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Robotics in the Pittsburgh Region

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The worldwide robotics market is expected reach $25 billion by 2010. The lion's share of that amount, $17 billion, will be carved out by personal and service robotics.

The world market for industrial robots is projected to increase a yearly average of 5.6 percent through 2009, culminating in about 130,150 units sold in 2009, at which time there will be an estimated total of 1,112,500 units in operation worldwide.

The mobile (sometimes referred to as agile) robotics industry continues to span the gamut with a higher concentration of uses in industrial, commercial and defense applications. A significant number of applications market address the "three Ds" – work that is dirty, dangerous or dull for humans. The Defense Advanced Research Projects Agency (DARPA) predicts that revenues in this category of robotics will comprise a significant portion of the United States' economy by 2036.

The worldwide market for robotically assisted surgery systems and equipment are set to have rapid growth and are forecast to reach $14 billion by 2014. The International Federation of Robotics has estimated that there currently are more than 6,400 medical robots in use around the globe.

In a recent report of a two-year study sponsored by NASA, the National Science Foundation (NSF) and the National Institutes of Health, the authors noted that the United States still is a leader in such areas as health care robotics, but faces strong competition from abroad.

Robotic research in the U.S. has been driven primarily by the Department of Defense, while Japan, Korea and Europe are more focused on commercial products. DARPA and NASA, the main sponsors of robotic research in the U.S., have reduced their funding in recent years.

Mobile Robots

For the past 25 years, scientists have been engaged in researching and developing certain core enabling technologies in areas, such as sensors, computer vision, perception, navigation, mobility and man-machine interfaces in order to make robots more perceptive, more mobile and more autonomous. These technologies are now reaching development levels that enable them to be integrated with standard or custom-developed electro-optic and/or electro-mechanical devices and components to produce intelligent, adaptable and largely automated robotic applications, devices, vehicles and other solutions.

Mobile robots monitor, perceive and map their surroundings. They detect and identify physical characteristics and perform complex tasks in intricate, unpredictable, changing and/or inaccessible environments. These robots reduce the need for human attention, interaction and intervention. In addition, they greatly benefit customers by substantially increasing productivity, significantly improving cycle times, drastically decreasing costs and greatly reducing the risk of worker injury, property damage and other losses.

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Next-generation mobile robotic systems have begun to emerge in the existing industrial robotics market. It is also expected that a far wider range of mobile service robots in various defense, industrial, commercial, consumer, agricultural, construction, transportation and healthcare markets will take hold over the next decade. The anticipated growth in the adaptation of mobile robotic technologies holds the potential to reach critical mass in the not too distant future and spark a boom in robotics-driven business development activity. Pittsburgh is poised to capitalize on this boom through what has been termed "contributing base" and "enabling core" technologies.

Enabling core technologies are at the heart of mobile robotics, and they consist of a number of integrated sensor, processing and software technologies that can be categorized into several key areas.

Sensing and perception technologies include ladar (laser radar), stereovision and software technologies, such as sensor data fusion, object detection and localization. These enabling core technologies also allow mobile robots to create and maintain a real-time, continually updated, consolidated and detailed view of their assigned area and/or surrounding environment. These technologies also enable mobile robots to identify, classify and locate specific items and features (e.g. selecting parts on an assembly line, finding and framing curbs on the side of a road, detecting faces in a crowd, etc.) and to map their current location in the context of their perceived environment.

Intelligent behavior technologies include navigation, planning, control, machine learning, machine health, human-robot interaction, cooperative behavior and other artificial intelligence software technologies that enable mobile robots to 'think' and act, based on their broadly defined job functions (e.g. "evade any situations that might cause an accident"). These technologies enable mobile robots to plot travel paths, determine other courses of action, perform needed commands and functions, monitor, diagnose and mitigate system failures, work in concert with other system components, including other robotic devices, and interact with their human operators.

System integration technologies include the processes and tools needed to integrate elements of the enabling core and contributing base technologies to produce an effective, operationally capable, reliable, supportable and affordable mobile robot. There are several factors that, in turn, significantly impact the efficiency and effectiveness in engineering a system, product or application based on mobile robotic technologies. Among these considerations are the adoption of industry standard or open system architectures, the evolution of software development processes and tool sets, the development of common assessment methodologies, including quantitative standards and metrics, and the use of modeling and simulation tools.

Within contributing base technologies, as differentiated from the areas described above, there are several underlying areas that, although not specific to robotic applications, are often adapted and integrated to create the basis for many mobile robots. These contributing technologies can be grouped into a couple of key areas.

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Computing and communication technologies include increasingly small, powerful, energy efficient and cost-effective microelectronics, such as microprocessors, antennas and other components. These components are needed to permit high-bandwidth, wireless data networking and other mobile communications to occur with their human operators and other subsystems.

Mobility and platform technologies include power/energy sources (such as fuel cells), materials technology (such as composites), mobility technologies (such as those found in crawling robots) and payload technologies, such as manipulator arms that collectively enable mobile robots to move about and perform physical tasks.

Research Assets

While Pittsburgh has been somewhat slow to develop a large industry base in any single robotics field, the region has had and continues to foster a defining presence in the larger North American robotics community.

But Pittsburgh's robotics development situation is not uncommon. Most North American activity in non-industrial and service robotics takes place around universities with substantial research programs, such as the University of California at Berkeley, MIT, Stanford University and Carnegie Mellon University. One reason for this trend is that research universities are simply better equipped than young start-ups to fund research and development programs.

As the demand for non-industrial robots increases, Pittsburgh will be in a strong position to develop its industry base, due to unparalleled research resources.

Established in 1979, the Robotics Institute at Carnegie Mellon University has made Pittsburgh a worldwide leader in robotics research. Its mission is to conduct basic and applied research in robotics technologies relevant to industrial and human service tasks. Seeking to combine the practical and the theoretical, the Robotics Institute undertakes diversified efforts and approaches to robotics science to achieve its mission. Today the institute is a $50 million enterprise with a team of 300 people whose research breakthroughs are changing the fields of agriculture, medicine, mining, transportation, space exploration and national security. The Institute's work has furthered the goals of several government agencies, including NASA, DARPA, the Department of Energy, the Department of Transportation and the Environmental Protection Agency.

The Robotics Institute also is the largest research facility of its kind in the United States. Its staff currently is working on more than 250 projects housed within eight robotics-related sub-centers, which include:

The Center for the Foundation of Robotics encourages and facilitates fundamental robotics research, both theoretical and experimental. Participants explore basic issues in manipulation, mobile robotics, manufacturing, control, motion planning, graphics and other topics. The Center provides a venue for fundamental research collaboration through the foundation's seminars and occasional micro-courses or tutorials.

The Center for Integrated Manufacturing and Decision Systems is an eclectic group of people, projects and labs involved in research in the fields of manufacturing, visualization and interfaces, intelligent coordination and logistics, intelligent sensors, measurement, control and artificial intelligence.

The Field Robotics Center focuses on the use of mobile robots in field environments, such as work sites and natural terrain, where the robots must safeguard themselves while performing non-repetitive tasks and objective sensing, as well as self-navigation in random or dynamic environments.

The Medical Robotics Technology Center is a program aimed at pursuing perfection in healthcare. The Center performs basic and applied research in computer-assisted surgery, smart medical and diagnostic tools, two-dimensional and three-dimensional medical image analysis and informatics, rehabilitative and prosthetic devices, assisted living and preventive healthcare equipment and continuous healthcare process improvement. The Center is harnessing and extending robotics and information technologies developed at Carnegie Mellon and elsewhere, and in collaboration with medical centers and biotechnology companies in the Pittsburgh region, quickly getting research results into clinical practice and commercial development.

Magnetic Levitation Haptic Consortium involves magnetic levitation haptic devices that allow users to interact with computed environments by manipulating a handle that is levitated by magnetic means. Users can translate and rotate the handle while feeling forces and torques from the virtual environment. The motors, encoders, linkages, gears, belts, cables and bearings of traditional haptic devices are simply dispensed with in favor of a direct electrodynamic connection to the handle held by the user. The Microdynamic Systems Laboratory is working to provide low-cost high fidelity magnetic levitation haptic interfaces to additional researchers under an NSF major research equipment grant by re-engineering old magnetic levitation systems to provide much higher performance while drastically reducing its cost. The Center currently is building a batch of nine new systems for distribution to members of the consortium.

The National Robotics Engineering Center is a technology transfer organization that designs, develops and tests robotic systems and vehicles for industrial and government clients. The Consortium combines systems engineering disciplines, analysis, design, simulation, integration and testing with applied research capabilities in autonomous, sensing and unmanned robot platform designs. The Consortium also excels in rapid integration and field-testing of automated systems, and

several of their products have made the transition to industry and the military.

The Vision & Autonomous Systems Center is a large research group consisting of more than 100 faculty, students, staff and visitors, working in the areas of computer vision, autonomous navigation, virtual reality, intelligent manipulation, space robotics and related fields.

The Quality of Life Technology Center is a unique partnership between Carnegie Mellon and the University of Pittsburgh that brings together a cross-disciplinary team of technologists, clinicians, industry partners, end users and other stakeholders to create revolutionary technologies that will improve and sustain the quality of life for all people.

Computer enthusiasts already share software codes over the Internet, but robotics requires more elaborate efforts. For that reason, the Center has launched a Web site, where academics, students, commercial inventors and enthusiasts can share ideas, technologies and software critical to robot development.

One promising CMU technology is snake robots. Associate Professor Howie Choset has demonstrated snake-like robots that can climb up and around pipes. These articulated, remote-controlled devices are designed to carry cameras and electronic sensors and can be controlled with a joystick. Built from lightweight aluminum or plastic, the robots are about the size of a human arm. Rescue professionals say it generally takes about 90 minutes for rescue workers to gain access to a disaster site, while a robot can plunge in immediately. Choset said the robots may not be ready for use for another five to 10 years, depending on funding.

Also in development is a robot developed by Research Professor Ralph Hollis that essentially is a five-foot, 95-pound robot that travels atop a single aluminum sphere coated in urethane. Believing that simple is best, Hollis and his team of graduate students eventually made the Ballbot twist, turn and travel in any direction without the need for room to maneuver. Next the team will add a drive so its cylindrical trunk can rotate to face any direction without the ball needing to turn. They also hope to add a head and arms that would swing to help Ballbot keep its balance.

In June of 2006, CMU won a soccer championship at the RoboCup 2006 World Championship in Germany, with its soccer-playing AIBO robots defeating 19 other teams and compiling a 53-3 scoring advantage in six games, including five shutouts. Other CMU robots provided color commentary during robotic soccer matches. Although Carnegie Mellon's AIBO team placed third in 2008, a joint team representing CMU and the Georgia Institute of Technology was one of only three participating in the exhibition of humanoid robot teams.

RoboCup is an international project to promote artificial intelligence, robotics and related fields through soccer competitions. The goal is to develop humanoid robots capable of beating the human world soccer champions by 2050.

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A part of Carnegie Mellon's School of Computer Science, the university's Robotics Institute is the only institution in the country offering M.S. and Ph.D. programs, as well as an undergraduate minor in robotics. Stanford, MIT and Berkeley offer competitive robotics education programs, but they do not offer formal degrees.

Technology transfer is enabled through industry-research partnerships at the Robotics Institute. Affiliate companies participate by sponsoring specific research projects. In return, they receive research results prior to public release; access to highly trained research personnel; information on promising robotics talent and graduate students and access to the Institute's vast library, archives, global affiliations and other additional resources and activities.

For fiscal year 2009, the Robotics Institute's sponsored project expenditures were $55.2M, including 43 grants from the NSF totaling $6.9M. Other sources of funding included the Department of Defense, private industry, foundations, NASA and other federal and non-federal sources. The Robotics Institute recently declared that it is participating in the Lunar X Prize competition among nongovernmental organizations to win $20 million for landing a robotic rover vehicle n the moon.

In late 2008, two groups of researchers at the Robotics Institute received a total of $10 million in grants from the U.S. Department of Agriculture to build automated farming systems. One is for apple growers and one is for orange growers, but both are designed to improve fruit quality and lower production costs. The systems use sensors on autonomous robotic vehicles or at fixed sites within the orchards to gather a multitude of data about tree health and crop status. Robotic vehicles will be used to administer precise amounts of water or agricultural chemicals to specific areas or trees. The vehicles also will be used to automate routine tasks such as mowing between tree rows.

The Robotics Institute also is active in technology transfer through invention disclosures, licenses, patents and spin-offs.

Carnegie Mellon's Robotics Institute and the university's Center for Technology Transfer and Enterprise Creation greatly expanded disclosure and licensing of robotic technologies over the last several years. Since 1989, the faculty disclosed 237 new inventions that resulted in 68 patent applications, 38 industry licenses and 48 startup companies. Since 2005 alone, there were 69 new inventions, 19 patent applications, 20 industry licenses and 10 new start-up companies.

Regional Industry Base

Research, talent and technology resources alone do not create a successful industry cluster. The region has made significant efforts to translate its historic robotics research expertise into a working and thriving industry base.

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The Technology Collaborative, a merger of the Robotics Foundry and the Pittsburgh Digital Greenhouse, is an independent, non-profit economic development organization whose mission is to develop industries that take advantage of the region's world-class assets in robotics, advanced electronics, cybersecurity and other digital technologies. The organization implements programs and initiatives intended to accelerate the growth of robotics technologies and to establish an industry cluster in the newly designated "RoboCorridor," encompassing southwestern Pennsylvania.

The RoboCorridor, anchored by Carnegie Mellon's Robotics Institute, encompasses a wide range of robotics-related organizations and initiatives, including the University of Pittsburgh School of Engineering and Swanson Center, the Software Engineering Institute, the Electro-Optics Center in Kittanning, the National Center for Defense Manufacturing and Machining in Latrobe, various defense-related engineering and manufacturing organizations based in Johnstown and the Applied Research Laboratory at The Pennsylvania State University in State College.

Currently The Technology Collaborative has a membership of 67 mostly regional robotics-related companies. The Pittsburgh Technology Council has a current membership of more than a dozen companies that extend the field into the wider arena of enabling technologies and automation, such as electro-optics (See "Electro-Optics in the Pittsburgh Region.") These enabling technology companies include American Robot Corporation, Cegelec, F.R. Industries/American Sensors, Integrated Industrial Technologies, Synapse Systems and Vocollect, among others.

At least two world leaders of robotic engineering, RedZone Robotics and McKesson Automation, are based in southwestern Pennsylvania.

RedZone Robotics, a spin-off from CMU, is the world leader in robots and mobile equipment that work where people cannot. It focuses on the construction and field service automation industry by developing innovative products that reduce costs, simplify operations, increase work quality and provide a safe work environment for customers. RedZone's robots are especially designed to clean, inspect and rehabilitate pipes, tanks, nuclear facilities and other hazardous or hard-to-reach environments. There are 1.2 million miles of sewer pipes in the U.S. with an average age of 57 years, which is seven years beyond their average life expectancy. For much of that pipe, tree roots and ground shifts are taking a tremendous toll over time, thereby providing a fertile market for RedZone. Another CMU spin-off, Workhorse Technologies, makes unmanned robots to explore and make maps of mines.

McKesson designs and manufactures hospital drug distribution systems that automate the storage, retrieval, dispensing, restocking and crediting of unit dose, bar-coded in-patient medications. The company's products reduce medication errors, increase cost savings and improve the quality of care. The Institute of Medicine declared that the lack of quality processes and a shortage of skilled workers in hospitals led to medication errors, which is the fifth leading cause of death of Americans. With 6,000 hospitals and 60,000 retail pharmacies in the U.S., potential customers that

perform repetitive activity that requires a high degree of accuracy, McKesson's products and systems will remain a tailor-made application.

Other international robotics companies with a presence in southwestern Pennsylvania include:

- American Robot Corporation, a manufacturer of industrial robots and motion controllers serving the automotive, aerospace, defense and general manufacturing industries.

- Cegelec Corporation, a $2 billion contracting and industrial automation company with 26,000 employees in 23 countries

- Coroware Test Labs, a Pittsburgh-based subsidiary of Innova Holdings, which provides impartial, objective conformance testing to ensure interoperability and communication standards conformity among intelligent, mobile service robotics

- GE Fanuc, a global company with 175 different models of manufacturing robots

- Science Applications International Corporation (SAIC), a leading developer of tactical mobile robotics systems, employs more than 44,000 in 150 cities worldwide. The $10 billion company maintains offices in Pittsburgh for its Center for Intelligent Robotics and Unmanned Systems.

A regional robotics startup that were acquired by large, publicly traded companies that recognized the tremendous market potential of their robotic technologies include:

- AssistWare Technology, a designer of robotic devices with consumer applications, such as one that prevents drowsy drivers from leaving the road, which was purchased by Natick, Massachusetts-based Cognex

What is most significant and unusual about the AssistWare acquisition is that Cognex chose to retain the Pittsburgh facilities they purchased, rather than relocate them to their existing headquarters.

A sampling of other successful robotics and automation companies headquartered in the region include:

- Aethon, a developer of indoor, pilot-less material hauling robots

- Applied Perception, a provider of sensing and navigation products that aid mobile robot developers and researchers

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- Astrobotic Technology, a designer and supplier of robots for research and development of the lunar frontier. The firm has secured NASA and commercial contracts.

- Automatika, a provider of design and system prototyping and product manufacturing of a wide variety of automated and robotic systems

- Blue Belt Technologies, a Carnegie Mellon spin-off company specializing in surgical robotics and image-guided, computer assisted surgery for improving the precision where replacement hips, knees and shoulders are implanted. The technologies are based on collaborative research of the Center for Orthopaedic Research and Carnegie Mellon's University's Medical Robotics Laboratory.

- Lightfoot, a designer and manufacturer of robotic order fulfillment systems for warehouses and distribution centers, with advanced technology accelerates the picking of cases of products to fill customer orders, with higher accuracy, predictability and efficiency, while minimizing breakage and workplace injuries

- Seegrid, a maker of affordable, autonomous industrial material handling robots with sensing, analysis and interaction capabilities that are ready to be put to work "straight off the truck"

Front Lines of Defense

The military ground robots market is anticipated to reach $43.7 billion by 2014. Market growth will come from countries, law enforcement agencies, fire departments, and first responders implementing automated process that supports existing manual process.

Recent regional robotics efforts support the development of a core expertise in robotics for the defense industry, especially since Congress has mandated that one-third of all military ground vehicles must be able to operate unmanned by 2015.

In 2005, Carnegie Mellon University made an impressive showing in DARPA's Grand Challenge desert race, with its two vehicles finishing second and third in a field of 23 vehicles, only five of which finished the entire 131-mile race. In a competition with teams that included private companies, universities and one high school, CMU's sponsors read like a *Fortune* 500 list: Boeing, Caterpillar, Intel, Snap-on, Google and many others.

In 2006, CMU unveiled a new unmanned ground combat vehicle commissioned by the Department of Defense. "Crusher" is a 6.5-ton, six-wheeled autonomous vehicle designed to negotiate harsh terrain. Crusher combines some capabilities of its predecessor, "Spinner," an invertible machine able to right itself, with mobility and autonomy technology, such as the use of terrain data.

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The Defense Department's Future Combat Systems (FCS) program was formed to develop network-centric concepts for a multi-mission combat system that will be overwhelmingly lethal, strategically deployable, self-sustaining and highly survivable in combat. The FCS aims to develop an ensemble of manned and unmanned ground and air platforms by 2010. This "robotic army" would be enhanced with artificial intelligence, affording the U.S. military more lethal and tactical capabilities, while removing human troops from the line of fire.

The FCS project is divided into three phases, the first of which, concept and technology development, received $154 million in funding and was led by Boeing's defense unit. The program currently is in its system development and demonstration phase.

Carnegie Mellon has had representation on FCS projects, and estimated spending on future phases in which local enterprises are well positioned to take part, is projected to be $34 billion.

National Center for Defense Robotics

The National Center for Defense Robotics (NCDR) was founded in 2002 to accelerate the development and integration of advanced robotics technology for defense-related applications, especially in response to the federal government's unmanned vehicle mandate. The NCDR received initial funding of about $5 million and currently works closely with member companies, universities and other organizations to select, fund and manage technology development and integration programs; facilitate teaming agreements, such as mentor-protégé relationships and to develop general, computer-based training materials for unmanned systems.

The NCDR's founders reasoned that there would be a significant increase in the amount of federal funding for programs, such as the Army's Future Combat Systems and that such continued funding could be used to help the formation and growth of a nascent agile robotics industry in Pennsylvania.

Agile Robotics defines a broad array of next-generation, intelligent, oftentimes mobile devices, vehicles and machines that reduce the need for human attention, interaction and intervention in repetitive, dangerous and inaccessible places. Agile robotics systems utilize integrated sensing and computing technologies to perform complex, high level tasks remotely and automatically. Tasks that an agile robot might perform include filling prescriptions, delivering supplies or vacuuming a carpet in a wide range of defined, yet dynamic environments, like hospital corridors, warehouse floors and people's living rooms. Collectively, such solutions constitute a new and emerging sector of the overall, worldwide robotics industry.

Formerly a unit of the Robotics Foundry and currently operating as a program initiative of The Technology Collaborative, the NCDR was created to develop relationships with the Department of Defense and to secure federally funded research projects. As a facilitator bringing together the manufacturing expertise of local companies and the research experience of Carnegie Mellon, the

NCDR began the task of establishing the region as a center for research, development and production of mobile robotics and related artificial intelligence technologies. Its efforts were focused on encouraging major defense contractors to build development and engineering centers in the region. Plans also call for establishing a major national center for robotics training, testing and standards.

In late 2008, the NCDR announced that it awarded robotics technology development sub-contracts totaling $1.11 million to four organizations, including three based in Pennsylvania, for developing advanced robotic systems, as well as small to mid-sized unmanned vehicles that maximize performance and decrease overall size and weight.

Today the NCDR operates from a $13 million facility in Pittsburgh where small, start-up robotic companies can develop and manufacture their products. It is the only non-profit initiative in the country dedicated solely to advancing the development of pragmatic, agile robotics technology and solutions for military applications, while in the process helping to establish an agile robotics industry in the United States, with Pennsylvania positioned as one of the leading global centers for this emerging industry sector.

The NCDR is dually focused on helping meet the needs of the nation's warfighters and helping small technology companies commercialize their technologies. To accomplish this, the NCDR primarily concentrates on funding and managing technology development projects that transition innovative technologies out of universities and companies into products that directly save and impact soldier's lives. The NCDR works closely with various DoD organizations involved with unmanned systems to better understand their unmet needs and to identify areas that are high on their priority list.

The NCDR functions as a matchmaker, pairing identified government needs with the technology capabilities of small companies and universities. At the government's direction, the NCDR selects, funds and manages projects that further develop, adapt and harden the available technology to produce working, prototype solutions for military experimentation and demonstration purposes.

In this role, the NCDR has made significant progress in awarding and managing federally funded projects and forging collaboration between government organizations and companies around the country with companies and universities based in the commonwealth.

During the federal fiscal year which ended September 30, 2008, the NCDR awarded eight technology development project subcontracts totaling nearly $2.2 million to six companies, including five based in Pennsylvania. Two projects at Carnegie Mellon University's Robotics Institute also were awarded. Further, all of these projects involved teaming Pennsylvania-based companies with outside-the-state government organizations.

The following are the eight projects that were subcontracted through the NCDR in 2008:

- **Caracal, Inc. –** Caracal proposed the development and production of m-plane-oriented SiC substrates for GaN and other III-nitrides crystal growth. This mixture of substrate and non-polar orientation unparalleled in the market will help to surmount built-in electric field effects. One of the most important applications includes the improved efficiency GaN-based visible and ultraviolet light emitting diodes used in illumination. The m-plane substrate will lend a pathway for development of non-polar AlN-based light emitting devices for a number of applications including UV water purification.

- **Concurrent Design Automation, LLC –** Concurrent EDA sought to prove that the arduous task of manually rewriting sequential software applications is not necessary to realize the full benefits of parallel processing hardware. Concurrent EDA will develop a software product that automatically extracts parallelism from sequential software and outputs optimized parallel hardware. By exploiting the power of parallel execution, computer intensive applications can be accelerated 10 to 100 times faster than their sequential form. Acceleration of this caliber is analogous to the leap in speed from a world-class sprinter to an F-16 fighter jet. This level of high-performance computing is desirable anywhere time is a critical factor. Example applications include: fingerprint identification (biometrics), protein sequencing (computational biology), derivative analysis (financial services) and three-Dimensional MRI Scans (medical imaging).

- **National Robotics Engineering Center at CMU –** Today's farmers need to be ever vigilant in task management and component scheduling in order to maintain profit margins. The National Robotics Engineering Center, partnering with John Deere & Company, proposed a predictive and dynamic planner for farming tasks that involve calculating capacity constraints and machine allocation, especially during times when the same vehicles are being used for multiple tasks. Both low- and high-level missions will be planned using combined software to calculate the most efficient plan of operations. There are many different implications for this type of technology including more productive crop layout design and ideal placement of fueling stations.

- **RemComm, Inc. –** RemComm had identified an area of emergency services where care can be enhanced through the development of a data transfer system over two-way radios. Though there are current tracking systems in place today, none of them is voice based, which would be an unmatchable resource to first responders due to the reliability of the proposed medium. RemComm plans to involve University of Pittsburgh radio and communication experts, as well as a public health and safety expert in order to gauge the growth of this potential market. This unique software system will be based on RemComm's proprietary core technology platform and will be field-tested for performance and security to fit market needs.

- **Robotics Institute at CMU –** Carnegie Mellon University teamed up with Seagate to demonstrate innovative video indexing technology and to produce commercial applications for this tool. The starting point for this project is the development of an approach to event detection in videos. The basis of the project is to develop algorithms that come closer to real time operation, improving accuracy of the technology, testing the technology using large data sets from real world applications and molding the technology in a way that non-expert users will be able to use easily.

- **Tomo Technology –** Tomo Technology manufactures standard and custom three-dimensional imagers used for object modeling, analysis and reverse engineering. Their current product offering uses a laser to generate a high accuracy scan of an object. The accepted proposal will develop a hybrid 3-D scanner that will replace a sweeping plane of laser light with a binary-coded structured laser light pattern. This new system will scan an object 50 times faster, yet will retain the high accuracy characteristics of their current system.

- **Valley Technologies, Inc. –** Valley Technologies Inc. planned a reconfigurable development platform for optical next- generation networks (NGNs.) Networks increasingly are requiring larger bandwidth and augmented security due to new multimedia services. This proposal seeks to minimize the cost and deployment time associated with transitioning to optical NGNs while improving future functionality by incorporating remotely reconfigurable options that will improve optical network efficiency. VTI currently is integrating advanced border security assets through NGNs for government prime contractors.

- **ZedX, Inc.. –** ZedX is involved in developing technologies that will increase knowledge of how to better sustain the viability of our food and energy systems. Specialty crops are susceptible to pestilence, much like most produce. This proposal aims to use wireless sensor networks (WSNs) to monitor crops and pests, according to previously developed disease models. Cost efficient WSNs will be installed, subfield, to transmit information into a Web-based data management system that will allow the grower to easily interpret and manage the field data. This also will allow the grower to make timely decisions and respond quicker, regarding the treatment of crops. ZedX's project is unique, because it uses the CMU sensor network that allows for integration with other sensors and because it proposes an end-to-end system.

Evolution and Collaboration

Collaborative efforts are already beginning to pay off.

Wexford-based Applied Perception won both an SBIR phase one and phase two grant to continue work on a robot that can retrieve injured soldiers from the battlefield. Applied Perception is creating

the hardware and software and sensors for navigation and patient detection. The company also is working on technologies that enable semi-autonomous behaviors for FCS vehicles

Likewise, Carnegie Mellon's Intelligent Software Agents Group (within the Robotics Institute) has been working jointly with the University of Pittsburgh to develop the Cooperative Attack Munition

Real Time Assessment (CAMRA) project. The objective of the CAMRA project is to develop large teams of autonomous, unmanned aerial vehicles that can sense their environment, react to changing situations and release their munitions, such as smart bombs. The Air Force sponsors of the project envision having hundreds or even thousands of these vehicles flying in support of troops within hostile battle spaces.

A joint three-year CMU-NASA project has developed technology that will be used to search for life on future Mars missions. The result, "Zoe," is a solar-powered robot that has been tested three times in the Atacama Desert in Chile, the driest desert on earth. Scientific instruments onboard Zoe are designed to find and identify microorganisms and then characterize their habitats.

We, Robots

In 1999, The Wall Street Journal labeled the Pittsburgh region "Roboburgh."

In living up to this moniker, public education efforts for robotics have not been overlooked. The Carnegie Science Center has developed a traveling robotics exhibit that brings Pittsburgh's rich robotics tradition to others across the county. A state-of-the-art Robotics Hall of Fame also is part of the display and is available to be viewed online.

Robotics also is taught in Pittsburgh's public and diocesan middle and secondary schools, either through actual robotics courses, exemplified previously by Schenley High School's Technology Studies Magnet or through robotics competitions and camps.

In 2006, researchers from the CMU Robotics Institute announced a new robot-building curriculum along with their partners, LEGO Education, called The Robotics Academy, which is partially funded by local foundations, including the Heinz Endowments and the Grable Foundation. Competitions have been held since 2000, the objectives of which are to help students apply principles of science and mathematics in making actual working robots. One such competition attracted 70 teams comprising a total of 1,000 local students.

The latest version of their MINDSTORMS Education NXT robot-building program includes updated software and hardware, simpler programming and a wireless capability. The Robotics Academy will continue to offer its RoboCamps, on line and standard summer camps that offer students adventures in which they use robotics technology to solve problems. The camps are offered

through CMU's National Robotics Engineering Center, and the academy has plans to establish the RoboCamps throughout the country.

At RoboCamp, children learn about the challenges, science and excitement behind engineering robots. Young students discover untapped abilities, witness "real" technology at work, and perhaps get a taste for a future profession. Activities include designing and building robots, learning programming and presentation software, working in teams, mastering tasks and sharing in a themed robotic adventure with their fellow campers. Parents and mentors are invited to an end-of-the-week "graduation" at the NREC.

The Technology Collaborative also administers a robotics education program that connects high school robotics curriculum with post-secondary degree courses. By way of an example, the program granted Allison Park-based A.W. Beattie Career Center $200,000 to support classes that train students to work with commercial and military robots.

The successful evolution of an industry from emerging to thriving requires a considerable amount of collaboration between the public, private and academic sectors. The organizations and centers discussed above aim to lead the way in these type of collaborations, by uniting the regional robotics community for the realization of this emerging cluster’s potential.

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http://vasc.ri.cmu.edu

www.cmu.edu/qolt

www.techcollaborative.org

http://www.rec.ri.cmu.edu/education

www.redzone.com

www.assistware.com

www.aethon.com

www.appliedperception.com

www.automatika.com

http://astrobotictechnology.com

www.bluebelttech.com

www.lightfootsystems.com

www.seegrid.com

www.robothalloffame.org

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