

AD _____

Award Number: DAMD17-02-2-0029

TITLE: Mobile Communication Platform

PRINCIPAL INVESTIGATOR: James F. Bates, Ph.D.
Kent P. Tonkin
Anthony J. Laratonda

CONTRACTING ORGANIZATION: Saint Francis University
Loretto, Pennsylvania 15940

REPORT DATE: September 2004

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for Public Release;
Distribution Unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

20041101 044

REPORT DOCUMENTATION PAGEForm Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY
(Leave blank)**2. REPORT DATE**
September 2004**3. REPORT TYPE AND DATES COVERED**
Annual (15 Aug 03 - 14 Aug 04)**4. TITLE AND SUBTITLE**
Mobile Communication Platform**5. FUNDING NUMBERS**
DAMD17-02-2-0029**6. AUTHOR(S)**
James F. Bates, Ph.D.
Kent P. Tonkin
Anthony J. Laratonda**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Saint Francis University
Loretto, Pennsylvania 15940**8. PERFORMING ORGANIZATION
REPORT NUMBER**

E-Mail: jrbates@cermusa.francis.edu

**9. SPONSORING / MONITORING
AGENCY NAME(S) AND ADDRESS(ES)**
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012**10. SPONSORING / MONITORING
AGENCY REPORT NUMBER****11. SUPPLEMENTARY NOTES****12a. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for Public Release; Distribution Unlimited**12b. DISTRIBUTION CODE****13. ABSTRACT (Maximum 200 Words)**

Hospitals and health clinics located in rural areas often lack the expertise needed to perform various consults and medical examinations. This situation could be improved through the use of telemedicine and communications technologies. However, quite often, these hospitals and clinics lack the financial and technological resources required to construct a permanent telemedicine suite within their facilities. Therefore, CERMUSA proposed the development of the Mobile Communications Platform (MCP) prototype. The main objective of the project is to improve the delivery of healthcare in under-served areas through the creation of a re-locatable telecommunications infrastructure that provides remotely located organizations with the ability to communicate and share information with distant sites. The prototype will utilize existing communications infrastructure to provide services or create its own link to the outside world through satellite technology. Once temporarily installed in the site, the MCP will be used for several purposes including telemedicine consults, information exchange, distributed learning, and emergency communications.

14. SUBJECT TERMS
No subject terms provided.**15. NUMBER OF PAGES**
51**16. PRICE CODE****17. SECURITY CLASSIFICATION
OF REPORT**
Unclassified**18. SECURITY CLASSIFICATION
OF THIS PAGE**
Unclassified**19. SECURITY CLASSIFICATION
OF ABSTRACT**
Unclassified**20. LIMITATION OF ABSTRACT**
Unlimited

Table of Contents

Cover.....1

SF 298.....2

Introduction.....4

Body.....5

Key Research Accomplishments.....8

Reportable Outcomes.....9

Conclusions.....9

Attachments

**Attachment A.....REMeD-D Prototype/Programmatic Market Research
Accomplishments**

Attachment B.....Robotics Operational Concept Document

**Attachment C.....Robotic Emergency Medicine and Danger-Detection Project
Implementation Plan**

I. Introduction

A. Mobile Communications Platform (MCP) Abstract

Hospitals and health clinics located in rural areas often lack the expertise needed to perform various consults and medical examinations. This situation could be improved through the use of telemedicine and communications technologies. However, quite often, these hospitals and clinics lack the the financial and technological resources required to construct a permanent telemedicine suite within their facilities. Therefore, CERMUSA proposed the development of the Mobile Communications Platform (MCP) prototype. The main objective of the project is to improve the delivery of healthcare in under-served areas through the creation of a re-locatable telecommunications infrastructure that provides remotely located organizations with the ability to communicate and share information with distant sites. The prototype will utilize existing communications infrastructure to provide services or create its own link to the outside world through satellite technology. Once temporarily installed in the site, the MCP will be used for several purposes including telemedicine consults, information exchange, distributed learning, and emergency communications.

B. Robotic Emergency Medicine and Danger-Detection (REMeD-D) Abstract

The Robotic Emergency Medicine and Danger Detection (REMeD-D) prototype will improve the delivery of emergency medical services to individuals in rural areas following an attack facilitated through the use of weapons of mass destruction (WMD). To accomplish its objectives, the REMeD-D prototype will utilize the Mobile Communications Prototype (MCP) as a command and control center that will receive and transmit data from the scene of the emergency situation to distant healthcare facilities. The REMeD-D prototype will utilize robotics and communications technologies to remotely extract victims, assess and monitor the physical condition of those individuals, and transmit the information back to the MCP prototype where it will be sent to a participating medical facility. Through the use of these technologies, first responders, in both civilian and military communities, will be able to remotely extract and transport victims from the effected area to local hospitals and other healthcare facilities without placing themselves in danger of contamination. To facilitate effective communication and education, a nationwide Homeland Security Conference and Exhibition will be held to promote Weapons of Mass Destruction awareness and encourage collaboration between governmental, non-profit, and private industry. As a result, the REMeD-D project will provide the model to follow when developing a system to prepare for and manage emergency situations resulting from a terrorist attack implemented through the use of weapons of mass destruction.

II. Body

A. Mobile Communications Platform (MCP)

1. Task #4 Prototype Analysis and Design

a. Task #4 Prototype Analysis and Design Research Accomplishments

Task #4, Prototype Analysis and Design, provided CERMUSA with the financial and technical expertise required to identify the technological, clinical, and vehicular characteristics of the MCP prototype. Once identified, these characteristics were used to develop three separate prototype design Statement of Work (SOW) documents that could be used to select vendors and services for the prototype construction phase of the project. When combined, these documents created a complete Systems Design Document. This Systems Design Document contains a detailed plan for the construction of a vehicle that is capable of fulfilling the requirements needed to accomplish the research objectives of the MCP project.

The statement of work documents were submitted to several vendors through a formal bidding process. Through the implementation of this process, CERMUSA was able to identify the most appropriate vendors for construction of the MCP prototype. In addition, after the bids were submitted, CERMUSA conducted a cost-benefit analysis to identify the most effective method of deploying the MCP prototype during the test and evaluation phase of the project. For more information please see Task #4 Deliverable: Prototype Analysis and Design submitted September 29, 2003.

Following the development of a detailed Systems Design Document, CERMUSA conducted an in-depth analysis of future prototype implementation. During Task #1, an initial cost-benefit analysis was conducted in an effort to assess the feasibility and cost effectiveness of implementing an MCP prototype. This cost-benefit analysis was created with the most accurate information available at the time.

In an effort to take advantage of the most recent information available, a second cost-benefit analysis was included in the Task #4 research plan. This second cost-benefit analysis was used to create a more accurate estimate of the costs associated with providing healthcare through the use of the future MCP prototype. In addition, this cost analysis also provided a trade-off analysis, describing the potential advantages and disadvantages of providing these medical services through the use of the MCP prototype. The trade-off-analysis, comparing MCP to a stationary telemedicine suite, outlined some of the advantages and disadvantages that would impact an organization's decision to either build a permanent telemedicine suite or utilize a vehicle such as the MCP to deliver healthcare services.

b. Task #4 Prototype Analysis and Design Research Results

The results of research efforts implemented during Task #4 can be found in the statement of work documents as well as the cost-benefit analysis found in Task #4 Deliverable: Prototype Analysis and Design submitted September 29, 2003. The following conclusions were drawn from those research results:

- The MCP will be built on a standard H1 Chassis outfitted with a custom built structure that will be mounted on the back.
- The custom built structure will house several communications technologies that provide the capability of supporting ISDN and satellite communications.
- The telemedicine system will consist of several technologies that will work together seamlessly to provide patient care.
- The MCP must be used among several facilities to justify the cost of construction and implementation.

2. Task #5 Prototype System Build/Prototype/Pilot

The MCP project is currently in Task #5 Prototype System Build/Prototype/Pilot. This phase is the execution of the approved MCP prototype design and, in some cases, may blend into the implementation phase. The MCP prototype is currently under construction and is scheduled to be completed by November of 2004. After construction is complete, a test plan will be carried out to evaluate and document its capabilities. The test plan, presently under development, is scheduled to be completed by November of 2004.

B. Robotic Emergency Medicine and Danger-Detection (REMeD-D)

1. Task #1: Prototype Technology/Programmatic Market Research

a. Task #1: Prototype Technology/Programmatic Market Research Accomplishments

Task #1: Prototype Technology/Programmatic Market Research facilitated the collection of data necessary to identify the technologies, practices, and methods that would be used to carry out the objectives established for the prototype. During this first phase of research, CERMUSA conducted an extensive market analysis that included a comparison study of all organizations, both private and public, that are developing and implementing initiatives similar in scope to the REMeD-D project. After identifying these projects, CERMUSA began to explore the technologies these organizations are employing to carry out their research objectives.

The methodology used to collect data throughout Task #1 involved the integration of two programmatic market research strategies. These strategies were employed in an attempt to access a variety of information sources that could provide an extensive and accurate overview of the technologies that could be used in the REMeD-D project. In addition, information was drawn from the data collected to identify potential research partners.

The accomplishments of research activities performed during Task #1: Prototype Technology/Programmatic Market Research Results can be found in Attachment A: REMeD-D Prototype Technology/Programmatic Market Research Accomplishments.

b. Task #1: Prototype Technology/Programmatic Market Research Results

Throughout Task #1, CERMUSA researched various robotics projects and platforms that could possibly be utilized and/or integrated into the design of the REMeD-D project prototype. In addition, several organizations were identified to begin the process of selecting partners and vendors for the project. This research process consisted of several steps that eventually led to the following conclusions. These conclusions provide a technical description of the future REMeD-D prototype, a list of potential organizations for partnership, and a plan for identifying robotics partners and vendors during Task #2, Prototype Programmatic Needs Assessment.

At the beginning of Task #1 CERMUSA technical staff developed a REMeD-D robotics operational concept document. This document included a comprehensive list of all capabilities and requirements that would potentially be included in the design of a robot that would fit the needs of the REMeD-D project. This document was used as a starting point for all research activities, providing a conceptual guide to researchers when collecting, organizing, and analyzing research results. It also served as an outline for future statement of work documents that would eventually be submitted to various robotics platform and technology integration organizations to build the REMeD-D prototype.

Through a series of meetings, discussions, and continued research activities, the initial technological estimates made for the robotics prototype solidified into a more definite set of requirements. Therefore, CERMUSA modified its original concept document to create the present Robotics Operational Concept document found in Attachment B: REMeD-D Robotics Operational Concept Document.

2. Task #2: Prototype Programmatic Needs Assessment

a. Task #2: Prototype Programmatic Needs Assessment Research Accomplishments

Several organizations were identified as being the most likely to serve as effective research partners and/or robotics technology vendors throughout the REMeD-D project. These organizations were categorized into three main groups including governmental organizations, research and educational institutions, and private corporations and vendors. During Task #2, CERMUSA further researched these organizations through a series of organizational site visits and technology conferences.

- Governmental Organizations -- The development of governmental research partners provided CERMUSA with insight into the needs of the Department of Defense and other public organizations that may benefit from the research. This

insight allowed CERMUSA to create a robotics prototype concept capable of serving those needs.

- Research and Educational Institutions - The development of partnerships with research and educational institutions allowed CERMUSA to learn from research that has already been conducted in the field of robotics. In addition, this research partner provided assistance in the development of a robotics statement of work document and the selection of robotics platform and technology integration vendors.
- Private Corporations and Vendors – The establishment of relationships with private robotics technology corporations and vendors provided CERMUSA with the technical expertise needed to develop a robotics platform and technology integration package capable of accomplishing the objectives of the REMeD-D project. These vendors were selected through a partnership research process guided by the Telemedicine and Advanced Technology Research Center (TATRC).

b. Task #2: Prototype Programmatic Needs Assessment Research Results

As a result of the research performed during the first two tasks of the project, CERMUSA, with the assistance of TATRC, was able to develop a project plan of implementation. Through a series of partnerships, several robotics engineering, software development, and research organizations will work with CERMUSA to accomplish the objectives of the REMeD-D project. During Task #3, Prototype Build, these partnerships will provide CERMUSA with the expertise, experience, and technological knowledge required to design and construct two robotics prototypes. A detailed description of this plan can be found in Attachment C: Robotic Emergency Medicine and Danger-Detection (REMeD-D) Project Implementation Plan.

III. Key Research Accomplishments

- Development of a detailed Systems Design Document used to select vendors and services for the prototype construction phase of the project,
- Conducted a second cost-benefit analysis to create a more accurate estimate of the costs associated with providing healthcare through the use of the future MCP prototype,
- Conducted an extensive market analysis to identify the technologies, practices, and methods that would be used to carry out the objectives established for the REMeD-D project,
- Development of a REMeD-D robotics operational concept document,
- Identification of REMeD-D project partners along with the creation of a REMeD-D project implementation plan.

IV. Reportable Outcomes

A. Deliverables

1. Mobile Communications Platform (MCP)

a. Task #4 MCP Prototype/Project Definition - Submitted September 29, 2003

B. Presentations

Laratonda, A.: "Mobile Communications Platform (MCP)", American Telemedicine Association Meeting and Exposition, Tampa, Florida, May 2-5, 2004.

Laratonda, A.: "Robotic Emergency Medicine and Danger-Detection (REMeD-D)", American Telemedicine Association Meeting and Exposition, Tampa, Florida, May 2-5, 2004.

V. Conclusions

A. Project Importance and Implications

Initial research results suggest that the construction of an MCP prototype would improve the delivery of healthcare and communications services in rural areas, while serving as a valuable research and development resource for the U.S. Armed Forces. The proper application of an effective MCP research plan has the potential to provide results related to several important fields of study. A well designed research prototype platform could serve several important purposes including emergency medical service support, rural healthcare delivery, and homeland security enhancement.

The MCP prototype could be used as a military research and development prototype to evaluate new technologies while also serving the educational and healthcare needs of individuals in remote and medically under-served areas. Serving as a research prototype, the MCP could be utilized to evaluate several forms of mobile communications and telemedicine technologies before they are implemented on the battlefield. While being used as an operational prototype, the MCP could provide civilians in rural areas with greater access to services such as public health screenings, continuing education courses, and physical examinations.

In addition, while being used in conjunction with other research prototypes, such as the REMeD-D project, the MCP could improve homeland security and medical services during natural disasters and other emergency situations. The MCP's robust communications infrastructure could be utilized to establish a temporary communications link that would allow healthcare personnel at distant hospitals to communicate with individuals at the the scene of the incident. This communication has the potential to improve emergency medical services during rural Weapons of Mass Destruction (WMD) attacks. This enhanced system of public defense will compliment the actions that are

being taken in more urban areas of the country, providing a safe refuge for victims of terrorism attacks in more populated areas.

B. Potential Problems and Recommendations

Throughout the past year, the research processes outlined in this annual report have had a tremendous impact on the development, implementation, and execution of the MCP and REMeD-D task deliverables. A significant stage in the development of every research project is the task of identifying the most appropriate research methods, resources, and organizational partnerships that can be utilized to accomplish the objectives established for the project. In an effort to utilize resources in the most efficient and effective manner possible, CERMUSA and TATRC have collaborated to ensure that all possible alternatives have been explored and considered before making important decisions concerning the direction of the projects. This exhaustive process has necessitated adjustments to the project timeline originally submitted for both the MCP and REMeD-D projects. However, in the interest of conducting responsible "due diligence" both CERMUSA and TATRC believe that this project implementation schedule adjustment will result in a responsible and organizationally sound testing and evaluation phase. The results of that testing and evaluation phase will build a solid base from which newer research projects and programs can be developed.

Attachment A

REMeD-D Prototype Technology/Programmatic Market Research Accomplishments

I. Research Methodology

The methodology used to collect data throughout Task #1 involved the integration of two programmatic market research strategies. These strategies were employed in an attempt to access a variety of information sources that could provide an extensive and accurate overview of the technologies that could be used in the REMeD-D project. In addition, information could be drawn from the data collected to identify potential research partners.

A. Internet Research Methodology

Initial research activities began with an investigation into information resources available to the general public on the Internet. The first step in collecting the data involved identifying research institutions and commercial vendors with the potential to assist CERMUSA in the development of a REMeD-D prototype. To identify and collect this online information, CERMUSA utilized a combination of several online search engines.

Through the use of these search engines, CERMUSA conducted an extensive broad search session of sites available for public access. This search session involved conducting several online key term searches. The search terms involved in this broad search session, listed below, were identified by CERMUSA's REMeD-D project team as being the most likely to return favorable results. All relevant results drawn from this initial search session were printed, read, and screened to identify new search terms that would potentially produce more data related to the goals of the REMeD-D project. The following terms were used during several Internet searches conducted between the months of October and December 2003.

- search and rescue
- search and rescue robotics
- robotics
- weapons of mass destruction
- unmanned ground vehicles
- unmanned vehicles
- homeland security
- wireless sensors

Following the initial broad search session, described above, several additional Internet search sessions were performed. The searches performed during these sessions included key terms such as organizations, technologies, and projects identified during the first search session. Terms taken from the following categories of information were included in the secondary search sessions. These categories were created through a careful analysis of the results derived from the initial search session. The resulting bibliography of complete search results can be found in Appendix A: Internet Programmatic Market Research Results.

- Organizations involved in the fields of robotics and homeland security
- Robotics technologies utilized by the organizations
- Projects and programs similar in scope to the REMeD-D project

Attachment A

REMeD-D Prototype Technology/Programmatic Market Research Accomplishments

B. Database Research Methodology

The second programmatic market research strategy employed during Task #1 involved the identification, selection, and utilization of several advanced technology information databases. These databases, accessed online through the Thomson Dialog Database Information Clearinghouse, contain articles and abstracts from thousands of scientific and technical research reports, publications, dissertations, and conference papers.

Dialog's Database Clearinghouse contains 900 databases providing global coverage of a variety of topics related to business, technology, and other professional fields of study. Therefore, when planning a productive research plan, CERMUSA's REMeD-D project team concluded that they should limit their search strategy to a few specific databases. To begin the research process, the team selected the top 15 databases returning the most relevant information related to the field of robotics technology. To identify these databases, the team conducted a broad search of all 900 Dialog databases found within the clearinghouse. The word 'robot' was used as the primary search term when gathering information. The results of this broad search indicated that, out of all 900 databases, the following 15 databases contained the most relevant information related to the topic of robotics. All data collected through this process was analyzed and organized into the bibliographic format found in Appendix B: Technological Database Research Results.

- INSPEC
- NTIS - National Technical Information Service
- Ei Compendex
- ABI/INFORM
- Gale Group PROMT
- Inside Conferences
- Wilson Applied Science & Technology Abstracts
- Gale Group Trade & Industry Database
- MEDLINE
- Federal Register
- FEDERAL RESEARCH IN PROGRESS
- Investext
- Wilson Business Abstracts Full Text
- Jane's Defense & Aerospace News/Analysis
- Gale Group Newsletter Database

II. Research Results

The results of Task #1 provided CERMUSA with the information needed to begin contacting potential robotics partners and vendors to discuss the possibility of collaboration. The collection of this data was implemented through two separate but related programmatic market research strategies. These strategies provided CERMUSA with the background needed to identify potential research partners, draft an initial robotics operational concept, and develop a base of knowledge that could be used as a resource throughout the implementation of the project. The programmatic research strategies included in the implementation of Task #1 included:

Attachment A

REMeD-D Prototype Technology/Programmatic Market Research Accomplishments

1. Internet Research
2. Technological Database Research

A. Internet Research Results

The results of the Internet Research strategy, found in Attachment A, can be separated into several categories. The information found in these categories is listed by organization name, title of article (where applicable), and URL address where the information can be found online. The categories consist of the following topics:

1. Robotics Research Organizations - Organizations, consisting of educational institutions and non-profit entities, conducting research related to the field of robotics and robotics applications and peripherals. Throughout the project, one or more of these organizations may serve as a research partner, providing professional guidance in areas where CERMUSA may need additional technical expertise and advice.
2. Robotics Commercial Development and Application Organizations - Organizations developing commercial products related to the field of robotics. Throughout the project, CERMUSA will be utilizing the services of one or more of these organizations to develop and build the robotics, communications, and sensing technologies needed to accomplish the objectives of the REMeD-D project. These organizations will be selected, through a formal bidding process, based on pricing, expertise, and professional reputation and ability.
3. Robotics Research Background Information - Articles, research studies, and other informational resources providing background information related to the field of robotics technology. This information will be used throughout the research process to select appropriate technologies, assess research results, and enhance CERMUSA's ability to develop a prototype capable of serving the needs of both the military and remote and rural areas.

B. Technological Database Research Results

The results of the Technological Database Research strategy, found in Attachment B, can be separated into several categories. The information found in these categories is listed by file number, database name, article accession number, title of article, and year of publication. Each database found in the Dialog Database Clearinghouse is assigned a unique file number. This number is listed first, followed by the name of the database and the article accession number. The article accession number uniquely identifies each article found in the database. Upon accessing the Clearinghouse resources a user can locate each article through the use of the database file number and the article accession number. The categories established for the Technological Database Research results consist of the following topics:

Attachment A

REMeD-D Prototype Technology/Programmatic Market Research Accomplishments

1. Communication Technology - Articles, research studies, and other informational resources describing technologies that could be used to facilitate communications during the operation of the REMeD-D robotics prototype.
2. Industrial Trends and Consumer Products Applications - Articles, research studies, and other informational resources describing robotics related products and services that are presently being developed produced for use in the public and private sector. These articles may also contain information summarizing present industrial trends while also discussing the future of the industry.
3. Military Applications - Articles, research studies, and other informational resources describing the use of robotics technologies in the United States Armed Forces.
4. Navigation Technology - Articles, research studies, and other informational resources describing technologies that could be used to enhance the navigational capabilities of the REMeD-D robotics prototype.
5. Search and Rescue Applications - Articles, research studies, and other informational resources describing the application of robotics technologies to sear and rescue operations. These operations may include searching for casualties and/or rescuing victims of natural disasters, weapons or mass destruction incidents, and chemical spills.
6. Sensing Technology - Articles, research studies, and other informational resources describing technologies that could be used to enhance the environmental sensing capabilities of the REMeD-D robotics prototype.

Appendix A

Internet Programmatic Market Research Results

Robotics Research Organizations

Applied Perception. <http://www.appliedperception.com>

Carnegie Mellon University Robotics Institute. <http://www.cmu.edu>.

Center for Robot Assisted Search and Rescue. <http://crasar.csee.usf.edu>

Columbia University Robotics Group. <http://www1.cs.columbia.edu/robotics/>

Drexel University College of Information Science and Technology.
<http://www.cis.drexel.edu/>

Harvard Robotics Laboratory. <http://hrl.harvard.edu/>

Henry Samueli School of Engineering and Applied Science.
<http://www.engineer.ucla.edu/>

IEEE Robotics and Automation Society. <http://www.service-robots.org>

Joint Robotics Program. <http://www.jointrobotics.com/>

Lawrence Livermore National Laboratory. <http://www.llnl.gov>

Massachusetts Institute of Technology Humanoid Robotics Group.
<http://www.ai.mit.edu/projects/humanoid-robotics-group/>

Mitre. <http://www.mitre.org>

National Institute of Standards and Technology (NIST). <http://www.nist.gov>

NAVSEA. <http://www.dt.navy.mil>

Redstone Arsenal, Alabama. <http://www.redstone.army.mil>

Robotics Foundry. <http://www.roboticsfoundry.org/faq.html>

Sandia National Laboratories. <http://www.sandia.gov>

Space and Naval Warfare Systems Command (SPAWAR). <http://www.spawar.navy.mil>

Stanford AI Laboratory. <http://robotics.stanford.edu/>

Tank Automotive and Armaments Command. <http://www.tacom.army.mil>

Tulane University. <http://www.som.tulane.edu>

Appendix A

Internet Programmatic Market Research Results

University of Southern California Center for Robotics and Embedded Systems (CRES).
<http://www-robotics.usc.edu/>

Ultra Wideband Working Group. <http://www.uwb.org>

Robotics Commercial Development and Application Organizations

Aether Wire and Location, Inc. <http://www.aetherwire.com>

Arrick Robotics. <http://www.robotics.com>

Cyrano Sciences, Inc. <http://cyranosciences.com>

Foster Miller, Inc. <http://www.foster-miller.com>

FANUC Robotics America, Inc. <http://www.fanurobotics.com>

Gecko Systems Inc. <http://www.geckosystems.com>

Honda. <http://www.hondacorporate.com>

Inuktun. <http://www.inuktun.com>

iRobot. <http://www.irobot.com/home/default.asp>

LifeWave, Inc. <http://www.lifewaveinc.com>

Lockheed Martin. <http://www.lockheedmartin.com>

McEwan Technologies, Inc. <http://www.mcewantechologies.com>

Multispectral Solutions, Inc. <http://www.multispectral.com>

Omnitech Robotics International. <http://www.omnitech.com>

Pulse-Link. <http://www.pulselink.net>

RedZone Robotics. <http://www.redzone.com>

Remotec, Inc. <http://www.remotec-andros.com>

Robotic Industries Association. <http://www.roboticonline.com/>

Rod Millen. <http://www.rodmillen.com/>

Appendix A Internet Programmatic Market Research Results

Time Domain. <http://www.timedomain.com>

Wisair. <http://www.wisair.com/>

Robotics Research Background Information

Center for Robot Assisted Search and Rescue (CRASAR). *Rescue robot demonstrated for mine disaster.* http://crasar.csee.usf.edu/MainFiles/july18_03.htm. July 18, 2003.

Center for Robot Assisted Search and Rescue (CRASAR). *Rescue robots get medical sensors.* http://crasar.csee.usf.edu/MainFiles/aug26_02.htm. August 26, 2002.

Center for Robot Assisted Search and Rescue (CRASAR). *Robots to the rescue.* http://sptimes.com/2003/03/02/Floridian/Robots_to_the_rescue.shtml. March 2, 2003.

Cyrano Sciences. *Electronic noses and how they help in our society.* http://ed.tsud.edu/tcubed/cool_tech/electronic_noses.htm. November 1999.

Dalli. *Unmanned aerial vehicle (UAV).* <http://www.dalli.com/usa/georgia07b.html>.

Defense-Aerospace. *Transformational stars: unmanned aerial vehicles or unmanned ground vehicles?* <http://www.defense-aerospace.com/data/features/data/fe238/>.

Foster Miller, Inc. *Man-portable robots for EOD, reconnaissance, communication, sensing, security and rescue.* <http://www.foster-miller.com/lemming.htm>.

Gecko Systems. *Mobile robotic solutions: SecurityBot™.* <http://www.geckosystems.com/SecurityBot/>.

Honda. *Meet ASIMO, Honda's humanoid robot.* <http://www.hondacorporate.com/new/?subsection=asimo>.

IEEE. *Search and rescue robots.* <http://www.service-robots.org/searchRobots.php>.

Lawrence Livermore National Laboratory. *A low-cost multi-terrain mobile robot for hostile environments.* http://www.llnl.gov/automation-robotics/1_star.html. October 9, 1997.

Lockheed Martin. *Long-lasting colonies: workshop on revolutionary aerospace system concepts for human/robotic exploration of the solar system.* <http://www.icas.edu/workshops/hress01/presentations/chun.pdf>. November 6, 2001.

Appendix A

Internet Programmatic Market Research Results

- Mitre. *Designing robot teams for military use.*
http://www.mitre.org/news/digest/advanced_research/02_03/ar_robotics.html.
February 2003.
- Mitre. *Military robotics: marching from the lab to the battlefield.*
http://www.mitre.org/employment/employee_spotlight/alan_christiansen.html.
November 2002.
- National Institute of Standards and Technology (NIST). *NIST-built urban ruin put search-and-rescue robots to the test.*
http://www.nist.gov/public_affairs/releases/n00-13.htm. July 27, 2000.
- National Institute of Standards and Technology (NIST). *NIST simulates urban destruction to test mechanical searches.*
http://www.nist.gov/public_affairs/techbeat/tb2000_08.htm. August 2000.
- National Robotics Engineering Consortium. *Automated material transport system.*
<http://www.rec.ri.cmu.edu/projects/amts/amts.shtml>. January 14, 2002.
- National Robotics Engineering Consortium. *Integrated air/ground vehicle system for semi-autonomous off-road navigation.*
<http://www.rec.ri.cmu.edu/projects/perceptor/perceptor.shtml>. March 19, 2003.
- National Robotics Engineering Consortium. *Dragon runner™.*
<http://www.rec.ri.cmu.edu/projects/dragon/dragon.shtml>. November 12, 2002.
- NAVSEA. *Unmanned vehicles – a technology whose time has come.*
http://www.dt.navy.mil/pao/excerpts%20pages/2001/unmannedV7_01.htm. July 2001.
- Omnitech Robotics International, LLC. *Modular autonomous robotic system (MARS).*
<http://www.omnitech.com/mars.htm>.
- Pacific Northwest National Laboratory (PNNL). *Electronic noses and their applications.*
<http://cns-web.bu.edu/pub/laliden/WWW/Papers/nose.html>. October 12, 1995.
- Rafael. *RAFAEL unveil new tactical UAV.* <http://www.uvonline.com/cgi-bin/view?t=N&r=N/1478>. May 6, 2003.
- Redstone Arsenal, Alabama. *Man-portable robotic systems (MPRS).*
http://www.redstone.army.mil/ugvsjpo/MPRS_PROGRAM_MAINPAGE.htm.
- Redstone Arsenal, Alabama. *Standardized robotic system (SRS) program.*
http://www.redstone.army.mil/ugvsjpo/SRS_MAINPAGE.htm.

Appendix A

Internet Programmatic Market Research Results

- Redstone Arsenal, Alabama. *USMC gladiator program*.
http://www.redstone.army.mil/ugvsjpo/USMC_PROGRAM_MAINPAGE.htm.
- Robotics Mobility Lab. *Rapid infusion of army robotics technology for force protection & homeland defense*. <http://www.asc2002.com/manuscripts/N/NO-02.PDF>.
- Robotics Mobility Lab. *Rapid infusion of army robotics technology for force protection & homeland defense*. http://www.asc2002.com/oral_summaries/N/NO-02.PDF.
- Robotics Trends. *Pentagon pouring funds into a host of land and sea robots*.
<http://www.robotictrends.com/securityarticle34.html>. September 6, 2003.
- Rod Millen. *Unmanned ground combat vehicle (UGCV)*.
http://rodmillen.com/print/print_ugcv.htm.
- Sandia National Laboratories. *Accident response mobile manipulator system (ARMMS)*.
<http://www.sandia.gov/isrc/ARMMS.html>.
- Sandia National Laboratories. *DIXIE surveillance robot*.
<http://www.sandia.gov/isrc/Dixie.html>.
- Sandia National Laboratories. *Fire ant*. <http://www.sandia.gov/isrc/fireant.html>.
- Sandia National Laboratories. *Fuel cell powered mobile robots*.
<http://www.sandia.gov/isrc/fuelcellrat.html>.
- Sandia National Laboratories. *Perimeter detection*.
<http://www.sandia.gov/isrc/perimeterdetection.html>.
- Sandia National Laboratories. *Rapid response investigation of robots for post-accident safety assessment*. <http://www.sandia.gov/isrc/minerobot.html>.
- Sandia National Laboratories. *RATLERTM at the sierra army depot*.
<http://www.sandia.gov/isrc/sadrat.html>.
- Sandia National Laboratories. *Rugged mobile robotic system for surveillance and reconnaissance*. <http://www.sandia.gov/isrc/Marvin.html>.
- Sandia National Laboratories. *SandDragon*.
<http://www.sandia.gov/isrc/sanddragon.html>.
- Sandia National Laboratories. *Surveillance and reconnaissance ground equipment*.
<http://www.sandia.gov/isrc/SARGE.html>.
- Space and Naval Warfare Systems Command (SPAWAR). *Ground surveillance robot (GSR)*. <http://www.spawar.navy.mil/robots/land/gsr/gsr.html>.

Appendix A

Internet Programmatic Market Research Results

Space and Naval Warfare Systems Command (SPAWAR). *Man portable robotic system (MPRS)*. <http://www.spawar.navy.mil/robots/land/mprs/mprs.html>.

Space and Naval Warfare Systems Command (SPAWAR). *Marsupial robots*. <http://www.spawar.navy.mil/robots/resources/marsupial/marsupial.html>.

Space and Naval Warfare Systems Command (SPAWAR). *Surrogate teleoperated vehicle (STV)*. <http://www.spawar.navy.mil/robots/land/stv/stv.html>.

Space and Naval Warfare Systems Command (SPAWAR). *Teleoperated dune buggy*. <http://www.spawar.navy.mil/robots/land/dbuggy/dbuggy.html>.

Space and Naval Warfare Systems Command (SPAWAR). *Teleoperated vehicle (TOV)*. <http://www.spawar.navy.mil/robots/land/tov/tov.html>.

Tulane University. *Cost Effective, Open Standards-Based Solutions for Homeland Security, Bioterrorism Defense and Healthcare Delivery*. <http://www.som.tulane.edu/tccep/documents/LouisianaHomelandSecurity.pdf>

University of California at Berkeley. Robotics and Intelligent Machines Laboratory. <http://robotics.eecs.berkeley.edu/>

University of California Los Angeles (UCLA). *UC, UCLA responds to terrorism attacks*. <http://www.today.ucla.edu/2002/020924terrorism.html>. 2002.

U.S. Army Maneuver. *Robotics and unmanned vehicles: the future*. <http://www.dtic.mil/ndia/2001testing/adams.pdf>. December 13, 2001.

UVOnline. *Ground robots to the rescue*. <http://www.uvonline.com/cgi-bin/view?t=N&r=N/1456>. 2003.

Appendix B

Technological Database Research Results

Communication Technology

- File 2: INSPEC. Accession Number: 7024158. *Evaluating control strategies for wireless-networked robots using an integrated robot and network simulation.* 2001.
- File 2: INSPEC. Accession Number 7697857. *NASA's Space Infrared Telescope Facility: seeking warmth in the cosmos.* February 2003.
- File 2: INSPEC. Accession Number 5932779. *Autonomous Mobile Periscope System (AMPS).* 1998.
- File 2: INSPEC. Accession Number 5583384. *Mobile Detection Assessment Response System program.* 1995.
- File 2: INSPEC. Accession Number 5090518. *Mobile Detection Assessment Response System.* Summer 1995.
- File 8: EiCompendex. Accession Number: 06603955. *Cooperative hunting of multiple mobile robots in an unknown environment.* 2003.
- File 8: EiCompendex. Accession Number: 05908535. *Evaluating control strategies for wireless-networked robots using an integrated robot and network simulation.* 2001.
- File 8: EiCompendex. Accession Number: 05803446. *Local communication-based navigation in a multirobot environment.* 1999.
- File 8: Ei Compendex. Accession Number 06236874. *Networked sensor communications for the objective force.* 2002.
- File 8: Ei Compendex. Accession Number 05830273. *Active visual localization for cooperating inspection robots.* 2000.
- File 15: ABI/INFORM. Accession Number 01286654. *Robots in the security services business.* Fall 1996.
- File 15: ABI/Inform. Accession Number: 02484289. *Vision-based tracking and control of remotely controlled vehicles.* 1997.
- File 65: Inside Conferences. Accession Number 04061907. *Wireless Inter-Vehicle Communication for Hazard Warning.*
- File 65: Inside Conferences. Accession Number 03330647. *Contour Model Guided Image Warping for Medical Image Interpolation.*

Appendix B Technological Database Research Results

- File 65: Inside Conferences. Accession Number 03239199. *A Vision Based Lane Departure Warning System.*
- File 65: Inside Conferences. Accession Number 02833115. *Monitoring and Warning Computerized System for a Semi-automatic Lift-up System of Pre-assembled Roof Floor.*
- File 65: Inside Conferences. Accession Number 01070098. *AURORA: A Vision-Based Roadway Departure Warning System.*
- File 65: Inside Conferences. Accession Number 04061907. *Wireless Inter-Vehicle Communication for Hazard Warning.*
- File 65: Inside Conferences. Accession Number 03330647. *Contour Model Guided Image Warping for Medical Image Interpolation.*
- File 65: Inside Conferences. Accession Number 00883803. *A Computer Networked Lasercom Scheme of Satellite Based Intelligent Robot Systems for Warning Earth Locations of Possible Natural/Nuclear Disasters Using Any Desired etc.*
- File 94: JICST-EPlus. Accession Number 04073315. *Research of a Small Search Rescue Robot.* 1998.
- File 99: H.W. Wilson. Accession Number: 04851772. *Honda's walking, talking robot, Asimo.* Jan. 28 2002.
- File 99: H.W. Wilson. Accession Number: 03277476. *Robots modeled after a colony of ants.* Feb./Mar. 1996.
- File 99: HW Wilson. Accession Number: 2602673. *Motion Planning of Multiple Mobile Robots for Cooperative Manipulation and Transportation.*
- File 148: The Gale Group. Accession Number: 14384813. *Entertainment robotics: competing teams of autonomous robot soccer players illustrate the challenges, pleasures, and promise of developing collaborative multi-robot applications.* March 2002.
- File 148: The Gale Group. Accession Number: 08901150. *Augmented reality for telerobotic control: a practical approach for today's bandwidths.* May 1996.
- File 155: MEDLINE. Accession Number 11565486. *Model-based supervisory control in telerobotics.* Spring 1996.
- File 266: Federal Research in Progress. Accession Number 00253054. *A close-up fiber optic remote viewing system for robotic and teleoperated systems.*

Appendix B

Technological Database Research Results

- File 266: Federal Research in Progress. Accession Number 00241749. *Multi-user, multi-access, wireless I-R communication system.*
- File 266: Federal Research in Progress. Accession Number 00261708. *Wireless communications for mobile robotic systems.*
- File 266: Federal Research in Progress. Accession Number 00249726. *Robotic vehicle communications controller.*
- File 266: Federal Research in Progress. Accession Number 00247244. *Development of a visual language telerobotic operator interface for rapid implementation of autonomous tasks.*
- File 266: Federal Research in Progress. Accession Number 00245190. *Robotic vehicle video image transmission.*
- File 266: Federal Research in Progress. Accession Number 00244875. *Optimizing the camera and positioning system for telerobotic worksite viewing.*
- File 266: Federal Research in Progress. Accession Number 00239212. *Simple man/robot interaction language.*
- File 266: Federal Research in Progress. Accession Number: 00245915. *Robotic Vehicle Video Image Transmission.*
- File 266: Federal Research in Progress. Accession Number: 00253043. *A Method of Improving the Dynamic Performance of Telerobotics Systems.*
- File 636: The Gale Group. Accession Number: 05421768. *Fujitsu devises home robot controlled by cell phone.* Oct 14, 2002.

Industrial Trends and Consumer Products Applications

- File 6: NTIS. Accession Number: 2015272. *Miniature Autonomous Robotic Vehicle (MARV).* 1996.
- File 8: Ei Compendex. Accession Number 05834141. *Robot-Draw, an internet-based visualization tool for robotics education.* 2001.
- File 15: ABI/Inform. Accession Number: 02531759. *Robots in unusual places: A look at the future.* 2002.
- File 15: ABI/Inform. Accession Number: 02516112. *Pointing the way to intelligent automation.* 1997.
- File 15: ABI/Inform. Accession Number: 02494988. *A new robot command library*

Appendix B Technological Database Research Results

which includes simulation. 1999.

File 15: ABI/Inform. Accession Number: 02484949. *Robots for the dangerous tasks.* 1999.

File 15: ABI/Inform. Accession Number: 02190578. *Innovation: The robo-claws have it.* Jun 25, 2001.

File 15: ABI/Inform. Accession Number: 01286655. *Mobile robots for a "real world".* Fall 1996.

File 15: ABI/Inform. Accession Number: 01285986. *Smoother moves for robots.* Sep 1996.

File 15: ABI/Inform. Accession Number: 01149933. *Robot ant-ics.* Feb/Mar 1996.

File 16: The Gale Group. Accession Number: 10170127. *Caretaker robot will keep terrorists at bay.* Oct 5, 2002.

File 65: Inside Conferences. Accession Number 03330578. *On-Line Signature Verification by Dynamic Time-Warping.*

File 148: Gale Group Trade & Industry Database. Accession Number 14133761. *France Looking To Launch EBRC Reconnaissance Vehicle Program Next Year.* December 17, 2001.

File 148: Gale Group Trade & Industry Database. Accession Number 13380753. *When bugs are the machine. (Mini Autonomous Robot Vehicle)* April 2001.

File 148: Gale Group Trade & Industry Database. Accession Number 11279829. *Robotics creating new markets for resellers. (Institute of Robotics and Intelligent Systems)* July 23, 1999.

File 148: The Gale Group. Accession Number: 14084009. *Learning from a Light, Lithe Biped; Honda continues corporate fondness for robotic research.* Dec 1, 2001.

File 148: The Gale Group. Accession Number: 13351729. *The Age of Robots.* April 23, 2001.

File 148: The Gale Group. Accession Number: 13117074. *2001: The Real Odyssey.* Jan, 2001.

File 148: The Gale Group. Accession Number: 13023900. *Robotic evolution in full Swing.* July 2000.

File 148: The Gale Group. Accession Number: 12951925. *Sewer work is fit for a robot.*

Appendix B Technological Database Research Results

Dec 1, 2000.

File 148: The Gale Group. Accession Number: 12812216. *Robots are marching toward a more intelligent and more mobile future.* Nov 20, 2000.

File 148: The Gale Group. Accession Number: 12291502. *Is This the Age of the Robot?* May, 2000.

File 148: The Gale Group. Accession Number: 11474331. *The right to buy: how to choose the right robot for your application.* Sept 1999.

File 148: The Gale Group. Accession Number: 11045213. *Moving beyond analysis, systems visualize their internal world -- Smart technologies make more-capable robots.* May 17, 1999.

File 148: The Gale Group. Accession Number: 10371894. *Robo - growth set to continue.* June 1998.

File 148: The Gale Group. Accession Number: 09336560. *Survival of the fittest robot.* Jan, 1997.

File 148: The Gale Group. Accession Number: 08509609. *Robot ant-ics.* Feb-March, 1996.

File 148: The Gale Group. Accession Number: 16418777. *Prestigious Scientific American 50 Names iRobot "Business Leader in Robotics"; Award Recognizes Leaders in Fields Ranging from Robotics and Computing to Agriculture and Energy.* Nov 10, 2003.

File 148: The Gale Group. Accession Number: 15767521. *A robot in everyhouse: Robots are not just for assembly lines any more. They're knocking at your front door ready to fetch you a beer, watch for prowlers, or play your favorite CD.* Oct 10, 2002.

File 148: The Gale Group. Accession Number: 14616720. *What to look for when selecting a robot.* May 2002.

File 148: The Gale Group. Accession Number: 14481206. *Lord of the robots: Rodney Brooks, director of MIT's artificial intelligence lab, is helping bring autonomous, intelligent machines into everyday use.* April 2002.

File 148: The Gale Group. Accession Number: 14348552. *A.I. Reboots: 2001 has come and gone, with dreams of a hal-like computer long since abandoned. But in scaling back their promises, artificial-intelligence researchers are finally starting to score significant successes.* March, 2002.

Appendix B

Technological Database Research Results

File 148: The Gale Group. Accession Number: 14297308. *Insect robot project lifts off to explore Mars.* Jan 21, 2002.

File 148: The Gale Group. Accession Number: 14539130. *Smarter robots: sending machines to do hazardous work is one rationale, but current considerations put robots in applications where superhuman accuracy and speed is the goal.* April 2002.

File 587: Jane's Information Group. Accession Number: 10849085. *Feature-Robots on the March.* August 01, 1996.

File 636: The Gale Group. Accession Number: 05330355. *TINY ROBOT DEVELOPED BY BERKELEY TEAM.* July 30, 2002.

Military Applications

File 2: INSPEC. Accession Number: 7249193. *Vision-based semi-autonomous outdoor robot system to reduce soldier workload.* 2001.

File 2: INSPEC. Accession Number 6538932. *Remote battlefield observer technology (REBOT).* 1999.

File 2: INSPEC. Accession Number 6497579. *Autonomous vehicle programs and applications at SPAWAR Systems Center.* 1999.

File 2: INSPEC. Accession Number 5729779. *Weaponization concepts for unmanned systems.* 1996.

File 6: NTIS. Accession Number 2223709. *Autonomous vehicles and the net-centric battlespace.* April 2000.

File 6: NTIS. Accession Number 2136867. *RSTA for small rovers in urban warfare.* May 1999.

File 6: NTIS. Accession Number 2104266. *Tactical Unmanned Vehicle (TUV), User Appraisal Phase I.* October 1998.

File 6: NTIS. Accession Number 1355447. *Developing Technologies for Army Autonomous Land Vehicles.* October 1985.

File 8: Ei Compendex. Accession Number 05965597. *Robotic technology integration for army ground vehicles.* 2001.

File 8: Ei Compendex. Accession Number 05435352. *Department of defense joint robotics program.* 1999.

Appendix B

Technological Database Research Results

- File 8: EiCompendex. Accession Number: 06159856. *Vision-based semi-autonomous outdoor robot system to reduce soldier workload.* 2001.
- File 8: Ei Compendex. Accession Number 05435367. *Remote Battlefield Observer Technology (REBOT).* 1999.
- File 8: Ei Compendex. Accession Number 06194583. *Army ground robotics research program.* 2002.
- File 8: Ei Compendex. Accession Number 04154314. *Design of the 'army-ant' cooperative lifting robot.* 1995.
- File 8: Ei Compendex. Accession Number 06159885. *TARDEC's robotics laboratory.* 2001.
- File 15: ABI/INFORM. Accession Nummber 02494963. *Mobile robots: big benefits for US military.* 1997.
- File 16: Gale Group PROMT. Accession Number 10778755. *United Defense To Study Armed Robotic Vehicles For Future Combat System.* September 17, 2003.
- File 16: Gale Group PROMT. Accession Number 05463839. *U.S. Army may arm scout reconnaissance robot.* February 9, 1998.
- File 16: Gale Group PROMT. Accession Number 10169179. *Robotic warrior goes into action in the hazardous caves of Afghanistan.* August 10, 2002.
- File 16: The Gale Group. Accession Number: 08969663. *Defense Contracts.* Sept 5, 2001.
- File 65: Inside Conferences. Accession Number 04223891. *Unmanned Undersea Vehicle Technology "A U.S. Naval Sea Systems Command Undersea Warfare Center Perspective."*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2596014. *Low-Cost UUVs for Military Applications.* 2003.
- File 148: The Gale Group. Accession Number: 10583159. *Project gives robotic 'soldiers' some nerve.* Nov 2, 1998.
- File 148: The Gale Group. Accession Number: 12274739. *Hooper Champions Crusader As Forerunner in Army Robotics.* June 28 , 2000.
- File 148: The Gale Group. Accession Number: 16040736. *Carnegie Mellon Hoping To Carve Out Subcontractor Role In FCS.* June 18, 2003.

Appendix B Technological Database Research Results

File 148: The Gale Group. Accession Number: 15890666. *The front lines of homeland defense: faced with defending the homeland against terrorism, government agencies rely on USF for innovative solutions.* June 2003.

File 553: Wilson Business Abstracts. Accession Number 04586432. *Military maneuvers use cutting-edge technology.* October 1, 2001.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10914207. *Unmanned surface vehicles assume new roles.* February 1, 2003.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10904686. *DARPA, US Army team to develop combat UAV.* January 16, 2002.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10898355. *COUGAR adds teeth to ground robots.* September 1, 2001.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10885287. *US Army to test mobility of UGVs.* July 19, 2000.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10883944. *USMC to buy robots for urban warfare operations.* June 7, 2000.

File 587: Jane's Defense & Aerospace News/Analysis. Accession Number 10875491. *US rethinks unmanned ground vehicles.* July 1, 1999.

File 587: Jane's Information Group. Accession Number: 10920421. *Future Combat Systems: The Global Battlefield.* August 27, 2003.

File 587: Jane's Information Group. Accession Number: 10919246. *Taking weight off the shoulders of battle troops.* July 16, 2003.

File 587: Jane's Information Group. Accession Number: 10914980. *Ground robotics advance, but questions remain.* February 19, 2003.

File 587: Jane's Information Group. Accession Number: 10910640. *Military priorities and future warfare.* September 11, 2002.

File 587: Jane's Information Group. Accession Number: 10906717. *Unmanned ground vehicles demonstrate their value.* April 01, 2002.

File 587: Jane's Information Group. Accession Number: 10904403. *Special Report - Afghanistan: the key lessons.* January 02, 2002.

File 587: Jane's Information Group. Accession Number: 10894977. *USMC seeks out new technologies.* June 01, 2001.

Appendix B

Technological Database Research Results

- File 587: Jane's Information Group. Accession Number: 10893238. *Terrorist Prevention: Technology versus Terrorism*. April 01, 2001.
- File 587: Jane's Information Group. Accession Number: 10890392. *GI, Robot*. January 01, 2000.
- File 587: Jane's Information Group. Accession Number: 10879585. *US Army to accelerate Future Combat Systems*. January 26, 2000.
- File 636: The Gale Group. Accession Number: 05542900. *USA: FOSTER-MILLER AWARDED CONTRACT FOR ROBOTIC SYSTEM*. Nov 3, 2002.
- File 636: The Gale Group. Accession Number: 05406207. *USA: IROBOT CORP., AWARDED CONTRACT FOR MTRS*. Nov 3, 2002.
- File 636: Gale Group Newsletter Database. Accession Number 05482570. *Unmanned combat vehicle expanded*. January 2003

Navigation Technology

- File 2: INSPEC. Accession Number 7541151. *A case study of how mobile robot competitions promote future research*. 2002.
- File 2: INSPEC. Accession Number 7538587. *RoboCup Rescue international research project*. 2002.
- File 2: INSPEC. Accession Number 6921600. *RoboCup Rescue. A grand challenge for multiagent and intelligent systems*. Spring 2001.
- File 2: INSPEC. Accession Number 6490418. *A portable parallel manipulator for search and rescue at large-scale urban earthquakes and an identification algorithm for the installation in unstructured environments*. 1999.
- File 2: INSPEC. Accession Number 7556115. *System design for robot agent team*. 2002.
- File 2: INSPEC. Accession Number 7394583. *Multiple application telerobotics-a review*. January 2002.
- File 2: INSPEC. Accession Number 7249209. *Vehicle intelligence and implications for robotics*. 2001.
- File 2: INSPEC. Accession Number 7068627. *The CLARAty architecture for robotic autonomy*. 2001.

Appendix B

Technological Database Research Results

- File 2: INSPEC. Accession Number 6832051. *Intelligent autonomy for the Manta Test Vehicle*. 2000.
- File 2: INSPEC. Accession Number 6814617. *Forward Deployed Robotic Unit*. 2000.
- File 2: INSPEC. Accession Number 6491274. *Tactical Visualization Module*. 1999.
- File 2: INSPEC. Accession Number 6383817. *Applications for mini VTOL UAV for law enforcement*. 1999.
- File 2: INSPEC. Accession Number 5617224. *A third generation security robot*. 1997.
- File 2: INSPEC. Accession Number 5583388. *MDARS product assessment system*. 1995.
- File 2: INSPEC. Accession Number: 7780461. *Motion guidance experiments with Scooter Cobot*. 2003.
- File 2: INSPEC. Accession Number: 7779523. *Target recognition by components for mobile robot navigation*. July-Sept. 2003.
- File 2: INSPEC. Accession Number: 7662692. *Development of a creeping locomotion snake robot*. 2002.
- File 2: INSPEC. Accession Number: 7509202. *Autonomous stair-hopping with Scout robots*. 2002.
- File 2: INSPEC. Accession Number: 7502312. *Robust object tracking of irregular terrain vehicle*. 2002.
- File 2: INSPEC. Accession Number: 6853273. *RoboCup Rescue project: challenges and benchmark*. 2000.
- File 2: INSPEC. Accession Number: 6545402. *A study of autonomous mobile system in outdoor environment. IV. Sign instructed navigation and autonomous loading for outdoor transportation*. 1999.
- File 2: INSPEC. Accession Number: 6480735. *A mobile robot employing insect strategies for navigation*. 31 Jan. 2000.
- File 2: INSPEC. Accession Number: 6096450. *An insect-based approach to robotic homing*. 1998.
- File 2: INSPEC. Accession Number: 6091318. *Development of a two-legged robot for use in complex environments*. 1997.

Appendix B Technological Database Research Results

- File 2: INSPEC. Accession Number: 6091282. *A solution for a mobile robot navigation into unstructured environments.* 1997.
- File 2: INSPEC. Accession Number: 5419103. *Robot self-localization by means of vision.* Publication Date: 1996
- File 2: INSPEC. Accession Number: 5418252. *Walking streets faster [robot path planning].* 1996.
- File 2: INSPEC. Accession Number: 5147165. *AMRU 3: a teleoperated six-legged electro-hydraulic robot.* 1995.
- File 6: NTIS. Accession Number 2270662. *Unmanned and unattended response capability for homeland defense.* November 2002.
- File 6: NTIS. Accession Number 2180849. *Advanced distributed simulation Technology II (ADST-II) Next Generation Reconnaissance Experimental Unmanned Vehicle (NGRXUV) Experiment II Final Report.* September 27, 1999.
- File 6: NTIS. Accession Number 2121336. *Advanced Distributed Simulation Technology 2 (ADST 2) Next Generation Reconnaissance and Experimental Unmanned Vehicle (NGR and XUV) DO Number 73, CDRL AB02 for Results of Analysis.* January 6, 1999.
- File 6: NTIS. Accession Number 1996645. *Simulation of small robotic vehicle performance during UXO gathering operations using discrete event control.* September 1996.
- File 6: NTIS. Accession Number 1954460. *MDARS Multiple Robot Host Architecture.* October 1995.
- File 6: NTIS. Accession Number 1928160. *Controller Studies for Dexterous Hand Manipulation.* October 1994.
- File 6: NTIS. Accession Number 1378691. *Robotic Telepresence: Applications of Human Controlled Robots in Air Force Maintenance.* 1988.
- File 8: EiCompendex. Accession Number: 06670825. *Flexible Binary Space Partitioning for Robotic Rescue.* 2003.
- File 8: EiCompendex. Accession Number: 06653498. *Control of a 3-dimensional snake-like robot.* 2003.
- File 8: EiCompendex. Accession Number: 06371199. *Motion planning of multiple mobile robots for cooperative manipulation and transportation.* 2003.

Appendix B Technological Database Research Results

- File 8: EiCompendex. Accession Number: 05851142. *Distributed robotic mapping of extreme environments.* 2001.
- File 8: EiCompendex. Accession Number: 05560584. *RoboCup rescue: search and rescue in large-scale disasters as a domain for autonomous agents research.* 1999.
- File 8: EiCompendex. Accession Number: 05441762. *Development of an autonomous field transport vehicle with an active vision system.* 1999.
- File 8: EiCompendex. Accession Number: 05229142. *Empirical learning in mobile robot navigation.* 1998.
- File 8: EiCompendex. Accession Number: 05101785. *Autonomous land vehicle navigation using millimeter wave radar.* 1998.
- File 8: EiCompendex. Accession Number: 04367312. *Development of legged robots for use in disordered environments.* 1995.
- File 8: Ei Compendex. Accession Number 06222982. *USAR competitions for physically situated robots.* 2002.
- File 8: Ei Compendex. Accession Number 05748125. *RoboCup rescue project.* 2000.
- File 8: Ei Compendex. Accession Number 06670694. *A Method for Transporting a Team of Miniature Robots.* 2003.
- File 8: Ei Compendex. Accession Number 06159871. *Vehicle intelligence and implications for robotics.* 2001.
- File 8: Ei Compendex. Accession Number 06010938. *An overview of emerging results in networked multi-vehicle systems.* 2001.
- File 8: Ei Compendex. Accession Number 05649932. *Robotics vehicle mobility study.* 2000.
- File 8: Ei Compendex. Accession Number 04821497. *Robustness and performance tradeoffs in torque control of robots with harmonic drive transmission.* 1997.
- File 8: Ei Compendex. Accession Number 06194604. *Value-driven behavior generation for an autonomous mobile ground robot.* 2002.
- File 8: Ei Compendex. Accession Number 06194587. *An intelligent behavior generator for autonomous mobile robots using planning-based AI decision-making and supervisory control logic.* 2002.

Appendix B Technological Database Research Results

- File 8: Ei Compendex. Accession Number 06159888. *Designing a behavior development environment to support the demo III robotics program.* 2001.
- File 8: Ei Compendex. Accession Number 05878557. *Virtual reality interfaces for visualization and control of remote vehicles.* 2001.
- File 8: Ei Compendex. Accession Number 05851136. *Challenges for deploying man-portable robots into hostile environments.* 2001.
- File 8: Ei Compendex. Accession Number 06194582. *Robotic follower: Near-term autonomy for future combat systems.* 2002.
- File 8: Ei Compendex. Accession Number 06194580. *Department of defense joint robotics program.* 2002.
- File 8: Ei Compendex. Accession Number 06194573. *System design for robot agent team.* 2002.
- File 8: Ei Compendex. Accession Number 05649950. *Teleoperation convoy.* 2000.
- File 8: Ei Compendex. Accession Number 05649939. *Intelligent mobility through omni-directional vehicles: A research program.* 2000.
- File 8: Ei Compendex. Accession Number 05649938. *Forward deployed robotic unit.* 2000.
- File 8: Ei Compendex. Accession Number 05649935. *Department of Defense Joint Robotics Program.* 2000.
- File 8: Ei Compendex. Accession Number 05476454. *Autonomous vehicle programs and applications at spawar systems center.* 1999.
- File 8: Ei Compendex. Accession Number 05435355. *Intelligent mobility for robotic vehicles in the army after next.* 1999.
- File 8: Ei Compendex. Accession Number 05169675. *Semi-autonomous tactical robots for urban operations.* 1998.
- File 15: ABI/INFORM. Accession Number 02494972. *Vehicles and robots for humanitarian demining.* 1997.
- File 15: ABI/INFORM. Accession Number 02494964. *Industrial mobile robots: the future.* 1997.
- File 15: ABI/INFORM. Accession Number 02484949. *Robots for the dangerous tasks.* 1999.

Appendix B Technological Database Research Results

- File 15: ABI/Inform. Accession Number: 02494978. *Atlas - road robot*. 1997.
- File 16: Gale Group PROMT. Accession Number 10290801. *Unmanned Combat Vehicle Expanded*. January 2003.
- File 16: Gale Group PROMT. Accession Number 04557839. *Components help researchers build better robots*. September 10, 1996.
- File 16: Gale Group PROMT. Accession Number 10849278. *ActivMedia Robotics & RMT Robotics Collaborate on Revolutionary New Intelligent AGV; First Industrial Automation Mobile Robot Designed for Flexible Manufacturing and Flexible Materials Handling Applications*. November 18, 2003.
- File 16: Gale Group PROMT. Accession Number 10695908. *Russia: Novaya Era to develop human-like robots*. August 5, 2003.
- File 16: Gale Group PROMT. Accession Number 10047078. *Your wish is my command: Here it is, the ultimate toy--and if you break it you can't get caught*. December 22, 2001.
- File 16: Gale Group PROMT. Accession Number 04484560. *New robotics plant ready to provide gateway to the stars; Lawrenceville facility will spearhead battle to develop mobile robots*. July 30, 1996.
- File 65: Inside Conferences. Accession Number 04858555. *Novel binary pneumatic actuation for EP-WAR3 biped robot*.
- File 65: Inside Conferences. Accession Number 04858511. *Warp1: towards walking in rough terrain -smooth foot placement*.
- File 65: Inside Conferences. Accession Number 04858479. *WARP1: towards walking in rough terrain-control of walking*.
- File 65: Inside Conferences. Accession Number 04845727. *Vision Based Obstacle Warning System for On-Road Driving*.
- File 65: Inside Conferences. Accession Number 04478553. *Numerical simulation of the absolute gait of EP-WAR2 biped robot*.
- File 65: Inside Conferences. Accession Number 04389563. *Computer Aided Decision System for the Warehouse*.
- File 65: Inside Conferences. Accession Number 04389560. *Control and Simulation of a Modern Automated Warehouse System via a Colored Timed Petri Net Approach*.

Appendix B

Technological Database Research Results

- File 65: Inside Conferences. Accession Number 04244012. *Crane and Shuttle Optimization in Warehousing Systems.*
- File 65: Inside Conferences. Accession Number 04243935. *A Mobile Manipulator for Installation and Removal of Aircraft Warning Spheres on Aerial Power Transmission Lines.*
- File 65: Inside Conferences. Accession Number 04081438. *Gait analysis of EP-WAR2 biped robot for walking and climbing stairs.*
- File 65: Inside Conferences. Accession Number 03568832. *The basic design of the quadruped robot Warp1.*
- File 65: Inside Conferences. Accession Number 01829624. *Rosie the Robot: Laboratory Automation and the Second World War, 1941 to 1945.*
- File 65: Inside Conferences. Accession Number 01765625. *The Development of a Cellular Automatic Warehouse.*
- File 65: Inside Conferences. Accession Number 04223891. *Unmanned Undersea Vehicle Technology "A U.S. Naval Sea Systems Command Undersea Warfare Center Perspective".*
- File 65: Inside Conferences. Accession Number 04081438. *Gait analysis of EP-WAR2 biped robot for walking and climbing stairs.*
- File 65: Inside Conferences. Accession Number 03568832. *The basic design of the quadruped robot Warp1.*
- File 65: Inside Conferences. Accession Number 01829624. *Rosie the Robot: Laboratory Automation and the Second World War, 1941 to 1945.*
- File 65: Inside Conferences. Accession Number 01765625. *The Development of a Cellular Automatic Warehouse.*
- File 65: Inside Conferences. Accession Number 00786458. *Real-world issues in warehouse navigation [2352-25].*
- File 65: Inside Conferences. Accession Number 00602438. *WARC - An Algorithmic Approach to Machine Cell-Formation.*
- File 65: Inside Conferences. Accession Number 00281131. *Controlling Multiple Security Robots in a Warehouse Environment.*

Appendix B Technological Database Research Results

- File 65: Inside Conferences. Accession Number 00257861. *Determination of Racemic Warfarin in Human Plasma by Robotic Sample Preparation and High-Performance Liquid Chromatography.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2580694. *WTC teaches engineering lesson about rescue robot.* September 9, 2002.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2466208. *AAAI/RoboCup-2001 Urban Search and Rescue Events: reality and competition.* 2003.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2312146. *Robots snake toward space.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2248881. *"Snakes" in space.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2074702. *Robotic ants on the march.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2645566. *Robust Open-Ocean AUV Launch and Recovery Systems.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2553345. *USAR Competitions for Physically Situated Robots.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2543469. *The Use of Robots as a Search Tool.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2254869. *Mock urban ruin puts robots to real test.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2673654. *Accuracy Considerations in a 3-D Ultrasonic Positioning System Based on the Difference in Time of Flights.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2618609. *Platform-Based Embedded Software Design and System Integration for Autonomous Vehicles.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2544519. *Dynamics and control of a towed underwater vehicle system, part i: model development.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2430195. *Real-time motion planning for agile autonomous vehicles.*

Appendix B Technological Database Research Results

- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2372049.
Analysis of landmark configuration for absolute positioning of autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2353377.
Neural dynamic optimization for control systems--part III: applications.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2222057.
Navigation system design using time-varying complementary filters.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1846405.
Robust course-boundary extraction algorithms for autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1797611.
Trajectory tracking for autonomous vehicles: an integrated approach to guidance and control.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1741639.
An evidential approach to map-building for autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1717656.
New visual invariants for terrain navigation without 3D reconstruction.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1689253.
Navigation of autonomous vehicles using linear array cameras.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1649049.
Planning shortest paths among 2D and 3D weighted regions using framed-subspaces.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1522676.
Smooth local-path planning for autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1428142.
Autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1428141.
Prolog to Autonomous vehicles.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1264854.
A design for a visual motion transducer.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 0951647.
Dynamic motion planning of autonomous vehicles.

Appendix B Technological Database Research Results

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2675642.
A Framework and Architecture for Multi-Robot Coordination.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2498145.
AeroSense highlights robotics applications.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1860548.
KNOSAR: a knowledge based system prototype for robot assisted urban search and rescue.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1140683.
Mobile systems.

File 99: HW Wilson. Accession Number: 2553344. *Snake Robots to the Rescue!*

File 148: The Gale Group. Accession Number: 15249341. *The mine machine: Inco sends remote-control bots into the deeps to save money--and miners.* Nov 25, 2002.

File 148: The Gale Group. Accession Number: 14384812. *Probabilistic robotics: planning and navigation algorithms exploit statistics gleaned from uncertain, imperfect real-world environments to guide robots toward their goals and around obstacles.* March 2002.

File 148: The Gale Group. Accession Number: 09212447. *Control innovation steers space-based robots.* Jan 6, 1997.

File 148: Gale Group Trade & Industry Database. Accession Number 14616112.
Boeing-SAIC FCS Team Awards Contracts For Unmanned Ground Vehicles, UAVs. June 6, 2002.

File 148: Gale Group Trade & Industry Database. Accession Number 13866757.
DARPA's disruptive technologies. October 2001.

File 148: Gale Group Trade & Industry Database. Accession Number 11134126.
PRECARN-IRIS helps researchers turn projects into products.(Institute of Robotics and Intelligent Systems conference demos new technologies)(Technology Information) June 18, 1999.

File 155: MEDLINE. Accession Number 15009612. *Analysis and experiments with an elephant's trunk robot.* December 2001.

File 155: MEDLINE. Accession Number 12016505. *Localization of virtual objects in the near visual field.* September 1998.

Appendix B

Technological Database Research Results

- File 266: Federal Research in Progress. Accession Number 00258338. *Shared Multi-Use Remote Facility.*
- File 266: Federal Research in Progress. Accession Number 00256753. *Electronic Map Display and Route Planner.*
- File 266: Federal Research in Progress. Accession Number 00254681. *Unmanned ground vehicle (UGV) indoor tracking system.*
- File 266: Federal Research in Progress. Accession Number 00254492. *Development of an unmanned ground vehicle locomotion system.*
- File 266: Federal Research in Progress. Accession Number 00254491. *Distributed vehicle control system.*
- File 266: Federal Research in Progress. Accession Number 00254488. *Unmanned ground vehicle mobility.*
- File 266: Federal Research in Progress. Accession Number 00254264. *Standardizing Control Unit/Robotic Vehicle Controls and Interfaces.*
- File 266: Federal Research in Progress. Accession Number 00253060. *Robotic guidance systems using specialized and generalized targets.*
- File 266: Federal Research in Progress. Accession Number 00253059. *Self-contained miniature dexterous hand.*
- File 266: Federal Research in Progress. Accession Number 00253057. *Development of an exoskeleton arm master for robot control.*
- File 266: Federal Research in Progress. Accession Number 00253056. *Design of an integrated arm/wrist/hand system for whole-arm manipulation.*
- File 266: Federal Research in Progress. Accession Number 00253043. *A method of improving the dynamic performance of telerobotics systems.*
- File 266: Federal Research in Progress. Accession Number 00252991. *Visual motion for rotorcraft guidance.*
- File 266: Federal Research in Progress. Accession Number 00252201. *A highly functional and versatile camera platform for a multi-purpose robotic vehicle.*
- File 266: Federal Research in Progress. Accession Number 00240925. *Mobile robot secure/AJ data links.*

Appendix B

Technological Database Research Results

- File 266: Federal Research in Progress. Accession Number 00269476. *Two-armed, mobile, sensate, research robot.*
- File 266: Federal Research in Progress. Accession Number 00245136. *Remotely piloted vehicle engine design.*
- File 266: Federal Research in Progress. Accession Number 00243468. *Control algorithm for redundant degree-of-freedom manipulators.*
- File 266: Federal Research in Progress. Accession Number 00240919. *Laser navigation for tactical robotic vehicles.*
- File 266: Federal Research in Progress. Accession Number 00240321. *Spatial data structures for robotic vehicle route planning.*
- File 266: Federal Research in Progress. Accession Number 00237977. *Mobile robot for hazardous duty (teleoperated firefighting hose delivery system).*

Search and Rescue Applications

- File 2: INSPEC. Accession Number: 6853273. *RoboCup Rescue project: challenges and benchmark.* 2000.
- File 2: INSPEC. Accession Number 6814624. *Issues in intelligent robots for search and rescue.* 2000.
- File 2: INSPEC. Accession Number 7278600. *AAAI/RoboCup-2001 Urban Search and Rescue events reality and competition.* Spring 2002.
- File 6: NTIS. Accession Number: 2273593. *Development of an Urban Search and Rescue Robot.* 2003.
- File 8: Ei Compendex. Accession Number 06222440. *Development of underwater search and rescue remotely operated vehicles.* 2002.
- File 8: Ei Compendex. Accession Number 06044844. *AAAI/RoboCup-2001 urban search and rescue events. Reality and competition.* 2002.
- File 15: ABI/Inform. Accession Number: 02062277. *Heading for disasters.* Sep 4, 2000.
- File 15: ABI/INFORM. Accession Number 02153953. *Preparing for Armageddon: How we can survive mega-disasters.* May/June 2001.
- File 15: ABI/INFORM. Accession Number 02287094. *Robot "babies" crawl through WTC debris.* December 13, 2001.

Appendix B Technological Database Research Results

- File 15: ABI/INFORM. Accession Number 02277296. *Robot rescue and recovery.* November 22, 2001.
- File 15: ABI/INFORM. Accession Number 01807190. *'Mrobots' to the rescue.* May 1999.
- File 16: The Gale Group. Accession Number: 09748477. *Smarter robots: sending machines to do hazardous work is one rationale, but current considerations put robots in applications where superhuman accuracy and speed is the goal.* April, 2002.
- File 16: The Gale Group. Accession Number: 10170124. *Robots to the rescue.* Oct 5, 2002.
- File 65: Inside Conferences. Accession Number 04721318. *Remote Control of Machines for Removal of Damages Being Result of Disasters, Wars, and Terrorist Attacks.*
- File 94: JICST-EPlus. Accession Number 045537076. *Development of a Small Search Rescue Robot.* 1998.
- File 99: H.W. Wilson. Accession Number: 04324618. *Robots being developed to perform search-and-rescue missions using artificial intelligence.* Sept. 4 2000.
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2661747. *The First IEEE Workshop on Safety, Security, and Rescue Robotics.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2614239. *The AAI-2002 Robot Rescue.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2580694. *WTC teaches engineering lesson about rescue robot.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2553697. *Rats, Robots, and Rescue.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2553346. *Working with Robots in Disasters.*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2553344. *Snake Robots to the Rescue!*
- File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2551440. *Robots assist in search and rescue efforts at WTC.*

Appendix B

Technological Database Research Results

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2466209.
AAAI/RoboCup-2001 Robot Rescue.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2277248.
RoboCup Rescue: a grand challenge for multiagent and intelligent systems.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2106188.
Marsupial and shape-shifting robots for urban search and rescue.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 2402393.
Disaster sites too complex for most robots.

File 148: The Gale Group. Accession Number: 13837445. *Robots to the Rescue.* July ,
2001.

File 148: The Gale Group. Accession Number: 12593023. *Heading for Disasters.* Sept
4, 2000.

File 180: Federal Register. Accession Number: 02463525. *Conforming Revisions to the
Wassenaar Arrangement List of Dual-Use Items and Revisions to Antiterrorism
Controls.* August 1998

File 553: Wilson Business Abstracts. Accession Number 04324618. *Robots being
developed to perform search-and-rescue missions using artificial intelligence.*
September 4, 2000.

Sensing Technology

File 2: INSPEC. Accession Number: 7538580. *Development of a rescue robot with a
multi-sensor hand system.* 2002.

File 2: INSPEC. Accession Number: 7490966. *Sensor based detection system for mobile
robot.* 2001.

File 2: INSPEC. Accession Number: 6885120. *Mobile robot with wide capture active
laser sensor and environment definition.* March 2001.

File 2: INSPEC. Accession Number: 6536322. *The RoboCup-NAIST: a cheap
multisensor-based mobile robot with visual learning capability.* 1999.

File 2: INSPEC. Accession Number: 5950475. *The use of low cost FM-CW radar
sensors in navigation.* March 1998.

File 2: INSPEC. Accession Number 7771660. *Networked sensors for the objective
force communications.* 2003.

Appendix B Technological Database Research Results

- File 2: INSPEC. Accession Number 5729767. *Joint Vision 2010/Force XXI and common, lightweight advanced sensors for unmanned aerial vehicles.* 1996.
- File 6: NTIS. Accession Number 2221331. *Comparison of the mobile detection assessment reconnaissance system (MDARS) and experimental unmanned vehicle (XUV) robotic vehicle models.* September 2001.
- File 8: EiCompendex. Accession Number: 08511663. *Mobile robot with wide capture active laser sensor and environment definition.* 2001.
- File 8: EiCompendex. Accession Number: 06518892. *Path planning for robotic demining: Robust sensor-based coverage of unstructured environments and probabilistic methods.* 2003.
- File 8: EiCompendex. Accession Number: 05289947. *3D-high accuracy sonar system for multiple mobile vehicles.* 1998.
- File 8: EiCompendex. Accession Number: 05279197. *Learning sensor-based navigation of a real mobile robot in unknown worlds.* 1999.
- File 8: EiCompendex. Accession Number: 05051043. *Learning what is relevant to the effects of actions for a mobile robot.* 1998.
- File 8: EiCompendex. Accession Number: 04367538. *Tactile sensing and force control for robotic applications.* 1995.
- File 8: Ei Compendex. Accession Number 05524442. *Feature detection and map building using ranging sensors.* 1999.
- File 8: Ei Compendex. Accession Number 06194602. *Road detection and tracking for autonomous mobile robots.* 2002.
- File 15: ABI/Inform. Accession Number: 02516444. *Sensor-referenced multiple robot cooperation for material handling.* 1998.
- File 15: ABI/Inform. Accession Number: 02248134. *Real time mobile robot sonar with interference rejection.* 1999.
- File 15: ABI/Inform. Accession Number: 02248131. *A CTFM acoustic spatial sensing technology: its use by blind persons and robots.* 1999.
- File 15: ABI/Inform. Accession Number: 01911039. *Robots that can see like humans.* Fourth Quarter 1999.
- File 15: ABI/Inform. Accession Number: 01656030. *Pneumatic grippers lighten up.* Jun 18, 1998.

Appendix B Technological Database Research Results

File 15: ABI/Inform. Accession Number: 01286659. *Deciding on robotics vision.* Fall 1996.

File 15: ABI/Inform. Accession Number: 01286657. *Robots shine in inspecting hazardous environments.* Fall 1996.

File 15: ABI/Inform. Accession Number: 01161133. *A critical look at robot vision.* 1995.

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1572709. *Compound vision.*

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1419712. *Decision-theoretic cooperative sensor planning.*

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1206438. *A parallel implementation of a multisensor feature-based range-estimation method.*

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 0967621. *94 GHz three-dimensional imaging radar sensor for autonomous vehicles.*

File 99: Wilson Applied Science & Technology Abstracts. Accession Number 1738870. *Observant robots.*

File 148: The Gale Group. Accession Number: 13554243. *The Robo-claws have It.* June 25, 2001.

File 148: The Gale Group. Accession Number: 09378008. *Robotic sensor simplifies precise positioning.* March 10, 1997.

File 148: The Gale Group. Accession Number: 08124366. *3-D vision eases task for hazardous-waste robots.* August, 1995.

File 148: The Gale Group. Accession Number: 07998850. *Sensor monitors robotic gripper jaws.* March 1995.

File 148: The Gale Group. Accession Number: 14493905. *ONR Team Looks For Autonomy In New Mine-Hunting Robots.* April 16, 2002.

File 155: MEDLINE. Accession Number 09777431. *Rotation and direction judgment from visual images head-slaved in two and three degrees-of-freedom.* March 2000.

File 155: MEDLINE. Accession Number: 09465715. *Plume-tracking robots: a new*

Appendix B Technological Database Research Results

application of chemical sensors. Apr 2001.

File 266: Federal Research in Progress. Accession Number 00258426. *Automated Assessment of Low-Dose Radiation Damage.*

File 266: Federal Research in Progress. Accession Number 00258337. *Foveal Extra-vehicular Activity Helper-Retriever.*

File 266: Federal Research in Progress. Accession Number 00253058. *Extended tactile sensing for dextrous robotic hands.*

File 266: Federal Research in Progress. Accession Number 00251111. *Multiple sensors fusion for object detection and position finding.*

File 266: Federal Research in Progress. Accession Number 00251110. *Intelligent digital proximity sensors for robotic applications.*

File 266: Federal Research in Progress. Accession Number 00265846. *An invariant landmark object recognition method based on adaptive receptive field model of primate's VisualCortex.*

File 266: Federal Research in Progress. Accession Number 00256589. *Intrusion detection from a moving platform.*

File 266: Federal Research in Progress. Accession Number 00248586. *Active detection and tracking sensor for passive targets.*

File 266: Federal Research in Progress. Accession Number 00246766. *A new motion detector as a non-scanning optical tracing system.*

File 266: Federal Research in Progress. Accession Number 00243385. *Telerobotic rendezvous and docking vision system architecture.*

File 266: Federal Research in Progress. Accession Number 00271092. *Skin analog sensor for mobile robotic systems.*

File 266: Federal Research in Progress. Accession Number 00268782. *Sensor and detection algorithm based clutter metrics.*

File 266: Federal Research in Progress. Accession Number 00264443. *Natural tracking control for telerobotic servicing robots.*

File 266: Federal Research in Progress. Accession Number 00248723. *STS/space station and robotic tracking systems.*

Appendix B Technological Database Research Results

- File 266: Federal Research in Progress. Accession Number 00243540. *Tactile telepresence system for dexterous telerobotics.*
- File 266: Federal Research in Progress. Accession Number 00243493. *Telerobot collision/obstacle avoidance based on real-time proximity sensors.*
- File 266: Federal Research in Progress. Accession Number 00243486. *CAD/CAE knowledge-base development tool.*
- File 266: Federal Research in Progress. Accession Number 00243467. *Telepresence sensor and control helmet.*
- File 266: Federal Research in Progress. Accession Number 00242955. *Arm mounted 3-D robot vision for tracking objects in a work cell.*
- File 266: Federal Research in Progress. Accession Number 00242368. *Advanced sensors for close proximity robotic mine detection.*
- File 266: Federal Research in Progress. Accession Number 00236873. *Terrain hazard detector sensor.*
- File 587: Jane's Information Group. Accession Number: 10866241. *Mini-robots sniff out chemical agents.* June 01, 1998
- File 636: The Gale Group. Accession Number: 05698987. *Robotic Vision Systems Inc.* Nov 25, 2003.

Attachment B

Robotics Operational Concept Document

Introduction

The Robotic Emergency Medicine and Danger-Detection (REMeD-D) prototype will be developed through a collaborative effort involving CERMUSA and several other organizations. Each organization will play a role in the development of the prototype. These organizations will build two robots capable of working together to accomplish the following objectives established for Task #8 of the Mobile Communications Platform (MCP) project:

- Remotely extract victims injured as a result of a weapons of mass destruction attack
- Remotely assess the physical condition of victims injured as a result of a weapons of mass destruction attack
- Share the information gained from these activities with local military and civilian authorities located in rural areas

When needed, telemedicine prototype developers may be included in the process to provide healthcare consulting services. Through the implementation of background market research, request for information results, and internal planning, CERMUSA has developed the following operational concept for the development of a REMeD-D robotics prototype.

Robotics Platform and Operation

Two robots will be utilized to accomplish the objectives of the project. These two robots will include an extraction robot, estimated to be about the size of an all terrain vehicle, and a smaller assessment robot, estimated to be about the size of a standard briefcase. The first robot will be the "assessment" robot. It will be stored and deployed from a cargo hold area within the "extraction" robot's protective armor. The "assessment" robot will embark from the "extraction" robot to evaluate the environment and locate injured individuals.

Upon arriving at the scene of the disaster and/or bioterrorism attack, the combined robots will be deployed from a security trailer. The "extraction" robot with the "assessment" robot within its shell will be guided via remote control technologies to a tactical position near the MCP Command and Control Vehicle to be used as wireless communications repeater, extending the effective range of the wireless communications. Next the "assessment" robot will be deployed.

The "assessment" robot will contain sensors to evaluate the quality of the air, cameras to provide video data, technologies to assess the condition of the individual, and possibly infrared or ultra wide band technologies that will allow it to essentially "see through" brush and other debris. After it has collected data from the environment, the assessment robot will then transmit information, through wireless technologies, to the extraction robot and/or the Mobile Communications Platform (MCP) Command and Control Center. Depending upon terrain, distance, and other environmental factors, this information may, or may not, be transmitted by the assessment robot, directly to the MCP. During operation, this information may be transmitted to the extraction robot, located somewhere between the MCP and the assessment robot, where it will then be relayed to the MCP command and control center. All environmental information and navigational data exchanged between all entities involved in the project will have the capability of being transmitted over a variety of wireless communications frequencies

Attachment B

Robotics Operational Concept Document

and modalities. Therefore, during the study, satellite, 802.11, UHF, and VHF frequencies, among others, will be evaluated as a means of robot and MCP communications. In addition, depending upon environmental conditions and the capabilities of these wireless technologies, the quality of data, such as video information, will vary. For instance, in some cases, real time video may be transmitted while at other times still shots of patients and the environmental conditions may be the only form of visual information available.

The extraction robot, estimated to be the size of a four wheel all terrain vehicle, will be used to extract the patient after the assessment robot has located the individual and assessed whether or not their physical condition is favorable enough to warrant an attempted extraction and rescue. After receiving information from the assessment robot, the extraction robot will transmit information to the MCP, when needed, and navigate its way to the location of the injured individual. During operation, the extraction robot may be controlled and operated in two ways. First, it may be able to navigate its way to the injured individual, without human intervention, through the use of information received from the assessment robot. Second, it may be driven manually, through the use of remote control technologies, to the site of the injured person. Upon arrival, the extraction robot will then load the person onto the patient transport platform and carry them back to the MCP command and control center. This may be done with the aid of the injured individual and/or through the exclusive use of remote control technologies without human intervention. To accomplish these objectives effectively, the robots will perform the following functions:

Environmental Assessment

Minimum Requirements:

- The detection of gases and/or airborne particles that may be hazardous to human health
- The use of video monitoring to provide operators with visual information regarding the scene of the emergency and the condition of injured individuals

Options to consider if technology and funding constraints allow:

- The detection of airborne pathogens that may be hazardous to human health
- The evaluation of water quality where needed
- The use of ultra wide band and/or infrared technology for detection of objects hidden from sight
- Audio monitoring equipment

Medical Assessment

Minimum Requirements:

- Evaluate a person to determine if they are alive before transport
- The use of video monitoring to provide operators with visual information regarding the scene of the emergency and the condition of injured individuals

Options to consider if technology and funding constraints allow:

- Detect patient heart rate

Attachment B

Robotics Operational Concept Document

- Detect patient pulse oximetry
- Detect patient body temperature
- Audio monitoring equipment

Patient Transport

Minimum Requirements:

- Safely extract a patient from the field and transport them back to the command and control center with little physical human intervention during the process

Options to consider if technology and funding constraints allow:

- Provide the patient with protection from enemy fire during transport
- Pick the patient up and place him or her on the transport platform without physical human intervention

**Attachment C
 Robotic Emergency Medicine and Danger-Detection (REMeD-D)
 Project Implementation Plan**

Organizational Roles

The following chart describes the organizational roles:

Organization	Responsibility
1. TATRC	<ul style="list-style-type: none"> • TATRC oversees the entire project to ensure that all players are working together and fulfilling their roles. • TATRC is the ultimate source of all project funding. • TATRC provides Irobot with \$150,000 dollars to purchase two Packbot Platforms. • TATRC provides funding to Foster Miller, Inc. to develop the patient extraction tool. • TATRC provides funding to CERMUSA to carry out the research objectives of REMeD-D project. • TATRC researches and purchases the chemical and biological sensing technologies required to assess environmental conditions.
2. CERMUSA	<ul style="list-style-type: none"> • CERMUSA purchases the extraction robot platform. • CERMUSA compensates Applied Perception for all robotics integration costs associated with the development of the extraction and assessment robots. • CERMUSA researches and purchases the medical and physiological sensing technologies required to assess the physical condition of patients. • CERMUSA develops a test plan and evaluates both robotics prototypes in a rural environment.
3. Applied Perception	<p>Applied Perception provides robotics consulting services to CERMUSA. Their responsibilities will include:</p> <ul style="list-style-type: none"> • Integrating the Foster-Miller extraction tool with the extraction robot platform. (Developing the mechanism that will load the stretcher onto the robotics platform after the patient has been secured.) • Outfitting the assessment robot with biological, chemical, and physiological sensors provided by both TATRC and CERMUSA. • Integrating the two robotics communications/robotics platforms to ensure that they work together efficiently and effectively.
4. Foster-Miller, Inc.	<ul style="list-style-type: none"> • Foster Miller, Inc. designs and constructs an extraction tool that is capable of picking up and securing a patient for extraction. • Foster Miller, Inc. works with Applied Perception to integrate the extraction tool with the extraction robot platform.
5. Irobot	<ul style="list-style-type: none"> • Irobot provides two Packbot robotics platforms for use as assessment prototypes. The platforms will be outfitted identically, each possessing the same features and technologies. After the test and evaluation phase, CERMUSA will keep one of the Packbots and TATRC will keep the other. • Irobot works with Applied Perception to outfit Packbots with chemical and biological sensing technologies.

**Attachment C
 Robotic Emergency Medicine and Danger-Detection (REMeD-D)
 Project Implementation Plan**

**Robotic Emergency Medicine and Danger-Detection (REMeD-D)
 Project Plan Responsibility Flow Chart**

