

Robots in an Intelligent Systems Course

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Introduction

In the spring of 2005 our department offered a new course entitled "Intelligent Systems" (IS). This course, which will be required for future CS majors, provides an introduction to a number of AI topics including predicate logic, frames, rule-based systems, neural networks, Bayesian networks, decision trees, and fuzzy logic. The theme of agents is woven throughout the course. Each section of the course employs a different simulation tool or language so that students can apply and experiment with the techniques they learn about in the classroom. The culminating project for the course was a two week project where students were given a basic Lego MINDSTORMS robot to experiment with. Their task was to program the robot for a race to be held on the final day of class.

The goals of the robotics exercise were to introduce students to issues that arise when working with an agent that interacts with the real world, to provide a project that involves team work, to get students excited about CS, and to help them to gain a broader understanding of the overall endeavor of AI.

Educational Environment

We are a small, undergraduate liberal arts institution with a computer science faculty of four, one of whom has a primary interest in AI and another who shares an interest in the field but whose teaching focuses in other areas. We have neither an engineering school nor a graduate program in a computing discipline. Thus, large-scale, cutting-edge robotics research is not feasible in this environment. Our first foray into robotics involved the purchase of several Lego MINDSTORMS Robotics Inventions kits for use in independent study projects with undergraduates. One of these projects led to publication and participation in a

AAAI Spring Symposium (Burhans and Kandeler, 2004). This year we have significantly expanded our robot inventory and are in the process of setting up a robotics laboratory. The Intelligent Systems class project is our first experience using robots in a course.

The Robots

The availability of low-cost, simple-to-use robot kits makes the introduction of robots into the undergraduate computer science curriculum a real possibility for faculty with little or no background in robotics and in relatively small institutions. While larger institutions may have many sophisticated robots there is quite a bit that can be accomplished with a Lego-based platform, either with HandyBoards (Martin, 2001) or the RCX brick. There are a number of AI educators with considerable experience in this area (Greenwald et al. 2004) and a wealth of innovative projects available both in published reports and on the WWW.

With a constrained amount of time for the robot project the student focus was on programming and experimenting with the robots rather than constructing them. However, students had to engage in some building in order to change the batteries or to make modifications. The robots were built by the instructor and two undergraduate research assistants using the basic navigator "Trilobot" design described in (Bagnall, 2002): a tank style robot with two motors (left and right) and two touch sensors on a front assembly. We added one light sensor that was used for line following. Students were responsible for building the necessary Lego structure to support the light sensor.

The programming platform used was Lejos (<http://lejos.sourceforge.net>), a Java-based platform for the MINDSTORMS. We loaded the Lejos firmware onto the RCX bricks and provided the students with a few simple programs to get them started.

We provided teams with an additional collection of Lego parts and encouraged them to personalize the robots. One team redesigned the front of the chassis to use a single

touch sensor when they realized they had a defective sensor port on their brick. They did this despite our offer of a new brick. This sort of attitude was emblematic of the project, which seemed to inspire both independence and innovation among the students.

The Project

The project assigned to the students was to program the robot so that it could follow a dark-colored curving track on a light-colored background, with no ninety-degree or greater turns in the track. At the end of the track was a wall which the robot should detect (by bumping into it), causing it to turn around and navigate back down the track to the start. This was a race, thus, speed was essential. Note that different approaches to finding the line after it is “lost” as it curves cause significant differences in robot speed.

Results

In a tightly contested race three of the four teams’ robots successfully completed the course with times ranging from 47 seconds (the winner: “Jon Bot Jovi”) to 66 seconds. The fourth team failed to implement line detection for both left and right turns. Teams personalized their robots with items ranging from a rotating palm tree to Lego pirates.

Student Reaction

Enthusiasm among the students for the robot project was extremely high: it clearly sparked their interest in a way that other projects have not, indicating the importance of robotics as a way of motivating and attracting students to further study in CS in general. Students asked for additional resources (manuals, books, Web sites) to read up on robotics and have spent considerable time experimenting. Different rates of sensor polling, different methods of staying on the line, etc. have all been tested by the student teams. This stands in marked contrast to the level of enthusiasm about many other CS course projects and the negligible degree to which students approach programming projects as experiments. It indicates a possibility of teaching students to learn about experimental science in the context of robotics.

A brief survey was given to students, the results of which are summarized in the table below. Scoring ranged from 1 (absolutely disagree) to 4 (absolutely agree). Students suggested that robots be used in additional courses, including introductory programming, hardware, and software engineering.

Current sophomores who have heard about the robotics project have already asked if we will offer the IS course again next year so that they can “build robots”.

Question	Average Score
I enjoyed working with robots	3.9
Using robots helped me learn more about agents in the world	3.4
Robots are an important part of AI	3.6
I would recommend that future IS classes use robots	4.0
Using robots gave me better insight into AI	3.8
I think we should use robots in other courses (see paper text for suggested other courses)	3.8
The robots were fun	4.0
I think robots would be a good way to interest students in CS	4.0

Conclusion and Future Plans

It is clear that students benefited from their experience with robotics. Future plans include incorporating robot-based projects for other topics covered in this course, for example, building a fuzzy controller for a robot and comparing it to a controller based on traditional logic, and introducing robotics into other CS courses.

References

Bagnall, B. 2002. *Core LEGO Mindstorms Programming: Unleash the Power of the Java Platform*. Upper Saddle River, NJ: Prentice-Hall.

Burhans, D. and Kandefer, M. 2004. Dustbot: Bringing a Vacuum-Cleaner Agent to Life. In Proceedings of the AAAI Spring Symposium on Accessible Hands-On Artificial Intelligence and Robotics Education, 82-84. Menlo Park, CA: AAAI Press.

Greenwald, L. and Kopena, J. 2002. On achieving educational and research goals with small, low-cost robot platforms. *IEEE Robotics and Automation Magazine*, Special Issue on Robotics in Education: An Integrated Systems Approach to Teaching 10(2):25–32.

Greenwald, L., Dodds, Z., Howard, A., Tejada, S. and Weinberg, J. eds. 2004. , *Accessible Hands-On Artificial Intelligence and Robotics Education, Papers from the 2004 AAAI Symposium*. TR SS-04-01, Menlo Park, CA: AAAI Press.

Kumar D. and Meeden, L. 1998. A robot laboratory for teaching artificial intelligence. In Proceedings of the 29th SIGCSE Technical Symposium on Computer Science Education (SIGCSE-98), *SIGCSE Bulletin* 30(1): 341-344.

Martin, F. 2001. *Robotic Explorations*, Upper Saddle River, NJ: Prentice-Hall.