Commercial Robots Come of Age

Because of the recently falling prices of mobile robots, anyone wanting to do research in robotics can now afford to. For some applications, robots have now become inexpensive enough for companies to offer commercial products for the average consumer.

Although robot lawn mowers have been demonstrated by researchers for decades, several companies finally offer commercial robotic mowing systems. Friendly Robotics (www.friendlyrobotics.com) and Husqvarna (www.husqvarna.com) are two such companies. They have developed similar solutions for a robotic lawn mower, but with very different implementations.

Friendly Robotics sells the Robomow RL-500. It comes with built-in proximity sensors that enable the mower to recognize obstacles in its path, bumper sensors if it gets too close, and tilt sensors that automatically stop the motor when the mower is tilted at an angle greater than 20 degrees. However, the main controlling factor is a perimeter wire buried in the ground. The Robomow will stay within the area of this guide wire, cutting in a triangular pattern.

The perimeter wire emits a 4.5-volt magnetic field that is sensed by the mower. At first, the mower straddles the wire, following the perimeter for a couple of laps. The RL-500 determines its position by counting wheel rotations and turns; it is what is known as a dead-reckoning system. After circling the yard twice, it then begins mowing back and forth. At the end of each cut, the RL-500 will stop, back up, and head off in a slightly different direction, ideally covering the entire yard.

Diagram of the Robomow RL-500 from Friendly Robotics.

The Robomow RL-500 is about the size of a push mower and weighs in at 78 pounds, including 28 pounds of batteries. The RL-500 takes 24 hours to recharge and lasts for about 2-1/2 hours. It sells for $795, with an additional shipping cost of $100. Sound dangerous? A 3-year, all-risk insurance policy is available for an additional $150.

Two robotic systems, the Solar Mower and the Auto Mower, are available from Husqvarna. Both of these mowers are much lighter than the RL-500, each weighing about 16 pounds. As the name implies, the Solar Mower is powered by the sun. Both of Husqvarna's mowers are designed to "live" in the yard and neither was designed to require human interaction. These, too, use a wire perimeter installed in the yard to control its operation.

Whereas the Solar Mower gets its power from the sun, the Auto Mower has a recharging station. It senses when its power is low and can reportedly find its way back to the recharger. Although the technical specifications didn't indicate all the details of operation, it appears that it also uses dead reckoning. The Solar Mower sells for $1,999, and the newer Auto Mower costs $3,000.

In addition to lazy people, these machines can also help people with arthritis, lower back pain, physical disabilities, or allergies.

It is good to see robotics systems making their way into commercial markets, but it is surprising how relatively primitive these robot lawn mowers are. They don't appear to use any of the advancements made in the last 20 years. Perhaps it is the dangerous task of cutting grass that has forced these machines to operate so conservatively, or that using more advanced techniques requires expensive processors.

Low-Cost Robotics

Like many universities, we have used the Handy Board architecture in our introductory robotics and artificial intelligence (AI) courses. The Handy Board was developed by Fred Martin for use in the Massachusetts Institute of Technology's LEGO Robot Design Project (6.270). It is a completely open architecture—everything from the schematics, parts list, and software to program it is available from the Handy Board website (el.www.media.mit.edu/groups/el/projects/handy-board). The Handy Board was a precursor to the hugely popular LEGO Mindstorms RCX robotics system.

The Handy Board is based on the Motorola 68HC11. It can control four motors and can receive eight analog and eight digital inputs. In addition, it has an associated expansion board, and many hackers are creating more functions for the system. It is a great tool for an introduction to robotics. You can build or buy assembled Handy Boards for about $200 to $300.

Martin has a forthcoming book coming titled *The Art of Robotics: An Introduction to Engineering,* (Addison-Wesley). The goal of the book is to support hands-on, introductory undergraduate engineering courses based on robot design. We welcome the book, which will fill a void in introductory robotics textbooks.

Although the Handy Board is slightly expensive, other, lower cost alternatives are available. Recently hackers have developed open-source tools for use on low-cost, mass-marketed computing architectures.

For example, the Palm handheld computer architecture (www.palm.com) can now be programmed using a mod-

The Handy Board, by MIT's Fred Martin, is an open architecture with complete specs for building, and code for running, on their web site.

ified GNU C compiler (see, for example, www.orbits.com/Palm). Although newer Palm models are much more expensive than the Handy Board, older versions are available for about the same price.

The Palm was seen at last year's AAAI Robot Competition sending controls to the robot named Road Runner. The demonstration was part of an exhibition by Alan C. Schultz and his colleagues at the Navy Center for Applied Research in AI to explore variable levels of autonomy.

If you own a Pioneer robot from ActivMedia (www.activmedia.com), you will find a Palm program based on Schultz's idea on their website for download. The program allows a Palm to send controls to the robot through a serial cable.

Possibly the cheapest controller available for robotics is Nintendo's Gameboy (www.gameboy.com). Gameboy costs about $70, and open-source development kits have been written that allow you to create a simple controller that has access to a few inputs and outputs (see www.devrs.com/gb/hardware.php, for example). If you don't mind working with a proprietary, closed architecture, Gameboy has an excellent display screen

and stereo output through headphones. Of course, you might have to schedule robotic use between Pokémon battles.

Vacuum cleaning has always been one of the primary targets of robotics, and Probotics has a solution in their Cye robotics platform (www.personal-robots.com). Cye costs about $1,000 but provides no controller. Instead, it is designed to use your Windows-based PC through a radio link.

Surprisingly, Cye doesn't have sonar, infrared, or laser sensors. Rather, it carefully (500 times a second) watches its own movement. When it suddenly begins to slow down, it knows it has bumped into something. Cye is small and comes with a small portable vacuum cleaner in the $1,000 package.

The Probotics company seems to be actively developing Cye; additional products are due out this year. In addition, the Probotics team has just released its Map-N-Zap software as open source under the GNU Public License (www.gnu.org).

Two new autonomous robots—both from ActivMedia Robotics (www.mobilerobots.com and www.activmedia.com)—made their professional debut at Robot Night at CMU's WIRE conference. Although the PeopleBot line was introduced last year, the new Performance PeopleBot has an entirely new, sleeker body. Its black base and top tray are joined by elegant, brushed-aluminum curves and it holds a tabletop-height gripper. Additional sonar sensors on the verticals allow full-length sensing for both avoidance and gripper-height adjustments. The 2-degree-of-freedom grip-

Smellbotics

Recently a few breakthroughs have brought smell to the arena of robotics. Smell, unlike vision and audition, is more complex, and more subtle, to model. A device was needed that can identify trace chemicals and then map them into human-oriented categories.

Enter the robo-nose developed by Cyrano Sciences of Pasadena, California (www.cyranosciences.com), and licensed from the California Institute of Technology. Rather than attempting expensive isolation of particular chemicals, the Cyrano sim-nose, which they call the Cyranose 320, is made up of 32 sensors on a chip. Each sensor detects the reaction of a specific polymer. When the chip is exposed to a smell, the 32 polymer sensors detect minute changes. The pattern across the sensors can then be used to identify the smell.

In effect, Cyrano Sciences has turned smell identification into pattern matching. Instead of requiring a huge, highly tuned, mass spectrometer (that could cost hundreds of thousands of dollars) to perform chemical analysis, the small chip is expected to cost about $5,000 and be available later in 2000. A prototype handheld system has been created that looks more like a walkie-talkie than a nose.

Such a device should spur new projects for those working in pattern matching. In fact, Evor L. Hines at the University of Warwick in England has already reported that his lab has been using an electronic nose to track the progression of bananas as they go from good to bad.

Other projects might include identifying different types of smoke, diagnosing disease, analyzing breath, and possibly developing a shirt with these chips in the underarms with a connected alarm system. OK, I made that last one up, but it still might be fundable. The device promises to be a useful technology to add to many robotic systems.

On the other side of smell recognition lies smell generation. DigiScents (www.digiscents.com) created a solution for making scents with a computer. The company has developed a method of indexing smells and "playing them back" through your computer through a device about the size of an external computer stereo speaker case. The device is called the iSmell Personal Scent Sythesizer.

DigiScents imagines its device to be used in association with Web content, interactive games, e-mail, movies, and music. One wonders the effect it might have in virtual worlds.

The ScentWare Software Development Kit (SDK) is now available for developers. Soon you will also have access to the DigiScents Snortal, where you can discuss and learn about flavors and smells, design and register scents, share scents, and send ScentMail.

Using a DigiScents product along with the Cyranose, you might be able to create an encryption scheme with smells. I imagine that a message would be encoded by DigiScents and sent (downwind, no doubt) to the recipient, where it would then by decoded by the Cyranose.

The Cyranose 320, from Cyrano Sciences, can recognize smells.

Labels on device: 6" Snout, LCD Display, Exhaust, Screen Contrast, RS 232/USB Connectors, Power Supply, Accessory Plus, Purge Inlet, On/Off Switch, Run Button

Low-Cost Robotics

per has double infrared beams between its paddles to sense objects being picked up. PeopleBots start at about $6,000.

The second new robot is called the AmigoBOT. AmigoBOT's sporty red race-car design had many people signing up on the waiting list for its first production run. AmigoBOT is a small robot designed for classroom or home use. Researchers will also use it for multirobot cooperation and similar studies because of its excellent sensing and low cost. AmigoBOTs are controlled by ActivMedia's excellent software system, which includes a new interpreter. The new system allows novice users to interactively enter commands and save them for later running. AmigoBOTs should be available by the time you read this. They will cost between $1,495 and $2,995.

Viruses in the News

The so-called ILOVEYOU virus demonstrated that many of our computing systems are still quite brittle. Although the program was only 274 lines long, it was able to harness the innovations built into Windows and propel itself around the world in a matter of mere hours. As it moved from machine to machine, it destroyed and altered core system files, deleted other files, and basically required reinstallation of the operating system.

Dozens of variants soon followed and were even more sinister than the original. One version mutated as it sent itself off to each unsuspecting recipient using a variation of a real e-mail message taken from the host's computer, thus making it more difficult to stop. Luckily, heightened security kept the copycats from producing as much damage as ILOVEYOU. Some have estimated the total damage in the billions of dollars. (Nevertheless, what do people do when the e-mail server is down? Might they be getting work done? Actually, they are probably talking about how long the e-mail server will be down.)

Businesses are creating new services to help combat these software infections. For example, Symantec is planning to release the Digital Immune System (DIS), which may be available by the time you read this. Symantec's solution is to simply attempt to spread its virus remover faster than the spread of the virus.

> With its Digital Immune System, Symantec hopes to spread a virus remover faster than the virus itself can spread.

DIS is a clever scheme, but it still has some problems. For example, some machines must become infected before a solution can be found. In addition, machines may continue to become infected while humans try to come up with an antidote. Even worse, a self-changing virus might be undetectable.

Unfortunately, even if researchers do develop an immune system so that a computing system could detect the pattern of an attacking virus, the solution might not ever make it to the users. Why not? Such a solution would be a one-shot sale, obviating the need for never-ending subscriptions of updates of the current system.

In a recent, related bizarre twist of virtual reality, owners of the software recreational game *The Sims* found their synthetic companions dying. It appears that Maxis game designer Will Wright secretly (and purposely) unleashed a simulated virus in *The Sims'* simulated world (www.thesims.com).

The game is about simulated people buying material goods and living life. They take out the trash, read books, cuddle on the couch, take showers, sleep, and have affairs with the neighbors. It is reported that people often purchase simulated PCs for their little Sims, then spend hours watching their Sims stare at the virtual computers. (Maybe we should encourage the Sims to go to graduate school, but it remains to be seen whether they could perform research.)

The virus was attached to an item that Maxis has available for free download from its website. Like the real-world version, the virus spread from object to object in the simulated world. If you didn't have your Sims rest and get better, they would die (or in the case of the simulated children, Social Services would come and get them.)

The Sims comes on CD-ROM for Windows 95 and 98 and sells for $49.95.

Machines that Read Fingerprints

Sony just launched a new fingerprint identification system. The product is a credit card–sized biometric device that is designed to provide authentication and data security.

In association with the device, Sony created a new protocol in security called "convergent authentication." The system combines a password and a fingerprint for a higher level of security.

In related news, Microsoft says that Windows will incorporate a biometric authentication technology from I/O Software Inc.

These two announcements indicate that ubiquitous biometrics will soon be as common as keyboards. But we might want to think twice about products that motivate people to cut off thumbs.

Upcoming Competitions

The annual AAAI Robot Competition is again taking place, this year in Austin, Texas, July 30 through August 2, 2000. It features three competitions: Hors d'oeuvres anyone?, Urban Search and Rescue, and the Grand Challenge.

The objective of Hors d'oeuvres anyone? is to create service robots that can offer hors d'oeuvres to attendees at the receptions. Each contestant is required to explicitly and unambiguously demonstrate interaction with the spectators.

In the Urban Search and Rescue task, robots must enter a fallen structure, find and identify victims, deliver a small package near the victim (representing a device to allow human rescuers to talk to the victim), determine severity of injury, and help human rescuers determine the location of the victims. The robot must then exit the structure.

For this problem, robots will be judged in one of three categories according to their basic ability to handle increasingly difficult scenarios in a specially designed structure.

The structure should have no additional lighting, other than what is simulated to be coming from natural sources, or an occasional internal light source. The easy section can be assumed to have an adequate amount of light in the majority of its space. As the robots move into more difficult spaces, lighting may be nonexistent. Robots using the more difficult section of the structure should bring their own light sources, if needed.

The Grand Challenge is a 10-year-long contest designed to challenge researchers to solve big problems in robotics. In a nutshell, the goal is to "attend the national conference on AI." One possible way of satisfying the goal is to drop off your robot in front of the convention center, have it find its way to the registration booth, register, and then make its way to a conference room where it gives a talk. Some teams made progress last year (the first year of the challenge), but you can imagine we have a long way to go.

We look forward to seeing this year's entries in Austin.

Ananova

The computer-generated woman Ananova is now online to read news to you (www.ananova.com). Her accent is neither distinctly American nor distinctly British, and she was apparently designed to have sex appeal. She handles sports, business, entertainment, and Internet news. She also can be programmed to read e-mail messages, traffic alerts, wake-up calls, or anything else.

She is capable of smiling when the news is amusing. Her animation software comes from Digital Animations Group in Edinburgh. Several fashion designers have expressed interest in designing her wardrobe.

RoboCup

In 1999, ORF Upper Austria, creator of the prestigious Prix Ars Electronica award, announced the presentation of a special award in 2000 to RoboCup-Soccer. ORF was known as a strong promoter of computer animation in its early days, but this year the organization decided to give the award to the RoboCup community. The jury in the interactive media category created the special award specifically for RoboCup. The celebration will be held September 4, 2000, in Linz, Austria, and will be broadcast live throughout Europe. (See www.robocup.org/02.html for details.)

Like AAAI's Urban Search and Rescue, RoboCup-Rescue is a new research domain of RoboCup. It targets search and rescue in large-scale disasters, such as the earthquake that hit Kobe, killing more than 5,000 people.

RoboCup added this domain because large-scale disasters are a socially significant problem. RoboCup-Rescue has features in common with soccer, such as a dynamic environment and incomplete and noisy information. It also has features that are absent in soccer, such as logistics, heterogeneous agents, long-range planning, and emergent collaboration between teams of agents.

The long-range goal of RoboCup-Rescue is to foster the science and engineering of search and rescue for large-scale disasters so that our research can directly contribute to society and save lives.

Similarly to the current RoboCup-Soccer contest, there will be tracks for simulators and real robots. RoboCup is currently developing a simulator for RoboCup-Rescue.

Barbara Hayes-Roth of Stanford/CS and Extempo Systems, Inc. (San Jose) obtained a U.S. patent on "a system and method for directing the improvisational behavior of a computer-controlled character which enables the character to reflect personality, mood, and other life-like qualities." She hopes that simulated characters—perhaps with multifaceted personalities, social warmth, and individual stories—will save the Internet from being a cold and lonely place. The patent involves storing current state (position, activity, mood), a set of possible physical and verbal behaviors, and a method of assigning and using transition desirability ratings. (For more details see www.uspto.gov/patft, Patent #6,031,549.)

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AI researchers Patrick Winston and Boris Katz at MIT have sued AskJeeves (www.askjeeves.com), claiming that the natural-language search engine interface violates the patents they were granted in 1994 and 1995.

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John Gilmore is starting a Gilmore Patent License movement, similar in spirit to the GNU General Public License for "copyleft" open-source software. The terms are still being worked out; Gilmore's license would let anyone use his patented inventions free of charge as long as they are offering all of their own patents (if any) under the same terms. This permits defensive patent use and the possibility of profit (as those seeking money for their own patents must still negotiate and pay licensing fees). Defensive users will be pooling and sharing their patents, but profit-takers can't join if they demand money from nonprofit-takers.

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A federal appeals court in Ohio has ruled that encryption code is protected speech because it is a means of communication between computer programmers. This is the first appellate decision to give First Amendment protection of software. Cleveland law professor Peter Junger's suit against export licenses for encryption programs will be reconsidered.

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WordNet is an open-source, free, online lexical reference system; its design was inspired by current psycholinguistic theories of human lexical memory. English nouns, verbs, adjectives, and adverbs are organized into synonym sets, each representing one underlying lexical concept. Such an electronic lexical database is considered to be the most important resource available to researchers in computational linguistics, text analysis, and many related areas. WordNet was developed by the Cognitive Science Laboratory at Princeton University under the direction of Professor George A. Miller. Many people have contributed to the success of WordNet. WordNet: An Electronic Lexical Database is now available from MIT Press. .WordNet 1.6 by Christiane Fellbaum is available on CD-ROM for $27.95 (see www.cogsci.princeton.edu/~wn/).

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You may have noticed a report in *Intelligent Enterprise* magazine that quoted Marvin Minsky as saying that he had been completely wrong for the last 20 years. "Totally inaccurate," Minsky says. A sequel to Minsky's popular *Society of Mind* is due out soon.

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Sony's PlayStation2 is so good at quickly processing high-quality images that Japan's Trade Ministry says that it could be used for missile guidance and other military uses. A military export license will be required.

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According to the latest Taulbee Survey (www.cra.org), AI/Robotics had the largest number of graduating

Ph.D.s. Of the 166 new doctoral recipients in AI and robotics in 1998–1999 (of the total 852 doctoral recipients in computer science [CS] and computer engineering [CE]). Sixty-eight took academic positions, 66 went to industry, 7 were employed abroad, 5 went to U.S. government labs or jobs, and 5 were self-employed. Of the 60 working in doctorate-granting departments, 30 were tenure-track, 7 were researchers, and 7 were teaching faculty; the remaining 16 took postdoctoral positions. Nine-month U.S. salaries for new Ph.D.s in CS or CE averaged $64,000 for tenure-track faculty, $57,000 for researchers, $51,000 for teaching faculty, and $37,000 for postdoctorates.

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Nominations for Sloan Research Fellowships in Computer Science are due September 15. Nominees must be U.S. or Canadian regular faculty in the early stages of their research careers. Winners will receive funds for whatever line of research they wish to pursue (see www.sloan.org/programs/scitech_fellowships.htm).

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The U.S. Army Research Laboratory (ARL) is seeking proposals for its Collaborative Alliances in Technology program, supporting extramural centers of research aimed at the Army's technology needs. This "federated laboratory" (or FedLab) concept has been an overwhelming success (see alerts.sciencewise.com/foaalert/dod/opp/mti/05040004.htm).

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The National Science Foundation (NSF) announced that it will focus on the underrepresentation of women and minorities in the information technology (IT) work force. See alerts.sciencewise.com/swalert/nsf/opp/NSF0077.htm for details of its Information Technology Workforce initiative.

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Notices of intent are due soon for NSF's Science and Technology Centers (STC) Integrative Partnerships Program. The program supports innovation in combining research, education, and knowledge transfer. Preliminary proposals are due August 11, and full proposals by April 2 next year (see alerts.sciencewise.com/swalert /nsf/opp/nsf0067.htm).

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NSF recently posted a new guide for its Combined Research-Curriculum Development (CRCD) Program, supporting multidisciplinary projects to improve college-level education in computer and information science and engineering (see alerts.sciencewise.com/swalert/nsf/opp/nsf0066.htm).

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NSF issued a request for proposals for its Faculty Early Career Development (CAREER) Program (see www.nsf.gov/cgi-bin/getpub?nsf0089). The Frequently Asked Questions (FAQ) document about the program is available at www.nsf.gov/cgi-bin/getpub?nsf0090.

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You can post or search for postdoctoral positions at www.Post-docs.com. See also the free University Job Bank and resume archive at www.UJobBank.com, which includes everything from campus jobs to government placements.

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CareerPath.com says it lists more than 350,000 jobs, updated daily.

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IN BRIEF

Guru.com, FreeAgent.com, and Ants.com are helping businesses find independent contractors. Guru.com has attracted 120,000 freelancers and 11,000 hiring companies since its launch in January of this year.

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If you've got technical management ability, try garage.com. Like others in incubator and venture-capital companies, they have to find management staff for many of the new startups. Some of their recruiting and team-building tips can be found at www.garage.com/bootcamp/seattlestuff.

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Did you know? More than 100 security-conscious companies have hired chief risk officers to watch for technical, economic, or public-relations dangers.

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The U.S. Sentencing Commission has voted to stiffen punishment for copyright violations, beginning in May. Even not-for-profit Internet piracy charges can result in 10 to 16 months in prison. The punishment for electronic theft is related to item value times the number of downloads, but limited to 3 years for a first offense. Punishment for identity theft and possession of bogus identification will also be increased, starting in November.

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The University of California at Berkeley Law School is forming a Samuelson Law, Technology and Public Policy Clinic to study and act on intellectual property and Internet privacy issues.

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Intel plans to post advanced Common Data Security Architecture software for free download by mid-May.

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If you enjoy these news briefs, you'll be glad to know that Ken Laws orchestrates an e-newsletter called Computists' Weekly (CW). In fact, many of these briefs came directly from Ken's service. Ken describes CW as a service that "keeps artificial intelligence researchers, computer scientists, and students up-to-date on news, trends, grant competitions, job opportunities, online resources, and career issues. It's a newsletter for AI researchers, rather than one about AI techniques." The membership price of CW in the United States has fallen by 50 percent this year. If you are willing to wait 2 to 3 weeks and wade through a bit of advertising, you can even get it free. Many other resources are available at the Computists Web site (www.computists.com).

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Do you have an item that you think is suitable for the News section in *intelligence*? We'd like to hear from you. Please send your item to *d.blank@csce.uark.edu*.