Spotlight on the Robotics Curriculum Clearinghouse

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In the previous "Education" column ("Teaching Robotics Everywhere," March 2006), Daniela Rus discussed the outcomes of the Robotics Education Workshop held in conjunction with the Robotics: Science and Systems conference at the Massachusetts Institute of Technology in June 2005. More than 30 professors from a wide range of institutions and backgrounds met for a day of presentations and discussions focusing on the "key issues of integrating robotics in an undergraduate curriculum." According to Prof. Rus, "the most important outcome of the meeting was a general agreement that we need an open repository of course materials for robotics in order to enable, support, and coordinate the teaching of robotics across universities."

In this column, we spotlight a repository for teaching robotics in primary and secondary schools that was launched by NASA in January 2005. The repository is called the Robotics Curriculum Clearinghouse (RCC) and is available at http://robotics.nasa.gov/rcc/. The RCC is part of NASA's agencywide Robotics Alliance Project (http://www.robotics.nasa.gov) and has been championed by David Lavery (the NASA program executive for Solar System Exploration and executive advisory board member for FIRST Robotics) and Mark Leon (director of the NASA Robotics Alliance Project.) Unlike the project's robotics competitions, whose missions are primarily to inspire students by creating *excitement* for robotics, the RCC is focused on furthering *education* in robotics.

The primary goal of the RCC is to review and disseminate "the best robotics-related curricula currently available to educators." The curricula in the repository span a large range of topics: traditional lesson plans (e.g., "My Own Robot"), material related to the NASA-affiliated robotics competitions (e.g., "PSA: the Astronaut's Helper" and "King of the Hill"), and curricula based on the use of a specific commercial product such as robot kits or microcontrollers (e.g., "An Introduction to RoboLab"). The RCC hosts a description of the material and a link to the external host site maintained by the individual author.

The RCC is set up to be navigated by either browsing or by searching based on keywords, grade level, and a number of other content-relevant criteria. At the time of writing this column, nearly 300 lesson plans spanning the range of kindergarten to higher and informal education were indexed on the site. Access requires a simple, cost-free registration process.

While not explicitly stated in its mission, the RCC is largely focused on primary and secondary education. However, a small number of curricula are tagged as appropriate for higher education. Despite the lack of focus on undergraduate and graduate education, the RCC is a valuable resource for the robotics community in academia. A university professor who is a nonspecialist in robotics but interested in using robotics as an application or an adjunct to an existing course (e.g., in electrical engineering) could rely on these materials. Second, many universities offer noncredit independent course activities designed to introduce students to new areas. The RCC materials would be appropriate for college experiences designed to introduce students to robotics. Furthermore, a number of lesson plans are directed at the college level, and many others can be adapted for use in higher education. For example, a large number of lesson plans contain descriptions of fairly simple, inexpensive lab exercises and design projects and could be augmented with more in-depth theory for a college-level curriculum. Additionally, the materials indexed by the RCC for commercial products are extremely thorough and might even be useful in their current form as documentation. The RCC could also be valuable in assisting robotics researchers with designing robotics outreach programs for local schools. Material that is accessible to younger audiences and laypersons can be easily accessed and modified for a specific program or event.

The identification of course materials to undergo the RCC review process has been primarily performed by the RCC project manager, Dr. Yvonne Clearwater, with only a small percentage of the content on the site coming from submissions. However, Dr. Clearwater hopes that as the repository gains popularity, this trend will be reversed. Educators can submit their original material by simply completing the site registration and a curriculum questionnaire.

All RCC submissions are peer reviewed by three independent parties, and entries can be accepted outright or sent back to the author with a suggestion to supplement the materials and resubmit. If accepted, NASA hosts a description of the available course materials and provides a pointer to the host site. The "report card" used by reviewers to evaluate submissions is given as feedback to submitters and is available to registered users.

While the RCC has no concrete plans to make a push into higher education, the site serves as inspiration for the repository proposed by the participants of the Robotics Education Workshop at the 2005 Robotics: Science and Systems conference. The changes needed to compile a "wikipedia" for teaching robotics include: new systems of curriculum development, classification and organization, in-depth lecture notes, level-appropriate labs, projects, and exam questions, evaluation tools, an extensive bibliography, a more systemized and transparent review process, an editorial board, and a more extensive user interface for contributing and accessing materials.

We hope that the resources provided by the RCC will prove valuable to you in your educational and research pursuits. Additionally, we look forward to the development of a similar repository that will help to mature robotics pedagogy at the university level and facilitate the teaching of robotics everywhere.

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The fifth article describes the MER surface operations process, the factors that influenced its development, and how the process has evolved over time. The sixth describes the visual odometry algorithm used on the MER rovers and summarizes its results from the first year of operations on Mars. The seventh article details the experience of driving the *Opportunity* rover on Mars from the point of view of the rover planners, the people who tell the rover where to drive and how to use its robotic arm. The eighth article is a comprehensive survey of NASA's past and future missions to Mars, detailing lessons learned and technologies required for future missions, either robotic or human.

The final article describes ESA's *Aurora* Exploration Program, with an emphasis on the development and implementation of technologies for the ExoMars project to be launched in 2011.

Thanks to the editor-in-chief and to all the reviewers and associate editors for helping to make this special issue a reality. We look forward to another special issue on planetary rovers and landers in four to five years, when we hope to be able to report on the successes of NASA's *Phoenix* Lander 2008, Mars Science Laboratory 2009, and the European ExoMars rover 2011.

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