RoadNarrows Presents General Purpose Brain-Packs, Controller Boards, and Robots for Education and Research

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Abstract

RoadNarrows is excited to demonstrate and discuss some new and up-coming products in robotics. These systems include:

- Humanoid robots interfaced with RoadNarrows' brain-and-sensor pack.
- A general-purpose robotic controller board called the OrcBoard used by MIT's Maslab robotics program, and RoadNarrows' plans for its productization.
- Complete robot products, such as K-Team's Khepera 3 Linux-based robot, Colorado State's Good Samaritan search and rescue robot, and the new e-puck from EPFL.
- Other emerging technologies e.g. a fuel-cell powered robot.

RoadNarrows would love feedback from the AI community in terms of important features they would like to see in new products. Alternatively, RoadNarrows presents challenges of operating a small U.S.-based robotics business to give educators and researchers insight from the business side. Supporting small robotics businesses helps develop the local industry in general, and creates jobs for future graduating students.

Description

Brain-and-Sensor Packs ("Robot Cerebrum")

Many new humanoid and legged robot kits are becoming available, and RoadNarrows is working on a generalized interface for some of these platforms. For the most part, these kits have few if any sensors and no processing power beyond a controller board, which makes them uninteresting to the AI community. With a small Linux-based "brain-pack" which includes digital and analog I/O abilities to support sensors, suddenly these legged servo-machines become true robots. By developing a re-usable system or "brain-pack" consisting of a small SBC, a set of sensors, and standard software interfaces, many off-the-shelf robots can become interesting tools for AI education and research.

Using a well-supported operating system such as Linux gives roboticists confidence that their work will be portable to other Linux-based solutions as the brain-pack hardware evolves to take advantage of new processing power on the market. The abstraction of the higher-level processing from the body and mechanics of the robot can also be compared to animal physiological models. This may be important for educational aspects of robotics, as well as engineering good robotic applications.

RoadNarrows' is using K-Team's Korebot and KoreIO (korebot.com) as the embedded Linux SBC for the brain-pack system prototype since it is well-designed for robotics applications, and it is already being used as the core processing board for several commercially-available robots such as K-Team's Koala and the Khepera 3. Sensors (e.g. camera) and software can easily be re-used from one platform to the other.

Robot Controller Boards ("Robot Cerebellum")

Following a goal of module re-use like the brain-pack, robot controller boards should also be designed to be compatible with a variety of robot solutions. Many good robot controller boards are now on the market so there are a lot of choices to consider. In general, wheeled robots require less number of motors and/or servos to control than legged robots. If a roboticist would like to use the same make of controller board to move both a wheeled robot and a 17 degree-of-freedom humanoid, for example, they would have to pick a controller board that has at least 17 motor/servo interfaces.

A very important aspect of choosing a controller board (or a robot based on a particular controller board) is the documentation, open-source software and hardware, and community support. A generalized controller board which is designed to fit all situations may not be cost effective, but a family of controller boards that are designed for different robot specifications but re-uses the software and majority of the design with consistent interfaces would be ideal.

RoadNarrows will demonstrate a controller board called the OrcBoard (orcboard.org). This robot board is developed by MIT's Edwin Olson and is being used by MIT in their Maslab robotics program (maslab.csail.mit.edu). It has great documentation and an

open java-based software architecture, which make it a very good choice for a generalized robotics controller. It is designed to communicate with a computer or processing board (such as a Nano-ITX) via USB or Ethernet.

The OrcBoard and products evolved from it are planned to be the platform for a new line of future RoadNarrows' robots, including wheeled robots, legged robots, and a search-and-rescue robot.

Complete Robots

K-Team's newly released Khepera 3 (K3) wheeled robot has some very nice built-in sensors and features, such as Ultrasound sensors and a swappable battery pack. By moving to a Linux-based system, K-Team is taking advantage of a large open-source community for software support (roadnarrowsrobotics.com/acatalog/ KTeam.html). GCtronics' e-puck robot (gctronic.com) is also a new choice for robotics education, with built-in Bluetooth, camera, microphones and speaker, using a 60MHz dsPIC processor.

For other robot products, RoadNarrows is considering additional solutions. Many roboticists like the idea of putting a laptop on a robot, or using another platform they prefer such as a PC104, Nano-ITX or Mac Mini. RoadNarrows has a goal of developing robot platforms which are flexible with inter-operable components.

Other Technologies

RoadNarrows is pursuing other technologies to enhance the educational and research benefits of their line of products. One area is the development of a fuel-cell powered robot to help advertise the issues of alternative energy, and to help foster growth in this area. RoadNarrows is also interested in partnering with researchers who have developed new sensors, software, robots, and curricula to enhance the company's product line.

Discussion

Changes in commercially-available technology related to robotics are occurring every year. For the most part, these changes are improvements that academics and researchers would like to adopt as soon as possible in order to advance their goals. This is especially true in the field of AI, because issues such as computing constraints and reliable sensor/actuator technology are very critical for proving algorithms. However, the trade-off is the effort to learn a new robotic system, new operating system, and re-integrate higher-level applications to the new software and hardware interfaces. The user also needs some confidence that the robot platform will be well-supported for the expected number of years the tools are planned on being used. Continued support is very important for robotic laboratories and classrooms. Finally, roboticists desire flexibility. A variety of robot types, e.g. humanoid, wheeled, and flying, can inspire a diverse set of students, or be more suitable for a variety of research goals.

As a small robotics company, RoadNarrows is trying to address some of the challenges of researchers and educators trying to adopt new robot-related technologies. Hardware and software re-use, portability of components, common tools, etc. are well-established ideas in industry. It would be wonderful if all the work that was developed on a small indoor robot is plug-and-play onto an outdoor robot used to navigate rough terrain. When technology improves, it would be great if one could swap more memory, a faster processor, better peripherals, and have all of the software and sensors still be supported.

How can systems be designed with re-use in mind, but at that same time take advantage of great new ideas and systems? What are the trends in the robot community? What do researchers and educators want in their classrooms in the coming years?

RoadNarrows is developing a modular system of robotic components. Robot platforms such as search and rescue robots, wheeled robots, and legged robots all share basic high-level components. One component is a controller board for low-level sensors and actuators. This can be considered to be part of a robot's peripheral nervous system, cerebellum, and motor cortex. A second component is a central computing or processor board solution for higher level decision making (e.g. the robot's cerebrum) that manages higher-level sensors such as vision, and communication with other robots or with a master computer for extending reasoning and processing functions. These integrated robot systems will be supported by the open-source software demonstration package called RNR Fusion used for high-level off-target robot control and advanced brain development. It is written in Python and works on Linux and Windows XP. The simple, open interfaces of the robot systems will also make the hardware easily supported by Pyro (pyrorobotics.org), Webots™ (cyberbotics.com), Microsoft Robotics Studio (msdn.microsoft.com/robotics), or other custom software package.

About RoadNarrows

RoadNarrows specializes in robotics for the research and education markets. RoadNarrows' R&D team is developing and integrating open-interface hardware and software robotic solutions to add more choices in configuration options with a focus on re-usability and portability of hardware and software components.

For revenue, the company sells and provides technical support for some of the most popular robotic product lines used by the academic community, including K-Team robots, Webots™, and GCtronic's e-puck. RoadNarrows is currently expanding its 3rd party product line to include several biped robots for educational use, including the MANOI by Kyosho (kyosho.com), and the exciting new android under development by Aldebaran Robotics (aldebaran-robotics.com) called Nao™.

For further information, please contact RoadNarrows at oneway@roadnarrowsrobotics.com.

Appendices

Figure 1 shows an exploded view of the hardware components of the brain-and sensor pack and their placement on a legged robot platform. There will be a mechanical attachment to affix the brain pack onto the robot plus provide electrical connections to the various components. The attachment hardware will be customized for each specific robot platform. The various components include a robot, controller board, helmet with camera, haptic shoes, Inertial Measurement Unit (IMU), breast mount plate or backpack, and a Linux SBC.

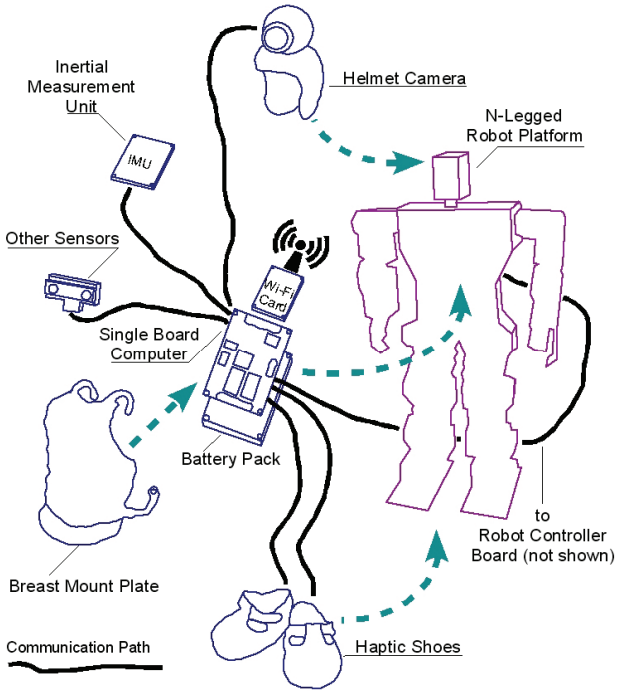

Figure 1: Exploded View of Brain-and-Sensor Pack

Figure 2 shows a swarm of GCtronic's new small e-puck robot developed by EPFL, Lausanne, Switzerland.

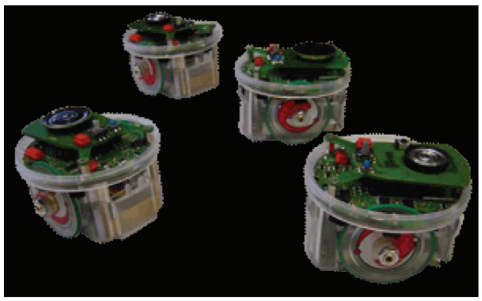

Figure 2: e-puck Robot Swarm

The MANOI AT01 educational robot by Kyosho in Figure 3 consists of a small controller board and 17 servo motors. The default kit comes with no sensors or SBC.

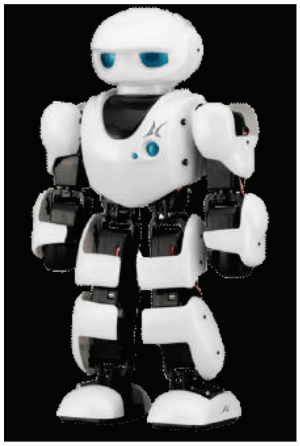

Figure 3: MANOI AT01 Humanoid Robot

The Korebot LE XScale embedded Linux board and KoreIO board in Figure 4 are ideal for providing a small form-factor with Linux functionality and standard peripherals such as USB and compact flash.

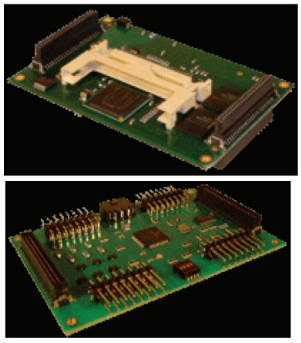

Figure 4: Stackable KorebotLE and KoreIO Boards

K-Team recently introduced a new high-end wheeled robot which is WiFi-capable via its Korebot stack, and has built-in Ultra-Sonic sensors as well as standard IR sensors. Users may choose a Bluetooth option instead of the Korebot stack.

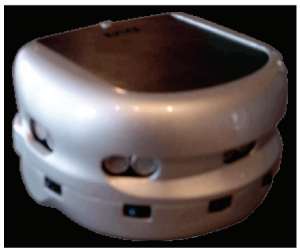

Figure 5: Khepera 3 (K3) Robot by K-Team