogrammetric Net (Preparation of Maps from Aerial Photographs)	AD 711 858	1961
Digital Data Editing System	ETL-0146	1977
Digital Data to Pressplate Study	ETL-0044	1976
Digital Image Manipulation and Enhancement System (DIMES) User's Handbook	ETL-CR-73-7	1973
Digital Laser Platemaker Modifications	ETL-0379	1984
Digital Map Color Proofing Methodologies Evaluation, Final Report	ETL-0372	1984
Digital Map Color Proofing Methodologies Evaluation, Final Report (Proprietary)	ETL-0373	1984
Digital Mapping Glossary	AD A782 328	1974
Digital Mapping System Concepts Study	ETL-CR-71-26	1971
Digital Mapping System: Mathematical Processing	ETL-CR-74-6	1974
Digital Mapping System Study	ETL-CR-71-25	1971
Digital Multicolor Recorders and Scanner The Technology and the Equipment	ETL-0551	1989
Digital Planimetric Compiler	ETL-ETR-72-1	1972
Digital Pre-Press System Design Study	ETL-0339	1983
Digital Radar Restitution	AD 448 230L	1964
Digital Rectification of Side-Looking Radar (DRESLR)	ETL-CR-73-18	1973
Digital Simulation of a Radar Image of Pisgah Crater Test Site, California	ETL-0019	1975
Digital Terrain Data Compaction Using Array Algebra	ETL-0108	1976
Digital Terrain Elevation Data Resolution and Requirements Study - Interim Report	ETL-SR-6	1990
Digital Terrain Elevation Model Analysis	ETL-0393	1985
Dimensionally Stable Opaque Cartographic Bases	1469-TR	1956
Direct Digital Color Proofing Technology Overview	ETL-0351	1984
Direct Electronic Transforms for Feature Extraction	ETL-0139	1978
Discrete Scattering Approach to Vegetation Modeling	ETL-0215	1980
Discrimination of Tropical Land Use in Puerto Rico: An Analysis Using Multispectral Imagery	ETL-CR-71-20	1971

TITLE	REPORT NO.	YEAR
Discrimination of Water from Shadow Regions on Radar Imagery Using Computer Vision Techniques	ETL-0404	1985
Display Technologies for Topographic Applications. Assessment of State-of-the-Art and Forecast	ETL-0016	1975
Distribution of Mean Monthly Precipitation and Rainfall Intensities	ETL-SR-72-5	1972
Diurnal Freeze-Thaw Frequencies in Selected Regions of the High Latitudes	ETL-0364	1984
Domain-Dependent Reasoning for Visual Navigation of Roadways	ETL-0445	1986
Doppler Satellite for Army Field Operations	AD 470 472	1965
Doppler Translocation Test Program	41-TR	1968
Doppler Translocation Test Program	ETL-ETR-74-5	1974
Dynamic Image Interpretation for Autonomous Vehicle Navigation	ETL-0437	1986
Dynamic Image Interpretation for Autonomous Vehicle Navigation, 1987 End of Year Technical Report	ETL-0516	1988
Dynamic Image Interpretation for Autonomous Vehicle Navigation - Final Report	ETL-0549	1989
Earth's Gravitational Field from Observation of Near-Earth Satellites and Terrestrial Gravity Measurements	RN-30	1968
EBR Extension of Graphics Generator to Include Symbols	ETL-CR-74-12	1974
Edge Detection Experiment Using the MARR Operator, An	ETL-0435	1986
Effects of Soil Moisture and Vegetation on Surface Temperature, The	ETL-0324	1983
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography	AD 226 577	1959
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography	AD 248 726	1960
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography, Final Report		1960
Effects of the Atmosphere on Aerial Photography	TN-70-1	1970
Electrofax Specifications for Army Five-Color Map Reproducing Equipment	AD 841 828L	1968
Electron Beam Recorder Applications Study	ETL-0120	1970
Electronic Angle-Measuring Device	ETL-TR-72-1	1972
Electronic Feedback Control of Mass-Spring Systems	ETL-0398	1985
Electronic Pointing Device (Microwave) System (Electrotransit)	AD 471 726L	1965
Electronic Printing Systems	ETL-0423	1986
Electronic Survey Equipment and Tests	AD-264 454	1960

TITLE	REPORT NO.	YEAR
Electro-Optical Image Processing with an Image Storage Tube	AD A836 685	1968
Electrophotographic Imaging Materials Evaluation	ETL-0266	1981
Electrostatic Paper and Toner Development		1969
Elevation Data Compaction by Polynomial Modeling	ETL-0140	1978
Elevation Data Edit Terminal	ETL-0328	1983
Empirical Surface Temperature Model, An	ETL-0503	1988
Emergency Target Location Function	21-TR	1965
End of Year Report for Parallel Vision Algorithm Design and Implementation	ETL-0467	1987
End of Year Technical Report: Dynamic Image Interpretation for Autonomous Vehicle Navigation	ETL-0463	1987
Engineer Design Test and Evaluation of a Planimetric Compiler	35-TR	1966
Engineer Design Tests and Evaluation of a Multipower Army Stereoscope	12-TR	1963
Engineer Route Reconnaissance Feasibility Study	AD 486 337L	1966
Engineer Test and Evaluation of the Command-Retrieval Information System/Direct Input (CRIS/DI)	42-TR	1968
Engineer Tests of 2.5x Reduction Printer	ETL-ETR-74-7	1975
Engineering Design Test Report: Inertial Surveying Equipment (ISE)	16-TR	1963
Engineering Evaluation of Pulsed Xenon Light Sources for Graphic Arts Use	2-TR	1961
Engineering Test Report: Elevation Meter, Ground	5-TR	1962
Engineering Test Report: Lightweight Gyro Azimuth Theodolite (Lear North-Seeking Gyro Model No. 11NG530A)	11-TR	1963
Engineering Test Report of the Integrated Mapping System	7-TR	1962
Engineering Test Report Short Range Electronic Positioning Equipment (SREPE)	9-TR	1963
Engineering Tests and Evaluation of a 9 by 18 inch Electronic Printer	1646-TR	1960
Engineering Tests and Evaluation of Multiplex Reduction Printer for Metrogon and Distortion-Free Photography	1431-TR	1955
Engineering Tests and Evaluation of Printers for the Preparation of 9½- by 9½-inch Diapositives for the Precision Stereoplotter	1538-TR	1958
Engineering Tests and Evaluation of the Photogrammetric Transforming Printer for 20° Convergent Photograph	1497-TR	1957

TITLE	REPORT NO.	YEAR
Engineering Tests of a Temperature-controlled Processing Unit, Deep-tank, for Photomechanical Film	1599-TR	1959
Engineering Tests of Diapositive Processing Unit	1628-TR	1960
Engineering Tests of Interim Target Location Systems for Use in Controlled Areas	1498-TR	1957
Engineering Tests of Interim Target Location Systems for Use in Uncontrolled Areas	1612-TR	1960
Engineering Tests of Opaque Cartographic Bases	1290-TR	1953
Engineering Tests of Scanning Stereoscope	1491-TR	1957
Engineering Tests of the Cartographic Grid Ruler	1486-TR	1957
Engineering Tests of the Cartographic Van Section of the Motorized Photomapping Train	1373-TR	1954
Engineering Tests of the PPI Radar Presentation Restitutor	1629-TR	1960
Engineering Tests of Translucent Cartographic Bases	1461-TR	1956
Engineering Tests of Two Printer-Developers, Ammonia Process, 24 Inch	1292-TR	1953
Enhanced Photomap Evaluation Study	AD 651 396	1967
Enlarging Printer, 3x	ETL-0049	1976
Environmental Conditions Experienced by Rockets and Missiles in Storage, Transit, and Operations	ETL-CR-74-3	1973
Environmental Conditions Experienced by Rockets and Missiles in Storage, Transit, and Operations, Supplement	ETL-CR-74-3-S	1973
Environmental Conditions in a Tropical Forest Region in Thailand	ETL-0129	1974
Environmental Position Errors of the GPS — Army User Equipment	ETL-0055	1976
Equilibrium Figures and the Normal-spheroid of the Earth Mass-Functions and Isostasy		1968
Equipment and Techniques for the Utilization of Convergent Photography in Mapping	1583-TR	1959
Error-Free Compression of Digital Imagery	ETL-0079	1976
Error Propagation into Orbital Positions	ETL-CR-73-13	1973
Error Propagation in Two-Photo Intersection	ETL-RN-72-1	1972
Error Statistics for Astrogeodetic Positions for an RGSS Test Course	ETL-0267	1981
Errors in Automatic Pass Point Mensuration Using Digital Techniques	ETL-0232	1980
Establishment of an Ideal World Geodetic System	AD 680 225	1968
ETAK Navigator Modification Final Report	ETL-0569	1990

TITLE	REPORT NO.	YEAR
ETL 211-OD Gravitational Model, A Union Solution of Optical and Doppler Satellite Determinations	AD 502 044L	1968
Evaluating Soil Moisture and Textural Relationships Using Regression Analysis	ETL-0226	1980
Evaluation and Comparison of Terrain Classification Methods (Type III)	AD 845 338L	1968
Evaluation and Test of a Five-Color Electrostatic Printing Machine for the Reproduction of Topographic Maps and Charts	25-TR	1965
Evaluation and Test of a Modified Plate Process Section, a Proposed New Photomechanical Process and a Redesigned Brush-Surfacing Machine	1560-TR	1959
Evaluation and Test of a Self-Contained Vehicle Land Navigation System	ETL-0167	1979
Evaluation and Test of a Single-Color Electrostatic Printing Machine for the Reproduction of Topographic Maps and Charts	19-TR	1964
Evaluation of a New Electrostatic Recording Medium	ETL-0102	1977
Evaluation of a Xerographic Process for Preparing Zinc Oxide-Silicone, Binder-Type Lithographic Plates	1545-TR	1958
Evaluation of Automatic Mapping APQ as a Radar Mapping System	31-TR	1966
Evaluation of Coherent Radar Photography	18-TR	1963
Evaluation of Color Recognition Devices for Making Color-Separations from Multicolor Maps and Charts	1401-TR	1955
Evaluation of Color Test Photography for Military Geographic Analysis: A Literature Review	ETL-TR-70-6	1970
Evaluation of Components for Some Elevation-Determining Systems	AD 407 297L	1963
Evaluation of Conventional Correlation Methods When Matching Infrared Imagery to Panchromatic Imagery	ETL-0195	1979
Evaluation of Experimental Xerographic Process for Lithographic Platemaking	1417-TR	1955
Evaluation of High Precision SHORAN-Controlled Photography	1484-TR	1957
Evaluation of Land Use Techniques for Processing MGI	AD 817 124L	1967

TITLE	REPORT NO.	YEAR
Evaluation of Multiband and Color Aerial Photography for Selected Military Geographic Intelligence in a Subtropical Desert Environment	54-TR	1970
Evaluation of Offset Collotype Printing for the Field Reproduction of Aerial Photographs	1465-TR	1956
Evaluation of Pointing to a Sharp Edge	AD 668 260	1968
Evaluation of Published Criteria for Identifying Metamorphic Rocks on Air Photos: Two Case Studies in the Northeastern United States	ETL-0326	1983
Evaluation of Registering Image Gradients When Matching Infrared Imagery to Panchromatic Imagery	ETL-0250	1981
Evaluation of Single and Multicolor Map and Chart Reproduction Equipment	ETL-0080 ETL-0553	1976 1989
Evaluation of the ERDAS Image Processing System and Its Potential Role in the Digital Topographic Support System, An		
Evaluation of the Method of Determining Parallax from Measured Phase Difference	ETL-0145	1977
Evaluation of the Prototype, Natural-Image Computer	48-TR	1969
Evaluation of the Stellar-Moon Camera System	AD 673 270	1968
Evaluation Tests of Royal Zenith, 29 Press	1490-TR	1957
Evidential Reasoning in Expert Systems for Image Analysis	ETL-0381	1985
Experimental Assessment of Improved Spatial Resolution LANDSAT Data	ETL-0268	1981
Experimental Correlator Studies	AD 374 450L	1966
Experimental Determinations of Fringe Counting Errors Associated with Rotation of a Corner Cube Forming an Arm of a Laser Interferometer	RN-26	1967
Experimental Heterodyne Optical Correlator	ETL-0071	1976
Experimental Production of Military Geographic Intelligence Products from Side-Looking Airborne Radar Imagery	AD 376 554	1966
Expert System for Minefield Site Prediction, Phase I, First Year Report	ETL-0492	1988
Expert System for Minefield Site Prediction, Phase II, Final Report	ETL-0534	1989
Expert System for Minefield Site Prediction, Phase III, Final Report	ETL-0552	1989
Expert System for the Computer-Assisted Identification of Features on SAR Imagery, An	ETL-0415	1986
Expert Vision System for Autonomous Land Vehicle Road Following, An	ETL-0489	1988
Extended Area Exit Pupil Viewer	ETL-0399	1985

TITLE	REPORT NO.	YEAR
Extension of Kendall's Concordance Test Where Ties are Allowed, An	ETL-0316	1983
Extraction of Mapping Detail from Radar Photography	AD 328 256	1961
Extraction of Mapping Detail from Radar Photography	AD 328 257	1961
Extreme 24-Hour Snowfalls in the United States: Accumulation, Distribution, and Frequency	ETL-SR-73-4	1973
Feasibility of a Reduced Power-Consumption Magnetometer for Use in a Digicomp Lensatic Compass	ETL-0547	1989
Feasibility of Using Optical Power Spectrum Analysis Techniques for Automatic Feature Classification from High Resolution Thermal, Radar, and Panchromatic Imagery	ETL-0186	1979
Feasibility Study for an All-Weather Surveying Signal Light	37-TR	1968
Feasibility Study for Field Generation of Input for Radar Scene Generation from DLMS Terrain and Elevation Data	ETL-0203	1978
Feasibility Study of a Quick Response Multicolor Printer (QRMP)	ETL-0242	1980
Feasibility Test of a Proposed 3-D Radar System	AD 349 882L	1964
Feasibility Test Program for Measurement of Gravity Anomaly Changes Using 2 MICRO-g Accelerometer in the Inertial Platform	ETL-CR-74-16	1974
Feature Analysis and Reduction of Laws Texture Measure	ETL-0343	1983
Feature Component Reduction Through Divergence Analysis	ETL-0305	1982
Feature Extraction Assessment Study, Final Report	ETL-0377	1984
Feature Extraction of the Illiac IV	ETL-0191	1979
Feature Tagging	ETL-0227	1980
FEED Evaluation	ETL-0322	1983
FEED Software Documentation	ETL-0335	1983
Fictitious Data Generator for Analytical Aerotriangulation	AD 640 799	1965
Field Artillery Plotting Equipment	1421-TR	1955
Final Report, Development of Mirror Stereoscope	1382-TR	1954
Final Report on Stable Cartographic Bases	1542-TR	1958
Final Report, Study of Digital Matching of Dissimilar Images	ETL-0244	1980
Finite Element Models of the Earth's Gravity Field Phase IV	ETL-0198	1979
Five-Color Separation Investigation	AD 662 725	1967

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Fixed and Multiple Frequency Angle Measurements with 35-GHz Microwaves	33-TR	1966
Floodplain Tree Species: A Bibliographic Literature Search with Abstracts	ETL-0193	1979
Flux Valve Heading Reference System	ETL-0134	1977
Forced Dynamics of Asymmetric Spacecraft	ETL-0039	1976
Forecast for the 1970's in Mapping, Charting, and Geodesy Research and Development	TN-70-2	1970
Formulas for Computing Atmospheric Refraction for Objects Inside or Outside the Atmosphere	RN-8	1963
Formulation of a Space Oblique Mercator Map Projection	ETL-0131	1977
Fort Belvoir Text Placement System, Final Technical Report	ETL-0199	1979
Fourier Transform Autocorrelation	ETL-0184	1979
Fractures in Rock: An Annotated Bibliography	ETL-0555	1990
Frequency Dependence of Backscatter from Rough Surfaces (An Experiment with Broad-Spectrum Acoustic Waves)	AD 847 275	1968
Full View Holograms	ETL-CR-70-1	1970
Further Investigation of an Electronic Angle- Measuring Device	ETL-TR-74-1	1973
Further Study of Digital Matching of Dissimilar Images	ETL-0385	1985
Gamma-Ray Spectrometer Study	ETL-0008	1975
GEISHA Computer Theory of Operation	AD 883 289L	no date
General Climatological Guide to Daily Freezing Conditions: Frost Days, Ice Days, and Freeze-Thaw Days, A	ETL-0287	1982
General Noniterative Solution of the Inverse and Direct Geodetic Problems	RN-11	1963
General Programming on a Parallel Processor	ETL-0062	1976
Geocentric Position and/or Orbital Parameters with Star Satellite Photography from a Single Camera Station	CR-102-1	1963
Geodetic Control by Means of Astronomic and Torsion Balance Observations and the Gravimetric Reduction of Levelling	AD 672 491	1967
Geodetic Control without Triangulation, Trilateration, or Gravity Data and Gravimetric Reduction of Levelling		
1st Interim Report	AD 447 994L	1964
2nd Interim Report	AD 461 100L	1965
3rd Interim Report	AD 477 474L	1965
Geodetic SECOR	AD 721 648	1962

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Geodetic SECOR Ground Equipment	AD 721 649	1964
Geodetic SECOR Satellite	ETL-TR-74-6	1974
Geodetic SECOR Wide-Band RF Subsystem	AD 721 641	1967
Geodetic SECOR Wide-Band RF Subsystem for SECOR Ground Equipment Sets	AD 824 780L	1967
Geodetic SECOR Wide-Band System	AD 721 640	1966
Geodetic Spacecraft, Final Report	AD 721 650	1961
Geodetic Spacecraft, Addendum	AD 721 651	1961
Geodimeter, Models I and II	1495-TR	1957
Geographic Modelling of Insurgency Resources	AD 848 723L	1969
Geographic Modelling of Insurgency Resources, Appendix	AD 851 896L	1969
Geoid Representation from Satellite-Determined Coefficients	AD 634 541	1966
Geologic Evaluation of Radar Imagery from Darien Province, Panama	AD 853 884	1969
Geometric Simultaneous Multistation Determination, with Constraints, Using Data from Geodetic Satellites	RN-22	1967
Geometrical Quality of Lunar Mapping by Photogrammetric Methods	RN-9	1962
Geomorphic Evaluation of Radar Imagery of Southeastern Panama and Northwestern Columbia	ETL-CR-71-2	1971
Geopotential Determination from Satellite to Satellite Tracking and Satellite Altimetry	ETL-CR-74-21	1975
Geopotential Determination from Satellite to Satellite Tracking and Satellite Altimetry, Supplement I	ETL-CR-74-21-S	1975
GEOPS	RN-25	1967
Geoscience Potentials of Side-Looking Radar, Vol. I	AD 650 498	1965
Geoscience Potentials of Side-Looking Radar, Vol. II	AD 650 499	1965
Geo-Spin Precision Inertial Survey	ETL-0135	1978
Gigas-Zeiss Digital Control Unit	ETL-ETR-73-1	1973
Gradiometer-Aided Rapid Gravity Survey System	ETL-0112	1977
Graphic Arts Symbol Generating Hardware for a Gerber Plotting System	ETL-CR-74-14	1974
Graphic Data Handling Techniques	AD 659 807	1967
Gravimetric Geodesy Free of Density Estimates through Analysis of Discrete Gravity Data	RN-12	1963
Gravity Anomalies as Indicators of Groundwater Reserves in Glacial Deposits	ETL-CR-73-16	1973
Gravity Correlation Studies for Determination of the Gravity Field of the Earth	AD 866 798L	1970
Gravity Study Program, Final Report	ETL-0262	1981

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Gravity Study Program, Interim Report	ETL-0253	1981
Ground Target Location Errors Derived From Measurements Collected From a Variety of Hypothetical Satellite Image Understanding Architecture Project, First Annual Report, The Sentinel Systems	ETL-0538	1989
Hail and Its Distribution	ETL-SR-73-3	1973
Hexagonal Data Base Study	ETL-0338	1983
Hexagonal Data Base Study, Phase II	ETL-0360	1984
High Resolution Optical Power Spectrum Analyzer	ETL-0127	1978
High Resolution Orthophoto Output Table (HIROOT)	AD 856 731L	1969
High Resolution Orthophoto Output Table	ETL-ETR-72-3	1972
High Speed Disc Memory and a Color Image Display for a Small Computer	AD 878 975L	1970
High-Speed, Large-Format Film Writer Methodologies and Design Study	ETL-0389	1985
High Speed Parallel Sensing Scheme	ETL-0119	1977
History of U.S. Army Engineer Topographic Laboratories (1920 to 1970)	ETL-SR-74-1	1973
Holographic Compensation of Wavefront Aberrations	ETL-RN-74-11	1975
Holographic Optical Elements With Low Q-Factors	ETL-0123	1977
Holographic Ray Tracing and Spot Diagrams	ETL-0052	1975
Holographic Stereogram Display Techniques for the Viewing and Mensuration of Stereo Photogrammetric Imagery	ETL-CR-74-2	1973
Holographic Terrain Displays	ETL-0083	1976
Holography and Stereoscopy	ETL-CR-72-2	1972
Horizontal Gradients of Gravity in Geodesy	AD 672 492	1964
Horizontal Gradients of Gravity in S.W. Ohio	AD 672 489	1967
Hot Weather Testing of 10-Second Direction Theodolite with Universal Tribrach and Universal Tripod, Astronomical Attachment, Universal Sun Compass, Lensatic Compass, and Wrist Compass Air Photo Patterns	1289-TR	1953
Hough Transform on the Butterfly and the NCUBE, The	ETL-0438	1986
Hourly and Daily Precipitation Frequencies for the United States	ETL-0498	1988
Hybrid Methodology for Deteccting Cartographically Significant Features Using Landsat TM Imagery	ETL-0589	1991
Hyperspectral Signatures (400 to 2500 nm) of Vegetation, Minerals, Soils, Rocks, and Cultural Features: I. Laboratory and Field Measurements	ETL-0573	1990

TITLE	REPORT NO.	YEAR
IBIS Query — Software to Support the Image Based Information System (IBIS) Expansion for Mapping, Charting, and Geodesy	ETL-0422	1986
Image Alignment and Correlation System	ETL-0237	1980
Image-Based Approach to Mapping, Charting, and Geodesy	ETL-0366	1982
Image Correlation on a Parallel Processor	ETL-0061	1976
Image Enhancement by Chemical Intensification	ETL-0014	1975
Image Processing for Visual Navigation of Roadways	ETL-0406	1985
Image-Processing Precision and Affecting Relative Orientation	ETL-RN-71-6	1971
Image Scanner Technology Study	ETL-0137	1978
Image Tube Validation Study	ETL-CR-70-5	1970
Image Understanding Architecture Project, First Annual Report, The	ETL-0499	1988
Image Understanding Architecture Project, Second Annual Report, The	ETL-0542	1989
Implications of Symbol Usage on U.S. Army Maps for an Automated Cartographic System	AD 667 979	1968
Implications of Symbol Usage on U.S. Army Maps for an Automated Cartographic System, Appendix	AD 667 986	1968
Improvement Program Automatic Map Compilation System	AD 442 522	1964
Improving Classification Accuracy of Radar Images Using a Multiple-Stage Classifier	ETL-0502	1988
Inertial Platform Subsystem for Army Artillery Inertial Survey System (GEISHA)	AD 681 931	1962
Inertial Positioning System Test Data Summary Report	ETL-0028	1975
Inertial Survey Applications to Civil Works	ETL-0309	1983
Inertial Survey Equipment (GEISHA)	AD 814 051	1963
Inferential Techniques for Soil Depth Determinations, Part I: Coleogyne ramossissima Torr. (Black-Brush)	ETL-0036	1975
Inferential Techniques for Soil Depth Determinations, Part II: Artemisia filifolia Torr. (Sand Sagebrush)	ETL-0176	1979
Influence of Atmospheric Refraction on Directions Measured to and from a Satellite	RN-10	1963
Instrument for Measuring Absolute Acceleration of Gravity	RN-17	1966
Instrument to Measure the Tilt of Large Structures, An	ETL-0313	1983
Instrumentation for Color Aerial Photography	ETL-RN-70-1	1970

TITLE	REPORT NO.	YEAR
Integration of Artificial Intelligence Concepts into the Methods for Extracting Line Objects from Monochromatic Aerial Imagery	ETL-0425	1986
Intelligent Advisors for Cross-Country Route Planning	ETL-0365	1984
Interactive Digital Correlation Techniques for Automatic Compilation of Elevation Data	ETL-0272	1981
Interactive Digital Image Processing for Terrain Data Extraction	ETL-0241	1980
Interactive Digital Image Processing for Terrain Data Extraction, Phase 2	ETL-0277	1981
Interactive Digital Image Processing for Terrain Data Extraction, Phase 3	ETL-0294	1982
Interactive Digital Image Processing for Terrain Data Extraction, Phase 4	ETL-0348	1983
Interactive Digital Image Processing for Terrain Data Extraction, Phase 5	ETL-0374	1984
Interactive Digital Image Processing Investigation	ETL-0172	1978
Interactive Digital Image Processing Investigation, Phase II	ETL-0221	1980
Interactive Image Analysis System Design	ETL-0312	1982
Interactive Knowledge-Based Cartographic Feature Extraction	ETL-0273	1981
Interagency Energy and Environmental Survey		1977
Interferometer Data Reduction Study	AD 503 143L	1969
Interim Solution Rectifier Van	1355-TR	1954
Interim Technical Progress Report, Ninth SemiAnnual Technical Report, Sep 1971-Mar 1972, Project THEMIS, A Center for Remote Sensing	ETL-CR-72-4	1972
Interpolation of Deflections from Horizontal Gravity Gradients	AD 672 490	1967
Interpolation of Gravity Anomalies and Deflection of the Vertical Components from Rapid Gravity Survey System Data	ETL-0075	1976
Interpretation of Radar Imagery for Terrain Analysis in Tropical Environments		1968
Introduction to the Terrain Effects on the Intelligence Preparation of the Battlefield (IPB)	ETL-0481	1987
Inverse Perspective of a Road from a Single Image	ETL-0429	1986
Inverse Scattering Applications in Determining Terrain Feature Parameters	ETL-0279	1981
Investigation and Evaluation of Planigon Lens Distortion Characteristics	1472-TR	1957

TITLE	REPORT NO.	YEAR
Investigation, Experiments, and Study of Electron Beam Recorder (EBR) Techniques for Map Production	ETL-CR-73-15	1973
Investigation of Bjerhammar's New Gravity Reduction Method	AD 460 404	1964
Investigation of Cartographic Pressplate Recording from Digital Data	ETL-0043	1976
Investigation of Continuous Photoconductive Layer Arrays	ETL-0011	1975
Investigation of Discrete Function Technology for Topographic Sciences	ETL-0162	1978
Investigation of Electro-Acoustic Technology for Topographic Application	ETL-0160	1978
Investigation of Extrema in Digital Images for Texture Analysis	ETL-0210	1979
Investigation of Fusion and Fixation Disparity Limits for Photogrammetry	AD 625 217	1965
Investigation of Linear Transformations for Automatic Cartographic Analysis	ETL-0181	1979
Investigation of Multiband Photographic Techniques, Vol. I	AD 479 300L	1965
Investigation of Photographic Mapping Detail and Data Encoding	AD 286 715	1962
Investigation of Techniques to Generate Contours from Stereo Pairs	ETL-0029	1975
Investigation of the Application of "Array Algebra" to Terrain Modeling	ETL-0141	1978
Investigation of the Electronic Distance Measuring Equipment Electrotape	AD 460 401L	1964
Investigation of the Geometrical Quality of the Relative and Absolute Orientation Procedures and the Final Results of the Photogrammetric Procedure	RN-6	1962
Investigations into the Problems of Relative Orientation in Stereo Aerial Photogrammetry	AD 452 686L	1964
Investigations of Basic Geometric Quality of Aerial Photographs and Some Related Problems	RN-4	1962
Investigations of the Use of Conventional Films in the ETL Cartographic EBR	ETL-0177	1979
Investigations Related to the Establishment of a World Geodetic System	AD 697 163	1969
IRS: A Simulator for Autonomous Land Vehicle Navigation	ETL-0455	1987
Joint Analyses in Glen Canyon National Recreational Area	ETL-0073	1976

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Kalman Filtering and Smoothing in Fotonap for Orbit Determination using GPS Measurements	ETL-0161	1978
KANDIDATS	ETL-CR-71-3	1971
Knowledge-Based Analysis of Scene Dynamics for Target Motion Detection, Recognition, and Tracking	ETL-0486	1987
Knowledge-Based Analysis of Scene Dynamics for Target Motion Detection, Recognition and Tracking, Second Annual Report	ETL-0525	1989
Knowledge-Based Images Analysis	ETL-0258	1981
Knowledge-Based Vision Techniques (March 1985 - March 1986)	ETL-0431	1986
Knowledge-Based Vision Techniques (March 1986 - March 1987)	ETL-0487	1987
Knowledge-Based Vision Techniques: Obstacle Detection and Avoidance, Fourth Annual Report	ETL-0536	1989
Knowledge-Based Vision Techniques, Third Annual Report	ETL-0521	1988
Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program	ETL-0439	1986
Knowledge-Based Vision Techniques for the Autonomous Land Vehicle (ALV) Program, Second Annual Report	ETL-0507	1988
Knowledge-Based Vision Techniques for the Autonomous Land Vehicle (ALV) Program, Third Annual Report	ETL-0512	1988
Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program Fourth Annual Report	ETL-0582	1990
Knowledge-Based Vision Techniques - Task B: Terrain and Object Modeling Recognition Executive Summary	ETL-0557	1990
Knowledge-Based Vision Techniques — Task B: Terrain and Object Modeling Recognition (March 13, 1985 - March 13, 1986)	ETL-0428	1986
Knowledge-Based Vision Techniques — Task B: Terrain and Object Modeling Recognition (March 13, 1986 - April 27, 1987)	ETL-0485	1987
Knowledge-Based Vision Techniques Task B: Terrain and Object Modeling Recognition, Third Annual Report	ETL-0535	1989
Knowledge-Based Vision Techniques Task B: Terrain and Object Modeling Recognition - Volume I: Autonomous Systems for Navigation and Terrain Recognition	ETL-0558	1990

TITLE	REPORT NO.	YEAR
Knowledge-Based Vision Techniques Task B: Terrain and Object Modeling Recognition - Volume II: Tech Base Vision Research	ETL-0559	1990
Knowledge-Based Vision Techniques Task B: Terrain and Object Modeling Recognition - Volume III: Image Understanding Software Environments	ETL-0560	1990
KT2 Gyro-Theodolite (Otto Fennel GMBH & Co)	57-TR	1970
Land Cover Classification from LANDSAT Data: Phase III of a Joint OCE/NASA Demonstration	ETL-0175	1979
Landforms of Granitic Rocks: An Annotated Bibliography, The	ETL-0566	1990
LANDSAT and DMA Elevation Study	ETL-0386	1984
LANDSAT D: Corps of Engineers Interface with Advanced NASA Ground Systems Study	ETL-0151	1978
LASS-II Rapid Geodetic Survey System (RGSS)	ETL-0518	1986
Light, Target for Ranging Pole	1402-TR	1955
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model 11NG531A	AD 486 317	1965
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model 11NG531B	AD 844 011L	1968
Linear Feature Extraction from Radar Imagery	ETL-0405	1985
Linear Feature Extraction from Radar Imagery, SBIR Phase II Base Contract	ETL-0469	1987
Linear Feature Extraction From Radar Imagery: SBIR Phase II, Option I	ETL-0497	1988
Linear Feature Extraction From Radar Imagery: SBIR Phase II, Option II	ETL-0530	1988
L.N.K. Software Systems for Transferring, Merging, and Displaying DFAD/DTED Data on AMS/CAPIR	ETL-0318	1983
Local Gravity Field Modeling	ETL-0448	1986
Long Range Survey System	AD 356 441L	1964
Long Range Surveying System	AD 328 203	1960
Low Cost Gyrocompass	ETL-0355	1984
Low Light Level Photography	32-TR	1966
Manual and Automated Line Generalization and Feature Displacement	ETL-0359	1984
Manual for Maintenance and Operation of the MB-1 Multiband Aerial Camera	ETL-0040	1976
Map Coating Concept Studies	AD 679 215	1968
Map Illuminator Test, Phase I	ETL-0034	1975
MAPCON Design Study	AD 854 619L	1967

TITLE	REPORT NO.	YEAR
Mapping Camera Image Errors Due to Star Camera Identification and Measuring Errors	ETL-RN-73-1	1973
Mapping from Airborne Radar Scope Presentations		1958
Mapping from Radar Presentations, Second Interim Report	1397-TR	1955
Mapping from Side-Looking Radar	AD 392 041L	1968
Mapping with Minimum Ground Control	1483-TR	1957
MAT Transponder Model No. 10002	AD 721 638	1967
Materials Research for Holographic Recording (Report No. 1, Multiple Image Storage of Continuous Tone Data in Volume Holograms)	ETL-0088	1976
Materials Research for Holographic Recording (Report No. 2, Bleaching Methods for Photographically Recorded Holograms)	ETL-0156	1978
Materials Research for Holographic Recording (Report No. 3, Hardened Gelatin Holographic Recording Materials)	ETL-0197	1979
Mathematical Analysis of a Technique for the Calibration of a Synthetic Aperture Radar	43-TR	1968
Mathematical Method for Inversion in Atmospheric Remote Sensing, A	ETL-0346	1983
Mathematical Techniques for Automated Cartography	ETL-CR-73-4	1973
Mathematics of Geodetic SECOR Data Processing	AD 721 837	1964
Matrix Evaluation of Remote Sensor Capabilities for Military Geographic Information (MGI)	ETL-TR-72-6	1972
MATS Performance with the SECOR System	AD 721 635	no date
MATS Transponder	AD 721 634	1966
Measurement of the Change in the Deflection of of the Vertical with a Schuler-Tuned North- Slaved Inertial System	ETL-0138	1977
Measurement Techniques of Electrical Parameters of Surface Materials in the X-Band Region	ETL-0304	1982
Mechanization Design, Performance Simulations, and Cost Trade-Offs Hybrid INS/GPS/PLRS Positioning and Orientation Systems	ETL-0409	1985
Mensuration and Reduction Accuracy and Precision Standard Applicable to an Integrated World- Wide Topographic System	58-TR	1970
Methodological Preliminaries to the Development of an Expert System for Aerial Photo Interpretation	ETL-0342	1984
Methodology for Military Geographic Analysis	36-TR	1967
Methods and Results of Remote Barometric Altimetry and Views on the Estimation of Meteorological Field Variables	ETL-RN-73-3	1973

TITLE	REPORT NO.	YEAR
Methods for Calculating Atmospheric Refraction and Its Perturbation	ETL-0299	1982
Micromap Camera for Display Systems	ETL-ETR-71-5	1971
Microreduction and Enlargement of Graphic Information Study (MEGIS)	ETL-0063	1977
Microwave Pointing Variations and Angle Measurements	26-TR	1966
Military Applications of Multiband Aerial Photography (Report No. 5 in the ETL Series on Remote Sensing)	ETL-0030	1975
Military Geographic Intelligence Products Associated with the SLAR Topo Map Test in Panama	ETL-ETR-70-10	1970
Military Potential Test of Selected Items of Hydrologic Survey Equipment	AD 890 746	1971
Military Significance of the USAETL Research Note "A New Solution for the Anomalous Gravity Potential Resulting from a Modification of Molodensky's Linear Approximation, Its Practical Significance, and Numerous Ramifications"	RN-34	1970
Miniaturized Gyrocompass	ETL-0289	1982
Miniaturized Gyrocompass (Small North-Orienting Device)	ETL-ETR-70-11	1970
Minipim-MK II Precision Indicator of the Meridian (British Aircraft Corp.)	45-TR	1969
Mini Raster-to-Vector Conversion	ETL-0269	1981
Mod II Power Supply for Army Artillery Inertial Survey System (GEISHA)	AD 814 067	1963
Modeling and Contouring Irregular Surfaces Subject to Constraints	ETL-CR-74-19	1975
Modes of Satellite Triangulation Adjustment, Vol. I	AD 633 863	1966
Modes of Satellite Triangulation Adjustment, Vol. II	AD 633 864	1966
Modification of a Cartographic Mapping Camera from Type T-11 to Type KC-4B (with Automatic Exposure Control)	ETL-TR-71-1	1971
Modification of the MUSAT Aerotriangulation Programs to Accommodate Bathymetric Image Points	ETL-0306	1983
Modifications to FOTONAP	ETL-0116	1977
Mono Versus Stereo Analytical Photogrammetry, Part 1	AD 664 184	1967
Mono Versus Stereo Analytical Photogrammetry, Part 2	AD 828 750	1968

TITLE	REPORT NO.	YEAR
Morphometry of Landforms: Quantification of Slope Gradients in Glaciated Terrain	ETL-RN-72-3	1972
Multi-Altitude Transponder — Volume I, Schematic Diagrams	AD 721 636	no date
Multi-Altitude Transponder — Volume II, Part 1, Test Procedures and Results of Test MATS Transponder	AD 721 628	no date
Multi-Altitude Transponder — Volume II, Part 2	AD 721 629	1967
Multi-Altitude Transponder — Volume II, Part 3	AD 721 630	1967
Multi-Altitude Transponder — Volume II, Part 4	AD 721 631	no date
Multi-Altitude Transponder — Volume II, Part 5	AD 721 632	no date
Multi-Altitude Transponder — Volume III, Final Reliability Report	AD 721 637	1967
Multi-Altitude Transponder — Volume IV, Design Considerations and Component Selection Criteria	AD 721 633	no date
Multi-Image Correlation Systems Study for MGI	AD 841 079	1968
Multi-Image Correlation Systems Study, Quantitative Evaluation of Electronic Multi-Image Processor	AD 870 453	1969
Multi-Image Pattern Recognition: Ideas and Results	AD 863 596	no date
Multi-Parametric Figures of Equilibrium: Curvature of the Plumb Line	AD 603 073	1964
Multi-Parametric Theory of Spheroidal Equilibrium Figures and the Normal-Spheroids of Earth and Moon		1966
Multispectral Image Maps from Landsat Thematic Mapper Data	ETL-0590	1991
Multiple Camera Analytical Triangulation Program		1965
Multiple Station Analytical Triangulation Program	AD 638 750	1965
Multipower Army Stereoscope	12-TR	
Multisensor Approaches for Determining Deflections of the Vertical	ETL-0314	1983
Multisensor Study of Plant Communities at Horsefly Mountain, Oregon	AD 698 098	1969
Multisource Image Analysis	ETL-0208	1979
Multispectral Capability of H&W Film (Photographic Technology Series)	ETL-0101	1977
Multispectral Target Signatures	ETL-0165	1978
MUSAT IV	ETL-CR-70-6	1970
Natural Image Computers, Vol. I	AD 856 137L	1967
Natural Image Computers, Vol. II	AD 856 138L	1967
Near-Real-Time Application of Digital Terrain Data in a Minicomputer Environment	ETL-0142	1978
Near-Surface Bathymetry System (Report No. 11 in the ETL Series on Remote Sensing)	ETL-0163	1978

TITLE	REPORT NO.	YEAR
Neural Networks for Object Detection Using All-Source Imagery	ETL-0585	1991
New Analyses and Methods Leading to Improved Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part I)	RN-35	1970
New Analyses and Methods Leading to Improved Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part II)	ETL-RN-70-3	1970
New Analytical Methods for Simulation/ Estimation of Asymmetric Satellite Dynamics	ETL-CR-73-21	1973
New Formulas Useful When Changing Ellipsoidal Parameters or Orientation	RN-2	1962
New Insights and Results Regarding L.F. Richardson's Turbulence Criterion	ETL-RN-72-2	1972
New Large-Scale, High-Resolution, Multicolor Software Display Concept, A	ETL-0388	1985
New Method for Determining Azimuth and Latitude Independent of Time and Zenith Distance	RN-17	1966
New Methods of Change Detection Using Multispectral Data	ETL-0586	1991
New Solution for the Anomalous Gravity Potential Resulting from a Modification of Molodensky's Linear Approximation, Its Practical Significance and Numerous Ramifications, A	RN-33	1970
1986 Year End Report for Road Following at Carnegie-Mellon	ETL-0464	1987
1987 Year End Report for Road Following at Carnegie-Mellon	ETL-0514	1988
1988 Year End Report for Road Following at Carnegie-Mellon	ETL-0537	1989
Noise Removal on Radar Imagery Using Local Gradient and Statistics	ETL-0402	1985
Noncontact Array Velocimeter	ETL-0077	1976
North-Seeking Gyrocompass, Final Technical Report	ETL-0251	1980
Observations on Multi-Peg Towers of Hanoi	ETL-0476	1986
Occurrence of Ice in the Form of Glaze, Rime, and Hoar-Frost with Respect to the Operation and Storage of V/STOL Aircraft	ETL-SR-73-1	1973
On Computing Histograms of Images in Log η Time Using Fat Pyramids	ETL-0454	1987
On the Energy Integral for Satellites	RN-29	1968

TITLE	REPORT NO.	YEAR
On the Thermal Nature and Sensing of Snow-Covered Arctic Terrain	ETL-RN-73-4	1973
Optical-Electronic Precision Pointing System	AD 883 021	1965
Optical Power Spectral Analysis for Machine-Readable Factor Maps	ETL-0212	1980
Optical Power Spectrum Analysis (OPSA) (Report No. 1 Recording Optical Spectrum Analyzer System Hardware)	ETL-TR-74-11	1975
Optical Theodolite Readout	AD 821 660L	1967
Optimized Digital Automatic Map Compilation System		
1st Interim Report	AD 412 798	1963
2nd Interim Report	AD 422 227	1963
3rd Interim Report	AD 432 243	1963
4th Interim Report	AD 600 117	1964
Optimized Method for the Derivation of the Deflection of the Vertical from RGSS Data	ETL-0122	1977
Optimized Post-Mission Determination of the Deflection of the Vertical Using RGSS Data	ETL-0164	1978
Orthographic Radar Restitutor Engineer Design Test	ETL-ETR-74-6	1974
Orthophoto Viewer and Transfer Device	AD 722 788	1965
Overview of Vision-Based Navigation for Autonomous Land Vehicles 1986, An	ETL-0479	1987
Parallel Algorithms for Computer Vision	ETL-0456	1987
Parallel Algorithms for Computer Vision, Second Year Report	ETL-0495	1988
Parallel Algorithms for Computer Vision, Third Year Report	ETL-0528	1989
Parallel Algorithms for Computer Vision, Final Report	ETL-0564	1990
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase I: Theoretical Analysis	ETL-RN-74-9	1974
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase II: Practical Considerations	ETL-RN-74-12	1975
Parallel Profile Plots for Visual Terrain Display	ETL-0115	1977
Parallel Vision Algorithm Design and Implementation, 1987 End of Year Report	ETL-0513	1988
Parallel Vision Algorithm Design and Implementation, 1988 End of Year Report	ETL-0541	1989
Parallel Vision Algorithms, First Annual Technical Report	ETL-0488	1987
Parallel Vision Algorithms, Second Annual Technical Report	ETL-0529	1989

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Particulate Matter Considerations in the Design of V/STOL Aircraft	ETL-SR-72-2	1972
Pattern Classification Techniques Applied to High Resolution, Synthetic Aperture Radar Imagery	ETL-0443	1986
PDEF: A Standard File Format for Data Interchange	ETL-SR-7	1991
Perception for Outdoor Navigation - First Year Report	ETL-0581	1990
Performance Evaluation of the Position and Azimuth Determining System (PADS) with an Improved Vertical Accelerometer	ETL-0166	1978
Phoenix Laser and Terrain Profile Test		1966
Photo Analysis of a Desert Area	ETL-0068	1976
Photo-Geomorphology of Coastal Landforms, Cat Island, Bahamas (Vol. II)	ETL-SR-74-5	1974
Photogrammetric and Tracking Network Analysis Program	ETL-CR-73-17	1973
Photogrammetric and Tracking Network Analysis Program for the UNIVAC 1108 Computer	ETL-0018	1975
Photogrammetric Applications to Field Artillery	56-TR	1970
Photogrammetric Aspects of the Heterodyne Optical Correlator	ETL-0095	1976
Photogrammetric Flash Triangulation for Corps of Engineers Field Use		
1st Interim Report		1960
2nd Interim Report	AD 265 036	1961
3rd Interim Report	AD 271 438	1961
Final Report	AD 271 439	1961
Photogrammetric Reduction for ATL	AD 223 674	1961
Photographic Visibility of Light Images on Aerial Film		1966
Photomap Reproduction System	AD 882 566L	1965
Pilot Program of Lunar Photography for Precise Selenodesy	AD 452 237	1964
Plastic-Scribing Color Separation for Military Cartography	1485-TR	1957
Platform Orientation System Test Program	ETL-0100	1976
Point Light Source Contact Printer	ETL-0084	1976
Photographic Technology Series		
Position and Azimuth Determining System (PADS)	ETL-ETR-74-1	1974
Position and Azimuth Determining System (PADS) Helicopter Study	ETL-0009	1975
Position and Surveying System (PASS)	ETL-CR-73-11	1973
Possibility of Adapting a Land Navigation System to Perform Artillery Survey	ETL-0078	1976

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Post-Mission Smoothing and Analysis of the Measurements of the Change in the Deflection of the Vertical Obtained by the Rapid Geodetic Survey System (RGSS) at the White Sands Test Range	ETL-0065	1976
Potential of Thermal IR Imagery for Supplemental Map Information in Snow-Covered Areas	ETL-0059	1976
Potential Sand and Dust Source Areas	ETL-SR-72-1	1972
Practical Field Accuracy Limits for a Wild T-2 Theodolite	30-TR	1966
Practical Second-Order Theory for the Disturbance Potential and Deflections of the Vertical, Including an Analysis of the Limitations of the Molodensky/Brovar Series and Downward Continuation of Gravity	ETL-RN-71-1	1971
Practical Tests of the Theoretical Accuracy of Aerial Triangulation	RN-1	1962
Precise Photogrammetric Orientation and Data Determination of HIRAN Mapping System AN/APQ 73	AD 238 857	1960
Precision Enlarging Printer (4X)	27-TR	1966
Precision 2.0X Enlarging Printer	55-TR	1970
Precision 3.3X Enlarging Printer	ETL-ETR-71-3	1971
Precision STARAN Correlator	ETL-0133	1977
Predesign Data for the Radar Stereo Equipment Program	AD 701 169	1969
Preliminary Image Data Extraction Experiments with the Phase I, Automated Image Data Extraction System-I	ETL-RN-74-7	1974
Preliminary Radar Feature Extraction and Recognition Using Texture Measurement	ETL-0315	1983
Preliminary Reliability Prediction — MATS	AD 721 639	1965
Preliminary Study into the Principles of Continuous Tone Electrophotography	AD 401 863	1962
Preproduction Model Cartographic EBR System	ETL-0246	1980
Proceedings of the International Symposium Figure of the Earth and Refraction	AD 825 792	1967
Product Improvement Test Report of Astronomic Surveying Equipment	28-TR	1966
Production of Dense Range Images with the CVL Light-Stripe Range Scanner	ETL-0491	1988
Program and Test Procedures to Determine the Geocentric Coordinates and Orbital Parameters of an Unidentified Satellite	AD 617 698	1968

TITLE	REPORT NO.	YEAR
Program Maintenance Manual for the Reference Scene Software (RSS)	ETL-0067	1976
Programmer for Army Artillery Inertial Survey System (GEISHA)	AD 814 065	1963
Programming Environment for Parallel Vision Algorithms, A (February 1985 - February 1986)	ETL-0433	1986
Programming Environment for Parallel Vision Algorithms, A (February 1986 - February 1987)	ETL-0457	1987
Programming Environment for Parallel Vision Algorithms, A - Final Technical Report	ETL-0563	1990
Programming Environment for Parallel Vision Algorithms, Third Annual Report, A	ETL-0510	1988
Project SAND — Availability of Construction Materials in the Mekong Delta	Tech Memo 156-1	1968
Project SAND (Phase III) — Analysis of Remote Sensor Imagery of Selected Areas in the Mississippi Delta	ETL-TR-71-3	1971
Project THEMIS: A Center for Remote Sensing Study Plan	AD 690 361	1968
Progress Report	AD 847 276	1968
Interim Report	AD 683 584	1968
Progress Report	AD 853 884	1969
Progress Report	AD 864 859	1969
5th Semi-annual Report	AD 869 511	1970
6th Semi-annual Report	AD 879 981L	1970
7th Semi-annual Report (ETL-CR-71-7)	AD 726 966	1971
8th Semi-annual Report (ETL-CR-71-21)	AD 735 752	1971
Final Report (ETL-CR-74-10)	AD A003 266	1974
Propagation of Very Short Radio Waves Through the Ionosphere and the Investigation of Ionospheric Models	ETL-RN-74-1	1973
Proposed Stereophotogrammetric System for Topographic Mapping from Photography Taken at Altitudes up to 100,000 Feet	1518-TR	1958
Prototype Automatic Mosaicking System	17-TR	1963
Prototype Electrostatic Image Reproducer	ETL-0035	1973
Prototype Image Spectrum Analyzer (PISA) for Cartographic Feature Extraction	ETL-0204	1979
Prototype Lithographic Enlarging Projection Platemaker	ETL-ETR-72-4	1972
Prototype Stereomat System	4-TR	1962
Quantitative Geography: Achievements and Prospects	ETL-CR-71-12	1971
RACOMS Cartographic Module	ETL-ETR-70-3	1970

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RACOMS Compilation Module I	ETL-ETR-70-1	1970
RACOMS Data Processing Module	ETL-ETR-70-4	1970
RACOMS Image Processing Module I	47-TR	1969
RACOMS Image Processing Module II	ETL-ETR-70-2	1970
RACOMS Map Revision Module	ETL-ETR-70-5	1970
RACOMS Operations Module	44-TR	1969
RACOMS Pass Point Marking and Measuring Instrument	53-TR	1970
RACOMS Reproduction Module	ETL-ETR-71-1	1971
Radar Backscatter from a Vegetated Terrain: A Discrete Scattering Approach	ETL-0159	1979
Radar Bridge Patterns Extraction and Recognition	ETL-0323	1983
Radar Image Simulation of Seasonally Dependent Reference Scenes	ETL-0188	1979
Radar Image Simulation Project	ETL-0098	1976
Radar Image Simulation Project: Development of a General Simulation Model and an Interactive Simulation Model, and Sample Results	ETL-0047	1976
Radar Image Simulation: Validation of the Point Scattering Model, Volume I	ETL-0117	1977
Radar Image Simulation: Validation of the Point Scattering Model, Volume II	ETL-0118	1977
Radar Image Simulation: Validation of the Point Scattering Method Addendum	ETL-0155	1978
Radar Mapping Beacon Analysis	ETL-CR-73-22	1973
Radar Mapping Test Ranges	AD 231 433	1959
Radar Network Adjustment		1962
Radar Presentation Restitutor		1956
Radar Sketching Device	20-TR	1965
Radar Stereo Equipment Program	AD 732 875	1971
Radar, Thermal Infrared, and Panchromatic Image Collection and Analysis	ETL-0249	1980
Radiative Transfer in One-Dimensional Discretely Stratified Media	ETL-0236	1980
RADOT Code for the Tracking of Radar Incident on Trees	ETL-0147	1978
RADOT Code System to Calculate the Radar Return from a Forested Area	ETL-0206	1979
Rainfall Intensities in the Conterminous United States and Hawaii (Supplement 1 to ETL-SR-72-5: Distribution of Mean Monthly Precipitation and Rainfall Intensities)	ETL-SR-74-3	1973
Range Imagery Algorithms for the Detection of Obstacles by Autonomous Vehicles	ETL-0461	1987
Rapid Cartographic Processing System Study	AD 454 086L	1964
Rapid Combat Mapping System Evaluation	ETL-ETR-70-8	1970

TITLE	REPORT NO.	YEAR
Rapid Geodetic Survey System	ETL-0074	1976
Rapid Geodetic Survey System (RGSS) Deflection of the Vertical and Gravity Anomaly Tests at White Sands Missile Range, 1980	ETL-0308	1982
Rapid Gravity Survey System Aided with Supplemental Gravimetric Data	ETL-0113	1977
RC-135A/USQ-28 Category II Test (The Photographic Resolution Capabilities of the KS-78A Camera Subsystem)	TM-69-1	1969
R&D Plan for Army Applications of AI/ROBOTICS	ETL-0296	1982
Recognition of Handprinted Symbols for Computer- Aided Mapping	ETL-CR-71-27	1971
Recording and Scanning Advances in Cartographic EBR Systems	ETL-0265	1981
Reduction and Classification of the Data Base List	AD 817 518	1967
Reduction Procedures for Absolute Direction and Geodetic Azimuths from Optical Observations of Satellites	RN-14	1965
Reflection and Identification Studies Applied to Terrain Imaging Radar	ETL-0331	1983
Refraction in Selected Model Atmospheres	AD 404 465	1964
Registration of a LANDSAT Image to a DTM — An Error Analysis	ETL-0350	1984
Relation Between the Spectrum of Surface Slopes and the Spectrum of Surface Elevations and its Usefulness in the Theory of Electro- magnetic Wave Scattering from Rough Surfaces	ETL-RN-70-2	1970
Relational Data Base Management Study	ETL-0136	1978
Relative Mapping Triangulation Program, Vol. I	AD 721 601	1969
Relative Mapping Triangulation Program, Vol. II	AD 721 602	1969
Relative Mapping Triangulation Program, Vol. III	AD 721 603	1969
Relative Mapping Triangulation Program, Vol. IV	AD 721 604	1969
Remote Sensing Field Guide - Desert	ETL-0588	1991
Remote Sensor Image Capabilities for Acquisition of Terrain Information	ETL-0054	1976
Remote Sensor Imagery Analysis for Location of Construction Materials in the Mekong Delta- Project SAND (Phase II)	52-TR	1970
Replacement of Photographic Imagery Equipment (RPIE)	ETL-0038	1976
Report on Atmospheric Obstructions to Visibility: Volume I — Study Results	ETL-0169	1979
Report on Atmospheric Obstructions to Visibility: Volume II — Results of Literature Search	ETL-0170	1979

TITLE	REPORT NO.	YEAR
Research and Design of a PROM Coherent Optical Processor	ETL-0219	1980
Research and Development Acceptance Test Report Surveying Instrument: Azimuth, Gyro, Light-weight (Lear Siegler, Inc. Models)	23-TR	1965
Research and Development of a Prototype Laser Point Marking Instrument	AD 673 291	1967
Research in Expert Interactive Cartographic Systems	ETL-0417	1986
Research in Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program (June 1, 1985 - May 31, 1986)	ETL-0444	1986
Research in Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program (June 1, 1986 - May 31, 1987)	ETL-0482	1987
Research in Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program Third Annual Report	ETL-0522	1988
Research in Knowledge-Based Vision Techniques for the Autonomous Land Vehicle Program Final Annual Report	ETL-0545	1989
Research in Space Photogrammetry	AD 722 789	1961
Research in Surveying, Mapping and Geodesy	AD 230 066	1959
Research Institute Lectures on Geography	ETL-SR-71-1	1971
Research on Refinement and Interpretation of Gravity Anomaly Computations	AD 831 840	1968
Research Studies Related to Mapping, Geodesy, and Position Determination — Summary Report		1960
Research Studies Related to Mapping, Geodesy, and Position Determination	AD 286 300	1961
Research Studies Related to Mapping, Geodesy, and Position Determination Interim Report No. 10	AD 286 297	1961
Interim Report No. 11	AD 286 298	1961
Interim Report No. 13	AD 286 299	1962
Interim Report No. 14	AD 284 969	1962
Interim Report No. 15	AD 298 584	1962
Research Studies Related to Mapping, Geodesy, and Position Determination — Final Report	AD 402 602	1963
Results of Space Triangulation Adjustments from Satellite Data	RN-13	1965
Review and Analysis of U.S. Army Geodetic SECOR System and Development	AD 818 483	1962
Review of New Geographic Methods and Techniques, Vol. I	AD 700 151	1969
Review of New Geographic Methods and Techniques, Vol. II	AD 700 176	1969

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Review of Photosensitive Materials for Holographic Recordings	ETL-0128	1978
Road Boundary Detection for Autonomous Vehicle Navigation	ETL-0407	1985
Road Detection on Radar Imagery	ETL-0403	1985
Robotic Vehicle Terrain-Navigation Subsystem: Conceptual Design Phase	ETL-0332	1983
Robust Image Understanding - Techniques and Applications - First Annual Report	ETL-0580	1990
RPIE Symbol Placement Accuracy	ETL-0076	1976
Ruggedized Geodetic SECOR		1964
Ruggedized Geodetic SECOR System	AD 722 642	1967
RWPF Spatial Data Study	ETL-0367	1984
Sand and Dust Considerations in the Design of Military Equipment	ETL-TR-72-7	1972
Satellite Angulation	RN-16	1965
Satellite Geodesy Based on Stellar Orientation of Lines Between Unknown Stations	RN-32	1969
Satellite Observations of Widespread Fog	ETL-0361	1984
Satellite-to-Satellite Tracking for Orbit Improvement and Determination of a 1° x 1° Gravity Field	ETL-0064	1976
Satellite-to-Satellite Tracking Study for the Global Positioning System (Rotating-Y Configuration)	ETL-SR-74-6	1974
Satellite, U.S. Army Type II, Geodetic, Final Report Volume 1	AD 871 283	1963
Volume 2, Appendix, Antenna Patterns	AD 871 284	1964
Volume 3, Appendix, Environmental Test Results	AD 871 285	1964
Scale Problems in Geographic Research	ETL-CR-71-16	1971
Scattering from a Vegetation Layer with an Irregular Vegetation Soil Boundary	ETL-0270	1981
Scattering of a Code-Modulated Radio Signal and Associated Multipath Range Errors	ETL-0125	1977
Scene Classification Results Using the Max-Min Texture Measure	ETL-0300	1982
Selected Bibliography of Corps of Engineers Remote Sensing Reports	ETL-0126	1977
Semiautomatic Coordinate Reader	ETL-ETR-71-4	1971
Semi-Automatic Pass Point Determination Using Digital Techniques	ETL-0051	1975
Sensing Array System with Image Statistics Processing, A	ETL-0297	1983
Sentinel Satellite Positional Precision Derived from the NAVSTAR Global Positioning System	ETL-0544	1989

TITLE	REPORT NO.	YEAR
Sequential Independent Model Block Analytical Triangulation (SIMBAT)	AD 805 606L	1966
Service Tests and Subsequent Modifications and Test of Compass Sun, Universal, 0 to 90 Degrees North and South Latitudes, with Case	1422-TR	1955
Shaded Relief Images for Cartographic Applications	ETL-0259	1981
Shape from Projecting a Stripe Pattern	ETL-0453	1987
Side-Looking Radar Data Requirements for Automated Mapping on the UNAMACE	ETL-CR-72-18	1972
Side-Looking Radar Presentation Viewing and Measuring Instrument	22-TR	1965
Signal Signatures of Topographic Features Using Analog Technology	ETL-0185	1979
Simple Analytical Methods for Estimating Short-Term Rainfall	ETL-0441	1986
Simple Computer Database System for UNIX, A	ETL-0494	1988
Simplified Electrostatic Color Printing	ETL-0421	1986
Simulation of a Radar Image for Garden City Test Site	ETL-0007	1975
Single-Lens, Four-Channel Multiband Camera (Report No. 3 in the ETL Series on Remote Sensing)	ETL-ETR-74-4	1974
Single Photo Analysis of Sampled Aerial Imagery	ETL-RN-74-10	1974
Smart Mapping, Charting and Geodesy Control Generator, Phase I, A	ETL-0458	1987
Smart Mapping, Charting and Geodesy Control Generator, Phase II, A	ETL-0523	1988
Software Conversion of Standard Linear Format (SLF) to Standard Interchange Format (SIF)	ETL-0394	1985
Software System Description for Minefield Site Prediction Expert System	ETL-0449	1987
Solution of the General Analytical Aerotriangulation Problem	AD 202 318	1958
Some Relations Between the Geometrical Quality of Topographic Mapping and Aerial Photogrammetry	RN-7	1962
Sparse Area Stereo Matching Experiment	ETL-0424	1986
Spatial Data Structures for Robotic Vehicle Route Planning	ETL-0520	1988
Spatial Light Modulators: Test and Evaluation	ETL-0192	1979
Spatial Sampling: A Technique for Acquisition of Geographic Data from Aerial Photographs and Maps	ETL-CR-71-11	1971

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Spatial Target Location Errors Derived From Measurements Collected From Sixteen Satellite Constellations	ETL-0532	1989
Spectral Reflectivity Data: A Practical Acquisition Procedure	AD 880 049L	1970
Spectral/Spatial Resolution Targets for Aerial Imagery (Report No. 1 in the ETL Series on Remote Sensing)	ETL-TR-74-3	1974
Stable Platform Assembly for Army Artillery Inertial Survey System	AD 681 932	1962
Stable Platform Electronics for Army Artillery Inertial Survey System (GEISHA)	AD 681 933	1962
Star Pattern Recognition and Spacecraft Attitude Determination	ETL-0173	1978
Star Pattern Recognition and Spacecraft Attitude Determination, Phase II	ETL-0211	1979
Star Pattern Recognition and Spacecraft Attitude Determination, Final Report	ETL-0260	1981
STARAN Image Processing	ETL-0243	1980
Stars' Position Determined by Combining Micrometric Observations with an Observed Known Star in a Vertical Plane Close to the Meridian	RN-20	1967
State-of-the-Art Assessment of Automatic Name Placement, A	ETL-0427	1986
State-of-the-Art of Slope Mapping	ETL-0060	1976
Status of Aerial Color Photography in Government Agencies	TB-1	1968
Stereo Analysis of a Specific Digital Model Sampled from Aerial Imagery	ETL-0072	1976
Stereo Radar Analysis	AD 903 321L	1970
Stereo Radar Techniques Study, Phase I, Vol. 1 — Analysis	AD 800 171L	1966
Stereoplotter, Topographic, Projection-Type High Precision	1627-TR	1960
Stereoscopic Terrain Display for Measurement Applications	ETL-0002	1974
Stress Analysis, Study of the M4 Van Expansible and Adapter, Detachable Running Gear	AD 636 445	1966
Structural Analysis from Radar Imagery, Eastern Panamanian Isthmus	AD 715 322	1970
Studies in Zinc Oxide Photoconductivity	AD 673 836	1968
Studies of Gravity in Space According to Bjerhammer	AD 485 687L	1966

TITLE	REPORT NO.	YEAR
Study and Analysis of the Position and Azimuth Determining System (PADS) Field Maintenance Concept	ETL-CR-74-22	1974
Study and Analysis of the Position and Azimuth Determining System (PADS) for Mapping, Charting, and Geodesy Applications	ETL-CR-73-12	1973
Study and Prototype Model Design of a Miniaturized Gyrocompass, Interim	AD 462 322	1964
Study and Prototype Model Design of a Miniaturized Gyrocompass, Final	AD 465 330	1965
Study of a Digital Interface Design for the Quick Response Multicolor Printer (QRMP)	ETL-0327	1983
Study of Classification and Nomenclature of Vegetation	ETL-0058	1976
Study of Digital Matching of Dissimilar Images	ETL-0248	1980
Study of Environmental Monitoring and Information Systems	ETL-CR-72-1	1972
Study of Knowledge-Based Systems for Photo Interpretation	ETL-0235	1980
Study of Lithographic Fountain Solutions	AD 830 674L	1967
Study of Panoramic-Metric Image Matching for Photogrammetric Instrumentation	AD 474 839L	1965
Study of Potential Application of Holographic Techniques to Mapping (Interim Report)	ETL-CR-70-8	1970
Study of Potential Application of Holographic Techniques to Mapping (Final Report)	ETL-CR-71-17	1971
Study of Raster Metafile Formats	ETL-0363	1984
Study of Solution of a Large System of Linearized Normal Equations and the Inversion of the Associated Coefficient Matrix	AD 676 849	1968
Study of Stereophotogrammetric Systems for Topographic Mapping with Very High Altitude Aerial Photography	1352-TR	1954
Study of Visual Stereoscopic Acuity		1956-1957
Study of the Accuracy of Visual Planimetric Pointings to Photographic Edges with Different Characteristics	ETL-CR-71-19	1971
Study of the Application of Piezoelectric Techniques to a Small North-Orienting Device	AD 486 467L	1966
Study of the Characteristics of the Holographic Stereomodel for Application in Mensuration and Mapping (Part I of Final Report)	ETL-CR-73-14	1973
Study of the Characteristics of the Holographic Stereomodel for Application in Mensuration and Mapping (Part II of Final Report)	ETL-CR-73-14	1973

TITLE	REPORT NO.	YEAR
Study of the Effect of Corona Conditions on Electrostatic Processes	ETL-CR-72-17	1972
Study of the Effects of Nonhomogeneous Target Backgrounds on Photogrammetric Coordinate Measurement	AD 722 790	1969
Study of the Human Visual System in Support of Automated Feature Extraction	ETL-0271	1981
Study of the Impact of the Global Positioning System on Army Survey	ETL-0070	1976
Study of the Interaction of a Positive Corona with Selenium Coatings Relevant to the IFAX Printing Process	ETL-CR-74-7	1974
Study of the Long Range Position Determination System	AD 505 912	1969
Study to Establish a Method of Selecting Input Photographic Material for Automated Compilation Equipment	ETL-CR-71-24	1971
Study to Optimize Performance of the Rapid Geodetic Survey System — Interim Technical Report	ETL-0252	1981
Study to Optimize Performance of the Rapid Geodetic Survey System — Second Interim Technical Report, A	ETL-0264	1981
Study to Optimize Performance of the Rapid Geodetic Survey System — Addendum Report, A	ETL-0321	1983
Surface Climate of the Arctic Basin	ETL-TR-71-5	1971
Surface Gravity Effects of Subterranean Tunnels	ETL-0069	1976
Surface Materials and Terrain Features of Yuma Proving Ground, Part I Summary Description	ETL-0021	1975
Survey of Digital Image Display Systems (Soft Copy)	ETL-0085	1976
Survey of Digital Image Scanning Systems	ETL-0087	1976
Survey of Display Devices (Hard Copy)	ETL-0086	1976
Survey of Mass Storage Systems	ETL-0082	1975
Surveying Instrument: Azimuth, Gyro, Lightweight (SIAGL) (Lear Siegler, Inc.)	ETL-TR-72-2	1972
Synthesis Guide for Cross-Country Movement (Report No. 4 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0220	1980
Synthesis Guide for Helicopter Landing Zone and Drop Zone Sites	ETL-0401	1985
Synthesis Guide for Lines of Communication (Report No. 7 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0263	1981

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Synthesis Guide for Obstacle Siting (Report No. 9 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0283	1982
Synthesis Guide for River Crossings (Report No. 11 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0344	1983
System Analysis of the Entire Topographic Support System	ETL-0390	1985
System Analysis of the Entire Topographic Support System (TSS), Final Report	ETL-0158-2	1978
System Analysis of the Entire Topographic Support System (TSS), Interim Report	ETL-0158-1	1978
System and Design Study for an Advanced Drum Plotter	ETL-CR-70-3	1970
System for Automatic Secure Transmission and Reception of Topographic Information — Maps, Photographs, or Alphanumeric Facsimile — at TV Rates	ETL-CR-71-2	1971
System for Topographic Inquiry — No. 1, Micrographic Subsystem	ETL-ETR-74-2	1974
System for Topographic Inquiry — No. 2, Alphanumeric Subsystem	ETL-0003	1975
System for Topographic Inquiry — No. 3, Alphanumeric Subsystem Data Base Listing	ETL-0004	1975
System for Topographic Inquiry — No. 4, Program Conversion Procedures	ETL-0005	1975
System for Topographic Inquiry — No. 5, Alphanumeric Subsystem Users Guide	ETL-0031	1975
Systematic Correction and Weighing of Analogue Aerial Triangulation Observations and Their Use in Strip and Block Adjustments	AD 476 273L	1965
Systematic Investigations of Geodetic Networks in Space, Interim	AD 482 852L	1966
Systematic Investigations of Geodetic Networks in Space, Final	AD 815 717	1967
Systems Concepts for Military Geographic Intelligence, Vol. I		1967
Tactical/Strategic Point Positioning Study	ETL-0319	1981
Target Location Errors Derived From a Hypothetical Target Tracking System	ETL-0531	1989
Technical Data on KC-Film, Toners, and Processes	ETL-0224	1980
Technical Report for Automatic Line Follower	ETL-CR-72-18	1972
Techniques to Improve Astronomic Positioning in the Field	ETL-0400	1985
Television Display of Topographic Information	ETL-CR-70-7	1970

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Television Display of Topographic Information, Phase II	ETL-CR-71-23	1971
Terrain Analysis Procedural Guide for Built-Up Areas (Report No. 13 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0352	1984
Terrain Analysis Procedural Guide for Climate (Report No. 5 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0247	1980
Terrain Analysis Procedural Guide for Drainage and Water Resources (Report No. 8 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0285	1982
Terrain Analysis Procedural Guide for Geology (Report No. 3 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0207	1979
Terrain Analysis Procedural Guide for Railroads (Report No. 10 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0311	1982
Terrain Analysis Procedural Guide for Roads and Related Structures (Report No. 2 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0205	1979
Terrain Analysis Procedural Guide for Soil (Report No. 6 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0254	1981
Terrain Analysis Procedural Guide for Surface Configuration (Report No. 12 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0352	1984
Terrain Analysis Procedural Guide for Vegetation (Report No. 1 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0178	1979
Terrain Analyst Synthesizer Station	ETL-0231	1980
Terrain Analyst Work Station (TAWS): 1AD After Action Report	ETL-0470	1987
Terrain Data of Mount Hayes D-4 Quadrangle, Fort Greely, Alaska (Report No. 4 in the ETL Series on Remote Sensing)	ETL-TR-74-7	1974
Terrain Effects Analysis Routine for an MGI System	ETL-0010	1975
Terrain Eigenvector Dyad Analysis	AD 649 347	1967
Terrain Factor Analysis and Automatic Color Coded Mapping Utilizing the IDECS	ETL-CR-72-13	1972
Test and Evaluation of a Baudot-FIELDATA Code Converter, Paper Tape	15-TR	1963
Test and Evaluation of 9 by 18 Rectifier for 12- and 24-inch Focal Length Photography	1460-TR	1956
Test and Evaluation of Target Map Coordinate Locator Equipment	14-TR	1963

TITLE	REPORT NO.	YEAR
Test and Evaluation of the Analytical Photogrammetric Positioning System, Advanced (APPS-II)	ETL-0293	1982
Test and Evaluation of the Direct Viewing Stereoplotter, Wernstedt-Mahan Type	1471-TR	1957
Test and Evaluation of the Headliner, Model 400	1568-TR	1959
Test and Evaluation of the Interim Halcon Mapping System	3-TR	1961
Test and Evaluation of the Interim Stereo- plotter, Topographic, Projection Type, High Precision	1493-TR	1957
Test and Evaluation of the Kelsh Plotter, Model 5000, Manufactured by the Instruments Corp.	1311-TR	1953
Test and Evaluation of the Near Real Time Exploitation System	ETL-0281	1982
Test and Evaluation of the Prototype Side-Looking Radar Restitutor	29-TR	1966
Test and Evaluation of the Santoni Cartographic Stereomicrometer	1644-TR	1960
Test and Evaluation of the 720 Plotter Manufactured by Bausch and Lomb Optical Co.	1348-TR	1954
Test and Evaluation of the Stereopontometer and Adapted Multiplex	1381-TR	1954
Test and Evaluation of the Stereopontometer with Kelsh Type Stereoplotters	1425-TR	1955
Test and Evaluation of Ultrasonic Scribing Equipment	1641-TR	1960
Test and Investigation of the Photonymograph (PN-4)	1537-TR	1958
Test of Map-Read Magnetic Declination Accuracy	ETL-148	1978
Test of Reconnaissance Photographic Transposer MAN/GSH-1	1566-TR	1959
Test Results of a Singer, Kearfott Division Modified Land Navigation System	ETL-0238	1980
Test Results of the Lear Siegler, Singer and Sperry Gyro Heading Reference Systems	ETL-0288	1982
Test Results of the Litton Low-Cost Semi- Strapped-Down Inertial Land Navigation System	ETL-0202	1979
Test Strategy for High Resolution Image Scanners, A	ETL-0345	1983
Testing and Ealuation of the Shiran System by Advanced Data Reduction Methods	AD 707 418	1969
Testing of an Experimental Viscous-Friction Coupled Small North Orienting Device	AD 822 011	1967
Tests and Evaluation of an Automatic Point Reading, Plotting, and Grid Ruling Machine	8-TR	1962

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Tests and Evaluation of an Earth Curvature Correction Device	10-TR	1963
Tests and Evaluation of the AS-11A Stereoplotter	50-TR	1969
Tests and Evaluation of the Zeiss Stereotype Stereoplotting Instrument	1567-TR	1959
Tests and Evaluation of Ultrawide-Angle Mapping Photography	6-TR	1961
Tests and Evaluations of Precision Coordinatographs	1-TR	1961
Tests of Basic Geometrical Qualities of Photogrammetric Plotting Instrument	RN-5	1962
Tests on the Change Detector		1964
Texture Analysis and Cartographic Feature Extraction	ETL-0370	1985
Texture Tone Study — Category Maps, Gradient and Homogeneity Images	ETL-CR-73-10	1973
Texture Tone Study — Classification Experiments	ETL-CR-72-16	1972
Texture Tone Study (Quantizing on the IDECS/PDP)	ETL-CR-72-3	1972
Texture Tone Study: Summary and Evaluation	ETL-0005	1975
Texture Tone Study with Application to Digitized Imagery	TR-182-1	1970
Texture Tone Study with Application to Digitized Imagery (Interim Report)	ETL-CR-71-14	1971
Texture Tone Study with Application to Digitized Imagery (Final Report)	ETL-CR-74-17	1974
Theodolite with Shaft Angle Encoder and Display	AD 662 080	1967
Theoretical and Experimental Study of Wave Scattering from Composite Rough Surfaces	ETL-CR-74-4	1974
Thermal Infrared Spectra of Natural and Man-Made Materials: Implications for Remote Sensing	ETL-0587	
Third-Order Co-Occurrence Texture Analysis Applied to Samples of High Resolution Synthetic Aperture Radar Imagery	ETL-0396	1985
Three Approximate Methods for Estimating the Best Subset of GPS Satellites Position Calculations	ETL-0556	1990
3-D Road Structure from Motion Stereo	ETL-0471	1987
Tight Upper Bound for the Speed-Up of Parallel Best-First Branch-and-Bound Algorithms, A	ETL-0462	1987
Topographic Data Output Study	AD 262 161L	1961
Topographic Eigenvector Analysis	AD 484 747L	1966
Topographic Radar Mapping Systems Design Study		1968
Topographic Relaxation Study	ETL-0209	1979
Total Optical Color System (Report No. 2 in the ETL series on Remote Sensing)	ETL-ETR-74-3	1974
Toward Automatic Extraction of Cartographic Features	ETL-0153	1978

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TPLOT: A Simple Program for Plotting Percent Composition Data on Ternary Diagrams	ETL-RN-74-2	1973
Training Course on Data Reduction of Radar Topographic Imagery	AD 721 653	1969
Transformation of Coordinates of Cartographic Digital Data	ETL-TR-74-8	1974
Transformations for Dimension Reduction and Expansion of the Discrete Fourier Transform Under Scanning	ETL-RN-74-3	1974
Transforming Printers: Acceptance and Engineering Tests	40-TR	1968
Transitional Design Study of the Position and Azimuth Determining System (PADS)	ETL-0001	1975
Tribrach, Universal	1453-TR	1956
Tripod, Universal, Final Report on Project 8-35-10-107	1413-TR	1955
Two Approaches to a Portable Color-Measuring System	RN-15	1966
Two Dimensional Path Planning with Obstacles and Shadows	ETL-0452	1987
Two-Way Linear Interpolation	ETL-RN-71-5	1971
Type I Geodetic Satellite	AD 721 652	1964
Typro Composer Photolettering Machine	1504-TR	1957
Unified Approach to Mapping, Charting, and Geodesy (MC&G) Data Base Structure Design	ETL-0144	1978
Unified Geodetic Parameter Program (GEOPS), Vol. 1 of 2 — Mathematical Analysis	AD 640 321	1966
Unified Geodetic Parameter Program (GEOPS), Vol. 2 of 2 — Program Description	AD 640 322	1966
Universal Analog Rectification System for Map Revision	24-TR	1965
Universal Automatic Map Compilation Equipment	51-TR	1969
Universal Radar Signal Processor (Correlator), Interim	AD 487 144L	1966
Universal Radar Signal Processor (Correlator), Final	AD 841 545L	1968
U.S. Army Type II Geodetic Satellites, Vol. 1	AD 721 645	1965
U.S. Army Type II Geodetic Satellites, Vol. 2	AD 721 646	1965
U.S. Army Type II Geodetic Satellites, Vol. 3	AD 721 647	1965
Use and Calibration of Distance Measuring Equipment for Precise Mensuration of Dams (Revised)	ETL-0048	1976
Use and Calibration of Distance Measuring Equipment for Precise Mensuration of Dams	ETL-0190	1979

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Use of a Vidicon to Digitize Certain Types of Target Image in a Photographic Background	AD 457 818L	1964
Use of Array Algebra in Terrain Modeling Procedures	ETL-0094	1976
Use of Edges of Photographic Images as Specifiers of Image Quality	ETL-CR-72-15	1972
Use of Radar Images in Terrain Analysis: An Annotated Bibliography	ETL-0024	1975
Use of Side-Looking Airborne Radar (SLAR) Imagery for Engineering Soils Studies	46-TR	1969
User's Guide for the Analytical Photogrammetric Positioning System (APPS), A	ETL-0446	1986
User's Guide to Data Preparation, Photogrammetric Navigation Analysis Program Fotonap	ETL-0174	1978
User's Manual for the Reference Scene Software (RSS)	ETL-0066	1976
Using Terrain Analysis to Predict Likely Minefield Sites	ETL-0325	1983
Utility of Radar Imagery in the Production of Tactical Terrain Data. Military Capabilities Report	ETL-0045	1975
Utilization of a Photogrammetric Facility (PF) in Human Engineering Laboratories Battalion Artillery Test Number Two (HELBAT II)	ETL-SR-71-2	1971
Variscale Stereo Point Marking Instrument	39-TR	1968
Vegetation and Terrain Effects on Digital Classification of LANDSAT Imagery	ETL-0292	1982
Vegetation and Terrain Relationships in South-Central New Mexico and Western Texas	ETL-0245	1980
Vegetation Data Extraction Software Documentation/User's Manual	ETL-0340	1983
Vegetative Cover Effects on Soil Spectral Reflectance	ETL-0284	1982
Vertical Obstruction Study, Final Report	ETL-0358	1984
Video Stream Processors: A Cost-Effective Computational Architecture for Image Processing	ETL-0229	1980
Vision-Based Navigation and Parallel Computing First Annual Report	ETL-0548	1989
Visual Factors Affecting the Precision of Coordinate Measurement in Aerotriangulation	RN-21	1967
Visual Navigation System for Autonomous Land Vehicles, A	ETL-0408	1985
Vision-Based Navigation and Parallel Computing Second Annual Report	ETL-0572	1990
Vision-Based Navigation for Autonomous Ground Vehicles, 1986 Annual Report	ETL-0432	1986

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Vision-Based Navigation for Autonomous Ground Vehicles, First Annual Report	ETL-0509	1988
Vision-Based Navigation for Autonomous Ground Vehicles, Third Annual Report	ETL-0519	1988
Vision-Based Navigation for Autonomous Ground Vehicles, Summary Report	ETL-0543	1989
Voice Interactive Systems Technology (VIST) Research	ETL-0349	1984
Voice Interactive Systems Technology (VIST) Research	ETL-0349	1984
Weather Extremes Around the World (Revision of NLABS Report TR-70-45-ES)	ETL-TR-74-5	1974
Weighted Line-Finding Algorithm	ETL-0200	1979
What is a Hill? An Analysis of the Meaning of Generic Topographic Terms	ETL-0576	1991
Wind Design Criteria for Field Shelters — A Study	ETL-0037	1975
Wire List GEISHA Computer	AD 847 667	1969
World Areas More Humid Than the Canal Zone during the Wet Season (Note 3 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-8	1974
World Areas with Higher Precipitation Intensities and Frequencies than the Tropic Test Center, Canal Zone	ETL-0022	1975
World Areas with Higher Temperatures than the Yuma Proving Ground During Summer (Note 2 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-6	1974
World Areas with Lower Temperatures than the Arctic Test Center During Winter (Note 1 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-5	1974
World Weather Extremes	ETL-0416	1985
Worldwide Distributions of Ambient Temperatures and Temperatures of Materiel Exposed to Direct Solar Radiation	ETL-SR-73-2	1972
Worldwide Distribution of Mean Dewpoint: Surface and Lower Atmosphere	ETL-SR-72-4	1972
Worldwide Distribution of Mean Monthly Dewpoint (Supplement to ETL-SR-72-4 "Worldwide Distributions of Mean Dewpoint: Surface and Lower Atmosphere")	ETL-SR-72-2	1973
Xerox 6500 Color Copier	ETL-0106	1977

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Zoom Transfer Scope	ETL-ETR-72-5	1972