RoboToy Contest – Designing Mobile Robotic Toys for Autistic Children

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Abstract

Since 1999, a group of professors and students at the Department of Electrical and Computer Engineering (ECE) of the Université de Sherbrooke has been organizing a robot design contest. The challenge is to design a mobile robotic toy to help autistic children develop social and communication skills. The idea is to see how robots could help autistic children open up to their surroundings, improve their imagination and experience less repetitive behavior patterns. The pedagogical objective is to get students involved in a project that has technological considerations and social impacts.

Introduction

The Department of Electrical and Computer Engineering at the Université de Sherbrooke offers two distinct bachelor engineering degrees, one in Electrical Engineering and one in Computer Engineering. In 1998, we initiated a pedagogical project in which Electrical and Computer Engineering (ECE) were introduced simultaneously to a group of 200 first-year undergraduate students registered in these two distinct programs. The primary goal of this project was to confirm early on the career choice of these students by putting them close to the reality of the profession and making them work on projects involving design and analysis abilities, autonomous learning, teamwork, communication skills and social considerations. We also wanted to create a stimulating and motivating learning environment, with a reasonable workload that favored the integration and the application of the engineering knowledge and skills.

It is with these objectives in mind that we developed our own mobile robotic platform named ROBUS [5], shown in Figure 1. Grouped in teams of four, students have to assemble, test and program the robot. They use it to learn simultaneously electronics, sensors, actuators and real-time programming in C. To make them apply the engineering knowledge and skills, we invite them to participate in a design project, more specifically the design of toy robots to help autistic children increase their ability to focus their attention and to be more opened to their surroundings. Autism is characterized by abnormalities in the development of social relationships and communication skills, as well as the presence of marked obsessive and repetitive behavior. Despite several decades of research, there is currently no cure for the condition. However education, care and therapeutic approaches can help people with autism maximize their potential, even though impairments in social and communication skills may persist throughout life. The idea is to see how robots could help autistic children open up to their surroundings, improve their imagination and try to break repetitive patterns. Such project allows students to work on creative and innovative solutions that have a social impact, close to what engineers are asked to do in real-life situations. The event organized is called the RoboToy Contest [4].

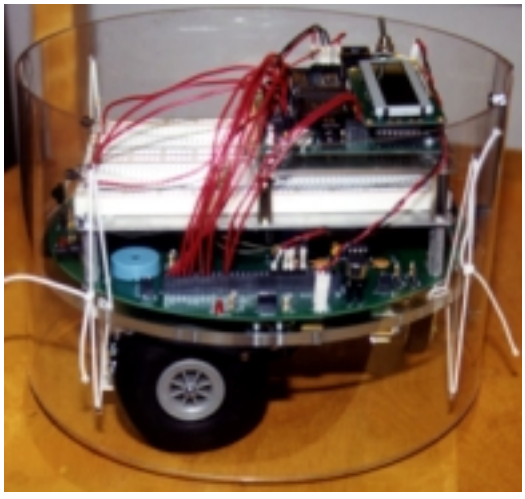

Figure 1. ROBUS (RObot Université de Sherbrooke)

Description of the RoboToy Contest

As indicated in the introduction, the goal of the contest is to design a mobile robotic toy that serve as a pedagogical tool to help children with autism develop social and communication skills. The challenge is to come up with a

design that can get the attention of the child and generate incentives for having the child make the effort of opening up to his or her surroundings. Using a mobile robotic toy is an interesting idea because it can create novel, appealing, meaningful and sophisticated interplay situations using speech, sounds, visual cues and movement. It is up to the students to add sensors and actuators of their choice, to construct the physical structure and appearance of the robot, and to develop the capabilities they believe to be appropriate for their robot. From an engineering perspective, it gives them the opportunity to experiment the difficulty of making choices and explaining them in relation to a "therapeutic" goal, instead of putting all sort of devices just for the fun of it. Students are then not only motivated by the engineering challenge of the project but also by the social implications of their work. In addition, students have a lot of latitude in proposing creative and innovative solutions. This leads to a great variety of interesting and distinct solutions, making the best of the sensors and the actuators available, the processing capabilities of the microprocessor board and what can be done in practice, while still considering the social impacts of the designs.

Students interested by the contest register in teams of three to ten people. Teams can be made of all ECE students or also of students from other disciplines. The contest is held in an exhibition hall where each team has a presentation stand to explain their design and market their product by putting up posters, preparing a presentation, showing videos, demos, decorations, etc. Teams have the morning to set up their stand, and the presentations opened to the public are done from noon to 5 pm. Each team has a presentation stand with posters describing their work. The jury composed of people working with autistic children and people with technical knowledge on ECE, evaluated each team based on an oral presentation of 5 minutes and a demo. The demo is held in the center of the exhibit hall, on a wooden platform. Using a microphone, students commented the behavior of their robots and also made it possible to hear the messages their robots were saying in different situations. Kindergarten children are also invited to play with the robots during this demo.

Robot designs were evaluated based on their ability to interact with children and their characteristics in regard to autism, originality and their presentation to the public. Evaluation by the members of the jury starts around 1pm, first by visiting the presentation stands, and then by having the ten best designs present their robots in the center of the exhibition hall. The jury then deliberates to find the top three designs. For the second edition of the contest, held in April 2000, cash prizes of 1000$, 500$ and 300$ were given to the winners. Participation prizes (like books, multimeters and a zip drive) are also given.

Examples of RoboToys

Figure 2 shows some of robots designed by the participants to the 1999 and 2000 editions. There were 12 entries in 1999 and 21 in 2000. All robots used a ROBUS platform with a Handy Board and an ISD ChipCorder device for voice recording and playback. However, each robot is very distinct from one to another. Different functionnalities have been implemented: moving parts (trunk, legs, arms, head, mouth), people following, games like 'Simon says', etc. Participants can use what they want to design their robots, like pyroelectric sensors, infrared range or proximity sensors, sonars, compass, bend sensors, mercury switches, contact sensors, position sensors, servo-motors, vibrating motors, electric pistons, LED displays, etc.

Figure 2. Examples of RoboToy entries

Pedagogical and Research Support

One factor that plays an important role in the contest is its connection with the *course GEI 321 – Introduction to circuits and microprocessors*. The goal of this course is to introduce the fundamentals of the analysis and design of basic analog and digital circuits, and also get students familiarized with microprocessor systems. The mobile robotic platform ROBUS and the Handy Board are used in the course. Around 200 freshmen are grouped in teams of four students, with each team sharing a robotic platform. The course is organized by having students work on a different project each week. Pedagogical material includes a textbook on Electrical Engineering [1], a book on robotics and the *Handy Board* [2], and documents presenting the activities of each week. Each Monday, the class meets for one hour to present briefly the materials to be covered and manipulations to be done during the week. Lab and supervised exercise periods are held on Wednesday's afternoon. On Fridays, students are evaluated by completing a test of around 30 minutes. On this day students also receive the document for the following week. On week #12, students are asked to integrate one sensor or one actuator of their choice to their robot. Then, on week #13, each team of students has to combine their work with the work of another team and present a complete robot design. This activity is extremely important to make students follow the programming methodology presented in the course, which facilitates integration. In addition, students who want to participate to the contest are allowed to present their design of a robotic toy for autistic children. This is an important incentive to help freshmen see that they can take on the challenge of the contest without compromising their grades (because of an excessive workload) in the courses they are taking.

Figure 3 – A child playing with a RoboToy

Also, we believe that to ensure the success of the RoboToy Contest over several years, it is not sufficient just to hold the event without doing real experiments with autistic children. Doing so is more related to research than education, but it is essential in order to get students involved and to establish real multidisciplinary collaborations. It is not possible to bring autistic children during the event because a public setup would not have been appropriate for them to interact with the robots. So for those who want to participate in such experiments, we bring robot to a class of autistic children [6]. Each child has his or her own distinct way of interacting with the robots. Some remains seated on the floor (see Figure 3), looking at the robot and touching it when it came close to them (if the robot move to a certain distance, the child just stop looking at the robot). Others move around the robots, sometime showing signs of excitation. One little girl showed clear indications that having the robot moved in the environment helped her become aware of its surroundings: she started to move around the room in a routinely fashion and, as time went by, she started to break the pattern by going to the robot and interacting with it. She even once dragged the robot by the tail to bring it back were it was supposed too (based on what she was used to see when she looked at the robot). Such experiments allows to see what works and what does not, in order to make the designs evolve over time and not just see the same kinds of designs years after years. It also helps combine research and education activities of faculty members. And most importantly, it contributes to the education of autistic children and get students introduced to another reality of life, working with kids with learning disorders, something that they might never have got to know. This then becomes a complete real life experience.

Conclusion

This paper is a short summary of what can be found in the references [3,4,5,6]. Organizing the RoboToy Contest reveals each year to be a very fruitful experience for all, students, teachers and collaborators. Surely, it requires lots of work by many people, but the benefits are much more important. Students develop rapidly important skills in electrical, computer and engineering in general. They also appreciate the fact that their work can actually be used in real situations. Just seeing kids play with their robots during the contest exhibition is really gratifying for them, just like the experiments done with autistic children. Students are also solicited to participate in various exhibits and events all year long, providing visibility for their work, to the university and the contest. We are also receiving official requests for lending robots to schools for children with learning disorders. By *making it real*, we have created a very rich activity for all. Since the RoboToy Contest is an extra-curricula activity supported by the Department of ECE, we also found a good way to make an efficient connection between course material and projects.

The activity should also have an impact on attracting undergraduate and graduate students, which is something that we cannot evaluate yet. Our hope for the future is to continue to make the RoboToy Contest evolve, and to interest other universities to join our initiative.

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References

[1] Hambley, A.R., *Electrical Engineering Principles and Applications*, Prentice Hall, 1997.
[2] Martin, F., *Robot Exploration A Hands-On Introduction to Engineering*, Prentice Hall, 2000.
[3] Michaud, F., Clavet, A., "Organization of the RoboToy Contest", in *Proc. American Society for Engineering Education*, new Mexico, June 2001.
[4] Michaud, F., Clavet, A., Lachiver, G., Lucas, M., "Designing toy robots to help autistic children - An open design project for Electrical and Computer Engineering education ", in *Proc. American Society for Engineering Education*, St-Louis, June 2000.
[5] Michaud, F., Lucas, M., Lachiver, G., Clavet, A., Dirand, J.-M., Boutin, N., Mabilleau, P., Descôteaux, J., "Using ROBUS in Electrical and Computer Engineering education", in *Proc. American Society for Engineering Education*, Charlotte, June 1999.
[6] Michaud, F., Théberge-Turmel, C., "Mobile robotic toys and autism", submitted to *IEEE Trans. on Systems, Man, and Cybernetics*, Dec. 2000.

RoboToy Contest: http://www.gel.usherb.ca/crj