Interactive Learning @ UMass Lowell

UMass Lowell Community Partnerships
Department of Computer Science
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Recognizing that robots are fun and engaging, Professors Fred Martin and Holly Yanco of UMass Lowell have designed an education program to stimulate an interest in science and technology for students from elementary school through college.

Teacher Workshops

Fred Martin and Holly Yanco host a variety of K-12 teacher workshops. Each fall, an introduction to classroom robotics workshop is run for teachers interested in bringing applied technology into their classrooms. The Botball and Botfest tutorial weekend occurs during the winter. In the spring, K-12 and university computer science educators gather to share their experiences during that school year.

In the classroom robotics workshop, teachers learn the Cricket Logo Blocks language to program the Handy Cricket robot processors. They work with a variety of sensors including touch, light, and infrared color detection sensors. In a three-hour workshop, teachers learn how to outfit a small mobile robot with sensors and program the robot to complete a task on its own.

Professional Development Points (PDPs) are offered to teachers for participation in our programs. We also offer scholarships for purchasing robotic materials.

Botball

Botball is a robot education program produced by the KISS Institute for Practical Robotics (KIPR) for middle and high school students. Participants in Botball receive a robot kit from which autonomous robots are built to solve a specified challenge in just seven weeks.

The Botball program teaches students more than how to build a robot. Students create and maintain a website for their team. They work collaboratively to design, program, and build their robot. They develop both offensive and defensive strategies. At the end of seven weeks, teams compete in a double elimination tournament. In addition, students present their development strategies, discuss the structure of their team, unexpected complications, and lessons learned.

A robot with its “puncher” extended. This design was one of many ways to solve the open-ended 2006 Botball challenge.

UMass Lowell has hosted the New England Regional Botball workshops and tournaments since 2002. Holly Yanco and Karl Wurst (Worcester State College) co-chair the event.

Botfest

Botfest is a science fair for robot enthusiasts of all ages, from novice to expert. Exhibitions range from grade school demonstrations to university level class projects to hobbyist tinkerings. Organized by Fred Martin, Botfest is held in conjunction with the New England Regional Botball Tournament.

Fourth grade students from the McCabe Elementary School in Smithfield, RI, exhibit their Computational Jewelry at Botfest 2003.

Art + Robotics = Artbotics

The Artbotics project connects artists and computer scientists to create robot art. Fred Martin and Holly Yanco work in close collaboration with Hyun Ju Kim (Art), Linda Silka (Center for Family, Work and Community), and Phyllis Procter (CS) of UMass Lowell and Jerry Beck, Diana Coluntino, and Diane Testa of Lowell’s Revolving Museum.

Robot technologies are used to teach computer science to high school and undergraduate students. Given a theme, students create an interactive museum exhibit using sensors and motors. Cricket Logo is used to program Handy Crickets, the brains of the art pieces.

Seven undergraduate students worked during the summer of 2006 to create two exhibits. "The Evolution of Puppetry" was first shown during the Lowell Folk Festival in July and again at "The Flow of Creation" gallery opening in August.

In the fall of 2006, Artbotics continued with twelve high school students and five undergraduate mentors in an after school program. The combination of art and computer science themed with “light” yielded "Eclecticity." This exhibit was shown at a gallery opening in November.

Artbotics is now a class offered to undergraduate students. The Artbotics project is funded by NSF (CNS-0540564).

An Artbotics mentor describes how each of the robotized world landmarks move as corresponding LEDs on the globe light up in the “Eclecticity” exhibit.

TEAMS Academy

UMass Lowell and fourteen regional high schools collaborated to create the Technology, Engineering, and Math Science (TEAMS) Academy. This program is designed to attract high school students to science, technology, engineering, and math (STEM) career fields. High school teachers work with faculty from the schools of science, engineering, and education to develop a unique series of multidisciplinary course topics that will allow students to apply STEM concepts in various fields.

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More than 250 high school sophomores attended full day workshops last fall. In the fall of 2007, high school juniors and seniors will be able to take special semester-long college courses at the university. Topics will include assistive technology, environmental biotechnology, baseball bats, and robotics.

Lawrence High School students load their robot with a vacuuming program. TEAMS Academy activities like this show real world applications for science and technology.

Robotics sessions are run by Fred Martin and Holly Yanco. Small groups of students collaboratively design, build, program, and test their robot's ability to perform a task. Students have a choice of missions including a wheelchair museum tour and robotic vacuuming. In the wheelchair museum tour task, the robot follows a black line on the floor, stopping at art works along the path. In the robotic vacuuming task, the robot vacuums as much area as possible without overlap.

Cricket Science

With Cricket Science, Fred Martin combines the use of classroom robotics that has become prevalent across the K-12 grade levels with the characteristics of science experiments. Students become highly engaged as they frame problems, run tests, debug issues, and pursue solutions.

Cricket Science provides materials that can be readily adopted into inquiry-based work by teachers and students. Materials include the Handy Cricket, sensors, and corresponding labs. Cricket Science is funded by NSF (REC-0546513).

iCODE

The Internet Community of Design Engineers (iCODE) project encompasses an after-school program, weekend events, and a two-week summer immersion. Students complete a series of hands-on engineering projects, featuring the Handy Cricket. As the students develop their skills and knowledge, the projects become more open-ended. iCODE offers middle school and high school students from Boston and Lowell a year-long enrichment experience.

The iCODE project is a partnership between UMass Lowell and Machine Science, Inc., a non-profit organization based in Cambridge, MA. The UMass Lowell team consists of Fred Martin, Douglas Prime (Engineering), Michelle Scribner-MacLean (Graduate School of Education), and Phyllis Procter. The Machine Science team is Sam Christie, Ivan Rudnicki, and Emily Lin. iCODE is funded by NSF (ESI-0624669).

Doug Prime, Michelle Scribner-MacLean, and Fred Martin (left to right) show off Handy Cricket creations. Projects like Mr. Cricket engage students in hands-on science.

UML Robotics Classes

Fred Martin and Holly Yanco also teach undergraduate and graduate course pairs. Students learn about robot design, sensors, robot autonomy, and control paradigms.

In Robotics I, students build mobile robots from Lego and program the Handy Board robot controller. Students complete weekly labs (e.g. light seeking, obstacle avoidance, wall following), the "Egg Hunt" midterm competition, and a final project. The PowerWheels jeep robot is an example of a final project.

MCP, a PowerWheels jeep turned robot, began as a Robotics I final project in Spring 2004. MCP is now the focus of the graduate Robot Design class.

In Robotics II, students learn advanced artificial intelligent robotics topics, including computer vision, machine learning, and localization and mapping. This year, the new Blackfin Handy Board and iRobot Roomba will be used in Robotics II. Students will create a new home robot using a Roomba as the platform. Students will also create fire-fighting robots for the Trinity College Fire Fighting Competition.

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Enabling Technology: The Handy Cricket

The Handy Cricket is used in several of our interactive learning projects. It is an embedded controller developed by Fred Martin. The Handy Cricket is palm-sized, measuring 2.5" by 2.25" including its four AA battery pack. It is programmed using Cricket Logo Blocks, a custom, simplified version of Logo. The Handy Cricket combines processing, sensor data collection, and actuation. It can receive information from sensors in its analog sensor ports and control output to its motor ports. Also, a group of Handy Crickets can "talk" to each other by sending and receiving infrared messages.

Related Links

- **UML Engaging Computing Lab**
  http://www.cs.uml.edu/ecg
- **UML Robotics Lab**
  http://www.cs.uml.edu/robots
- **Artbotics**
  http://www.artbotics.org
- **Botball**
  http://www.botball.org
- **Botfest**
  http://www.botfest.org
- **Cricket Science**
  http://www.cs.uml.edu/ecg
- **iCODE**
  http://www.icodeproject.org
- **TEAMS Academy**
  http://gse.uml.edu/academy

Selected Publications

F. Martin. "Little Robots that Could: How Collaboration in Robotics Labs Leads to Student Learning and Tangible Results." To appear in *Intelligent Automation and Soft Computing*, 2007.

H. A. Yanco, H. J. Kim, F. Martin and L. Silka. "Artbotics: Combining Art and Robotics to Broaden Participation in Computing." *AAAI Spring Symposium on Robots and Robot Venues: Resources for AI Education*, March 2007.

F. Martin and A. Chanler. "Introducing the Blackfin Handy Board." *Proceedings of the AAAI Spring Symposium on Robots and Robot Venues: Resources for AI Education*, March 2007.

F. Martin and A. Greenwood. "Using Programmable Crickets to Help Beginning Teachers Experience Scientific Inquiry." *Association for Science Teacher Education*, January 2007.

F. Martin, M. Lurgio and D. Coffey. "Robotic Jewelry: Inventing Locally Contextualized Mathematics in a Fourth Grade Classroom." *Proceedings of the Second International Conference on Informatics in Secondary Schools: Evolution and Perspectives,* November 2006.

D. Blank, D. Kumar, L. Meeden and H. A. Yanco. "The Pyro Toolkit for AI and Robotics." *AI Magazine* 27(1), pp. 39-50, Spring 2006.

L. Xu and F. Martin. "Chirp on Crickets: Teaching Compilers using an Embedded Robot Controller." *Proceedings of the 37th SIGCSE Technical Symposium on Computer Science Education*, March 2006.

F. Martin, K. Par, K. Abu-Zahra, V. Dulskiy and A. Chanler. "iCricket: A programmable brick for kids' pervasive computing applications." *Published in the 2nd International Workshop on Ubiquitous Computing (IWUC-2005),* May 2005.

D. Blank, D. Kumar, L. Meeden and H. A. Yanco. "Pyro: A Python-based Versatile Programming Environment for Teaching Robotics." *ACM Journal of Educational Resources in Computing*, Volume 4, Number 3, September 2004.

D. Blank, H. A. Yanco, D. Kumar and L. Meeden. "Avoiding the Karel-the-Robot Paradox: A Framework for Making Sophisticated Robotics Accessible." *Proceedings of the AAAI Spring Symposium on Accessible, Hands-on AI and Robotics Education*, March 2004.

H. A. Yanco and K. R. Wurst. "Beyond Botball: Science Experiments With Your Handyboard." *Proceedings of the National Conference on Educational Robotics*, June 2003.

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