Organization of the RoboToy Contest

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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. Such an opened and multidisciplinary design project requires careful preparation and the implication of students, faculty and experts. This presentation aim at describing the organization of the RoboToy Contest, to get other universities interested in such rich and fruitful initiative for all.

I. Introduction

If we want engineering students to learn how to be good engineers, we must put them as close as possible to real challenges similar to the ones they will have to face during their career. At the Université de Sherbrooke, in addition to the co-op training program, we are dedicated to make students work on projects as part of the curriculum[2]. Lots of curriculum reforms are now trying to include more projects as part of their pedagogical activities. It is no secret that this requires more work and resources than giving lessons by following a text book, but the benefits are enormous: it creates a dynamic learning environment where students and teachers move beyond what is requested or taught in regular courses. These projects require students to work in teams and develop the technical skills required to be competent in their discipline. We also want them to address the communication and economical aspects in their designs, and having them present their work to the public is a good way of doing that.

It is with these objectives in mind that our Department of ECE started in 1998 a pedagogical project in which a mobile robotic platform named ROBUS[8] is used to introduce a large group of first-year undergraduate students to electrical engineering and computer engineering. 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. 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[7,10].

This paper is a follow up on two previous presentations at the ASEE on this initiative, to address questions that were asked about the organization of the event and the evaluation of the designs. To do so, Section II gives a brief summary of the contest, with some examples of designs presented in its second edition. Section III presents the different issues that must be addressed in organizing such an event like the equipment required, sponsorships, how to coordinate the participation of students with class activities, and the importance of making it real by involving research issues and experts. Compared to other robotic competitions, one particularity of the

RoboToy Contest is that it does not involve a game where robots have to compete with each other and maximize a specific performance criterion to determine the winner, like for instance the Fire-Fighting Home Robot Contest[1]. Instead, members of a jury evaluate each robot according to specific criteria related to their area of expertise, as described in Section IV. Section V concludes the paper by presenting the impacts this activity is having on our programs.

II. 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.

Figure 1 – A team of students at their presentation stand, with their robot

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. 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) were also given.

Figure 2 – Public presentation of Pedro, a mexican robot toy

III. Organizing Committee and Responsibilities

At first, it seems relatively simple to organize such an event, but in fact it involves a lot of people over two semesters. Necessarily, this can only be accomplished with the involvement of students, teachers and technical staff. Here is a list of issues that need to be covered for the organization of the event:

- **Sponsorships and funding**. Inevitably, the contest would not be possible without finding sponsors for providing the financial support required for the event. For solicitation, we prepare each year a file that describes the contest, the results of the previous years, and the impacts (in visibility and outcomes on the education of students and on the subject of autism). We also present the financial report of the previous year, and the budget plan for the current year. After having contacted a potential sponsor by phone to get the coordinates of the person to contact, we send this file by mail approximately four months before the contest, and do a follow up by phone. Sponsors are asked to send their contributions and also a banner or some kind of publicity that are to be displayed during the contest. We also put their logo in the contest pamphlet. Finally, after the contest, we also send sponsors a letter of acknowledgement along with the contest booklet, to thank them for their support.
- **Equipment.** The first thing students need to have to participate to the contest is a mobile robotic platform. They can build their own, or we can lend them one of our ROBUS platforms. We can also lend other electronic devices that could be useful for their designs: an ISD ChipCorder device for voice recording and playback, pyroelectric sensors, infrared range or proximity sensors, sonars, digital or analog compass, bend sensors, mercury switches, contact sensors, position sensors, servo-motors, vibrating motors, electric pistons,

LED displays, etc. Depending on what students want to do, they can get familiarized with a great variety of sensors and actuators. Students have to leave a deposit for receiving these parts, which must be returned at the end of the contest. They can also purchase their own devices and use them on their designs. For the mechanical aspects of their designs, no support from the contest organization is provided. Teams find the components they need and build the additions they want on their robot platform.

- **Information about autism**. Autism disorder is not a subject covered in ECE curricula. So students have to find the information they need to elaborate the design specifications of their robot. The organization committee of the contest tries to help participants get informed about autism by organizing different activities. For instance, in 2000 the president of the Québec Society for Autism gave a seminar on autism, and shared his experience as a father of an autist. The École du Touret and the Department of Specialized Education at the Université de Sherbrooke also help us by providing videos and information on therapeutic approaches like the TEACCH program (Treatment and Education of Autistic and Related Communications Handicapped Children, based on activities using pictograms and geometrical shapes. Eight profiles of children, each with specific characteristics, are also available and from which robots can be designed to address. Observations made from the experiments done with robotic toys and children with autism are also provided.
- **Web site**. Having a web site is the best way to provide all the information required about the contest: team registration, rules, autism, electronic components, activities, sponsors, past events, etc. Contact information for the members of the organizing committee is also provided. Maintenance of the web site is an important responsibility, since it requires constant modifications before and after the event.
- **Local organization**. This involves all of the preparation required to make everything goes well during the day of the contest, like: reservation of the exhibition hall; renting the sound system (with a cordless microphone for the demos); layout and installation of the presentation stands, the sponsor banners and the main presentation area. We also use a specific room for jury deliberation, and we bring computers from the department in case students have to reinitialize their robot. It is also important to plan for having somebody take pictures and videos during the event. One person is also responsible for hosting the event. Since the students have to be on site for almost the entire day, we also provide some food to the participants.
- **Publicity and visibility**. Many things need to be done to publicize the event at different point in time. Before the registration period, we need to make the contest known to students of the department, the faculty and the university, and get them interested in participating. Before the event, we make invitation to the media, sponsors, important representatives, schools and the public in general to come at the exhibit. Pamphlets, posters and press releases are made and distributed. We also have made a logo for the contest, as shown in Figure 3. Every year we put together a contest pamphlet in which all of the robots presented during the event are described. Each team has to provide a description of their robot, along with a photo. We also invite a class of kindergarten kids to play with the robots during the event, since such a public setup would not be appropriate for autistic children. It is important to note that special care must be taken to inform the media that these children are not autistic, to avoid possible misunderstandings. Finally, after the contest we ask interested teams to keep their robots in working condition, because the organization committee receives requests from different instances to do demos of the robots. For instance, robots can be used in real experiments with autistic children, or also in various exhibits and news reports.
- **Evaluation and Prizes**. The evaluation process and criteria are described in more details in Section IV. But in regard to the organization, in addition to having to determine the evaluation criteria, we must recruit experts that will serve as members of the jury. During the event, one member of the organization committee is responsible for assisting them during the evaluation process. For instance, before the evaluation starts and while having lunch, this person informs jury members of the evaluation process and criteria, and explains how to use

the evaluation portfolio, which includes a contest pamphlet, instructions and the evaluation forms. This person can also answer questions the jury has about the evaluation criteria during their deliberation. It is also this person who brings the official results of the top three robots. The top three teams receive cash prizes, and the names of the winning teams are put on the contest trophy. After having announced the winners, the name of all participants are drawn for the participation prizes, which are in-kind. Also, each team receives a letter of acknowledgment for their participation. Students can use this letter and the contest pamphlet as part of their portfolio to get a summer job or an internship position.

Figure 3 – Logo of the RoboToy Contest

Eight months before the contest, the first thing to do is to constitute the organizing committee. Participants of the previous contest are solicited, along with members of the organizing committee that are still interested to participate. This can take around two months. Then, the organizing committee conducts weekly meetings to coordinate the issues presented above. In the 2000 Edition, the organizing committee was made of eight students and two professors. The 2001 committee involves ten students and two professors. Obviously, this event would not be possible without the implication of students in the organizing committee. They have a better understanding of what can be done to facilitate the participation in the contest, and can communicate information in a more direct fashion. The contest also reveals to be a great learning experience for the students involved in the organization.

Another 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[5] 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[3], a book on robotics and the Handy Board[4], 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. Table 1 presents the subjects covered in the course, along with the weekly projects. Note that 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.

Table 1 – GEI 321 Course Organization

#	**Subject**	**Project**
1	Course Introduction	Assembling ROBUS
2	Fundamentals of Electrical Engineering	Temperature control system
3	Resistive Circuits, and Introduction to Diodes	Door Alarm
4	Resistive Circuits	Using ROBUS with the Handy Board
5	Inductance and Capacitance	Electronic Flash
6	Analysis of RLC Circuits using Differential Equations, and Introduction to Bipolar Transistor	Analog Control for ROBUS
7	Complex Impedances and Frequency Response	Crossover Network Frequency Response
8	Microprocessor	Real-Time Programming and Behavior-Based Systems
9	Analog Sensors	Braitenberg Experiments
10	Digital Sensors and Motors	Dead-Reckoning
11	Operational Amplifiers	Clap Detector for ROBUS
12	Hardware / Software Integration	Integration of a sensor or an actuator on ROBUS
13	Project Presentation	Presentation of a robotic concept

Finally, 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[9]. 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 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. Other initiatives involving robots to integrate research with undergraduate education are also underway[6].

IV. Evaluation Process

As stated before, evaluation of the robot presented by each participating team is not, like in other robotic competitions, a matter of identifying the fastest, more clever or skillful robot. Instead, a set of criteria must be established that allows a jury of experts to compare each robot with the contest objective of designing a mobile robotic toy adapted to autism disorder. We decided to select jury members with three different kinds of expertise. The first, chosen among our sponsors, gives a general opinion on the robot appearance, behavior and presentation. The second, an expert on autism, concentrates on the relevance of the design with this problematic while the third, an experienced electrical and computer engineer, considers the design technical aspects. Specific criteria for each of these categories are presented in Figure 4. Jury members give (with a checkmark) a note from 0 (poor) to 3 (excellent) for each of the three criteria under his or her responsibility. For the 2000 Edition, we used two groups of three judges to evaluate the 21 entries, with each group evaluating approximately 10 robots. They took roughly one hour and a half to complete their evaluation. Then, after a 30 minutes deliberation, the six judges selected ten finalists for the general public presentation.

RoboToy Contest : Jury's Round 1

3 - Excellent
2 - Good
1 - Average
0 - Poor

	Diskcat	R3-D3	JoUjOu Techs	Mamboola	Houblonex	Bluescreen	Joyriders	Aut-o-Mates	Projet Rainmen	Visiteurs de l'espace
GENERAL EVALUATION										
• Presentation : speech, stand, poster, etc	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Appearance and concept	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Originality of the design	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
RELEVANCE to AUTISM										
• Appearance and concept	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Interplay and interactions	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Potential interest of a child with autism	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
TECHNICAL EVALUATION										
• Ease of use and autonomy of the robot	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Technical capabilities (hardware and software) of the robot	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
• Robustness, security and fabrication cost	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0
Check here if the robot has shown that it works well enough for a public presentation										

Figure 4 – Form used by the first group of jury members to evaluate ten robots

For the public presentation, finalists have about five minutes to present their robot and to demonstrate its capabilities. Jury members are asked to evaluate the quality of the presentation and of the demo. Jury members then do their final deliberation to determine the three winners, based on the public presentation (40%) and on their first round results (60%). This process took a little more than half an hour in the 2000 Edition. The jury also gives honorable mentions to some robots for robustness and security, innovation and ingenuity, appearance and attractiveness, public presentation and, finally, one for potential impact as a pedagogical tool for autistic children.

We believe that this evaluation process produced fair and good results, since the three winning robots were clearly among the best designs. What made it difficult is that the margin between the winners and the fourth to sixth places was very small: these designs were so good that we wished we had more prizes! Our evaluation process can also be improved in order to overcome the following difficulties:

- it lasts too long (close to four hours);
- it is difficult for the two groups of jury members to reconcile their opinions in order to select the finalists;
- almost half of the robots did not appear in a public presentation, which would have been appreciated by some of the non-finalists;
- the finalists present twice their robot demo, the first time to the subset of jury members and the second time to the public and the entire set of jury members. For one subset of jury members, they had to listen to the same presentation they attended during the first evaluation round.

For the next edition of the RoboToy Contest, we are elaborating a revised evaluation process using the same criteria but by having a set of jury members assist to the public presentation of all the participants while another set of jury members would visit all the stands.

V. Conclusion

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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