Building a robot to use in school – teachers and students learning together

A. Fernando Ribeiro
Univ. of Minho, Dep. Industrial Electronics,
Campus de Azurém, 4800-058 Guimarães, Portugal
fernando@dei.uminho.pt

***Abstract**. Robotics is becoming extremely popular amongst the youngsters, because it is fun, you can practice with hands-on and above all you get real results. Since most students have to develop practical works in their schools, robotics works are becoming very popular.*

But robotic is a multidisciplinary area of knowledge and therefore the school teachers might not have the know-how in all required fields.

The Robotics Group at University of Minho (Guimarães, Portugal), created a new robotics event called RoboParty© where they actually build robots from scratch (mechanics, electronics, programming, etc.) in 3 days (24 hours a day) supervised continuously by experts on the various fields. At the end, they take the robot home with them and they can continue using and improving it later on.

Keywords. Robotics, Event, Hands-on, Party, Learning.

1. Introduction

It is well known and accepted that in our future there will be mobile autonomous robots, new technological devices and ideas to help society in general, specially servicing robots to help humans in their everyday tasks.

Therefore, many robotics groups have been fostered to develop and improve such technological devices, but to continue that work more and more researchers are needed. Youngsters are very welcome to all these fields of research since their normally bring with them curiosity, new and rebel ideas, and will to work and to prove themselves. There is a trend to foster youngster's curiosity and interest for robotics engineering related areas, motivating them to learn in a structured way and forcing them to a hand-on-science experience.

That requirement of preparing the young generation for the robotics challenges of the future is extremely necessary and it depends very much on their teachers (primary and secondary schools) which should be available to teach them and to learn themselves also. When a robotics project is under way, in most cases it is much easier to motivate the students than their teachers. The robots built by the students and a possible participation in a robotics event normally attract the media, being possible to advertise publically their robots, giving some notoriety to the school. These projects also keep the students busy with learning rather than spending time in other less desirable activities.

2. Motivations to organize RoboParty©

The Group of Automation and Robotics [1] from University of Minho (Guimarães, Portugal) [2] has been developing mobile autonomous robots for the last 10 years, and has been participating actively on many national and international robotics competitions with some success, with special attention dedicated to the worldwide robotics challenge RoboCup [3], on the Middle Size League, with a team of 5 robots which can play football autonomously.

Primary and secondary schools from all over the country have been requesting this group to make robotic demonstrations and speeches, and the group use to travel to the schools with robots to fulfil their desire. But the frequency was getting so high that it was decided to organize an event working the other way round. The schools would come to the University of Minho and bring teams of students with one teacher (or person responsible by the team) for three complete days in a unique event, where they would be taught how to build a robot with their own hands, with lectures specially created for their young ages, by experts on robotics. The experience was a success and is here described.

3. RoboParty – a new type of event

The main objective was to teach robotics to youngster from 11 years old, to people who doesn't know anything about robotics, in an entertaining way, very practical with hands-on, in a friendship and helping environment, with lots of fun, breaks for entertaining/sports activities. It is also important to foster their enthusiasm by science and technology studies, and the participants are guided and supervised by experts on robotics.

The participants need to bring with them to the event a sleeping bag per person, a laptop computer for the team, the desire to learn robotics and good state of mind. In the end, they take home a mobile robot built by them, physical souvenirs from the RoboParty, lots of memories and possibly a new future.

Each team has 4 people, one of them an adult (a teacher or a parent). The participants are suggested to share information, ideas and knowledge with other teams, and in fact they help each other very frequently.

4. Event Facilities

The event was held on the University sports pavilion. The space was split into two areas: working area (2/3 of the overall space) with tables for the teams and electrical plugs; and a sleeping/sports area (1/3 of the space) where some entertaining/sports activities were held during the day and a sleeping area during the night, using sleeping bags on sports mattresses.

Figure 1. Sleeping Area

The sports hall has good conditions like central heating/air conditioning, a large number of toilets facilities, room with sports machines, security surveillance cameras, electronic entrance control, parking space, file cabinet with lockers, sound room, and a reception.

Nearby, there is the University canteen where the students had their meals and a huge campus garden where they can relax when they get tired.

A group of over 50 volunteers helped on the organization, all of them last year students of the Industrial Electronics degree.

There is a space where all participants attend the lectures (how to build the robot, how to solder electronic components, history of robotics, robotics competitions, servicing robots, etc.).

Another space was reserved for robots demonstrations (for anyone to show their robots or technological gadgets). Some of the robots on display were built at the University of Minho.

The entertaining/sports activities were very popular, like: indoor Air Modeling, Basketball, Football, Tennis table, Badminton, Wood Ball, Taekwondo, Yoga, Kickboxing, Judo, Karate, *Capoeira*, Stretches, Cardio Session, Triathlon indoor, Golf, Quick Chess, circus activities, Ballroom dance, Archery.

These activities are available most of the time and each participant can decide the activities he wants to participate. All these activities had professionals to help and teach the students.

5. RoboParty image

In order to make it more attractive, a designer was asked to make the event's image. A mascot was created called Ruminho (Robotics at University of MINHO). This mascot consists of a friendly two wheels robot, with two robotic arms and large eyes. Based on the Ruminho mascot, several entities were created: a T-shirt to offer all participants; a badge (with a transponder inside); trophies for the winners; a certificate for participants given in the end; a Ruminho plush (for sale); and posters to advertise the event (sent to schools weeks before).

Figure 2. RoboParty Image

Figure 3. RoboParty Poster

An appealing world wide web site was created [4] not just to advertise the event but also for other various reason like: to accept team registrations with all the personal details, to give participants all the necessary information to parents and tutors, to explain the rules of the event, the demonstrate with pictures the robotic kit they have to assemble, to publish related news, and above all to show the event live. With these cameras the parents can see their kids on-line on the working area.

Figure 4. RoboParty Web site

6. Event Contents

The event is made up of several parts:

- training and lectures (specifically created for youngsters)

Figure 5. Lecture about robot assembling

- two invited speakers to talk about robotics (normally robotics expert from a foreign country, so that they can practice their English language).
- actual hands-on robot build up (soldering and mechanics)

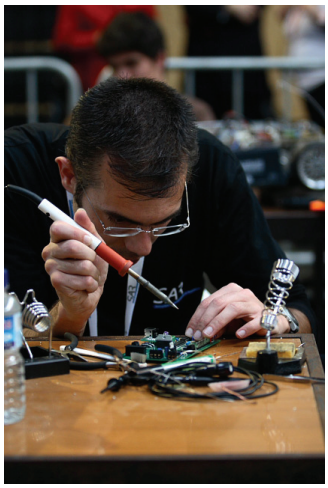

Figure 6. Soldering components

- robot programming (on their laptop)

Figure 7. Robot programming

- entertaining/sports activities (there is a huge activities list they can choose from). These activities allow them to rest mentally, to

try/learn new sports or other activities and to meet new friends.

Figure 8. Entertaining/sports activities

- optional small competition in the end of the event, to allow teams to show their robots working. It consisted of three leagues: dance (90 seconds on the stage), obstacle avoidance (small track where robots cannot collide with walls) and aesthetic (robots decoration)

Figure 9. optional competition

- demonstrations area, where other robots are on display, to motivate further developments
- During the event, there is a repairing stand to fix some major break downs made by the teams on the robots, and this stand can fix immediately and/or replace parts. All the robots will leave the event running properly.
- There are 50 electronics and programming experienced volunteers to walk around helping and guiding all teams. The volunteer are all University of Minho last year Electronics students.

7. Participants Kit

When participants arrive, they must bring a sleeping bag each one, plus a laptop computer for the team.

Then, their team leader checks them into the event as a team (all under age have to bring a permit from signed by the parents giving them permission to come to the event). They are given badges (with their photograph and a transponder) which gives them permit into the facilities, a RoboParty T-shirt for every one, a city map, a locker to keep their stuff closed, the program of the event, the robotic Kit in a box, a CD with instructions (a video) on how to build the robot, and then they are taken to their table on the working area.

Figure 10. RoboParty Box

The most basic tools to build the robot come in the box, but some others like the soldering gun they must bring from home or buy in the event. The web site contains a description of all necessary tools to build up the robot.

8. Building the robot

A robotic kit was developed on purpose for this event, by SAR - Soluções de Automação e Robótica [5] and University of Minho. This kit was baptized as Bot'n Roll ONE [6].

The robot assembly has three major steps: mechanics build up, electronics soldering and robot programming. All the necessary parts are in the box.

8.1. Mechanics

The participants start assembling the mechanical components which consist of a base where all the components attach to.

They start screwing one motor to an L shape motor holder, and attaching it to the base.

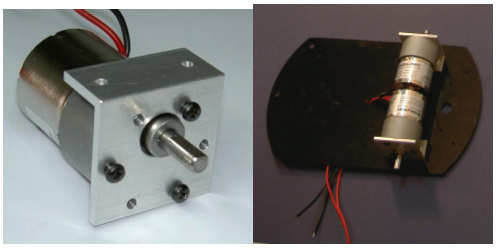

Figure 11. L shape Motor support (left) and robot base with two motors on (right)

Then the wheel is attached to the motor vein. This is repeated to both right and left motors/wheels.

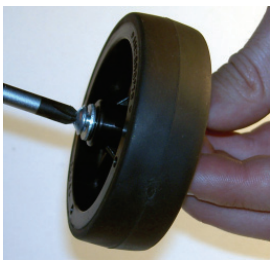

Figure 12. Robot Wheel

The third support of the robot (caster wheel) is also assembled and attached to base and the back side.

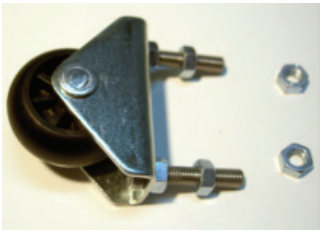

Figure 13. Caster wheel

Other components have to be assembled but that task will be carried out after the electronic board has been assembled.

8.2. Soldering electronic board

The second step is then to solder the electronic components on the electronic board. This board was developed on purpose with large electronic components to make it easy for the participants the soldering task.

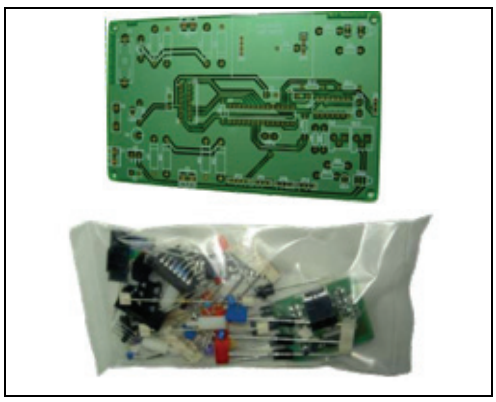

Figure 14. Electronic board (top) and electronic components (bottom)

The components are well and easily identifiable with colours or asymmetries and their location on the board is also easy to find because the board has the names written on it.

Before soldering the components a lecture on "how to solder" is given for those inexperienced. Another lecture is given to explain the participants what is a resistor, a capacitor, a battery, and LED, etc. These very basic instructions make them aware of the functionality of each component. The components soldering proved to be one of the most desired task by the youngsters.

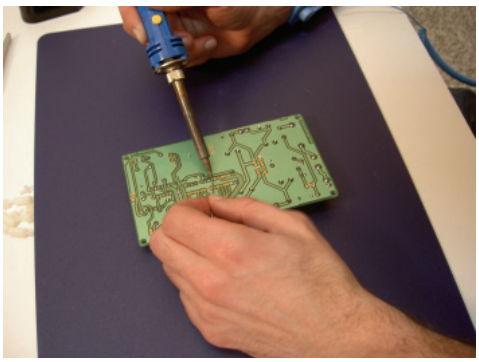

Figure 15. Soldering task

Even though there is a manual to follow, a CD is distributed on the box with videos on how to assemble the electronic board and all the volunteer are around the teams to guided and help the participants.

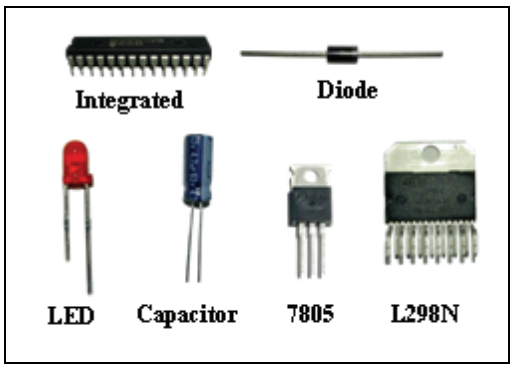

Figure 16. Major components

Once all the components are soldered, the board should look like the following picture.

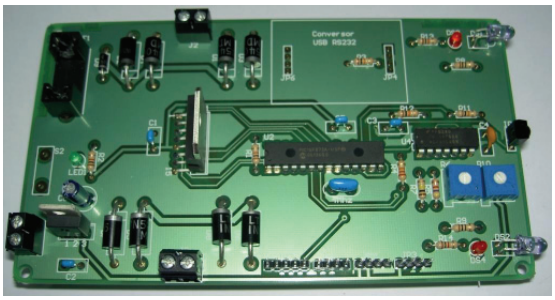

Figure 17. Board with components soldered

To make it easy for the teams to program the board, a USB-Serial converter is used on the board, but since this uses SMD's (very small components), this is given already assembled as a small secondary board and they just have to plug it on the main board.

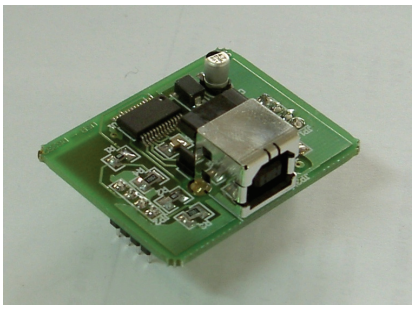

Figure 18. USB to serial converter

The board is then tested and placed on the robot (initial base where motor and wheel are attached.) with plastic supports.

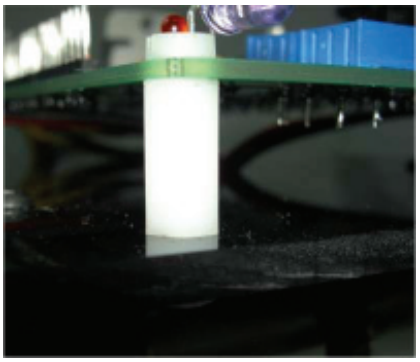

Figure 19. Board supports

The wires are then plugged in. Again, all the wires given have specific colours so that the participants do not mixed them. The main switch is mounted into place and the wires plugged.

Then the battery is placed under the robot and it gets stuck with Velcro, so that they can remove and replace it whenever they need without screws or any other mechanical device.

There are two optional extras for those teams who required it: a line follower and an LCD display. Those come already assembled and they just have to plug them on the robot.

The final aspect of the robot is pictured next.

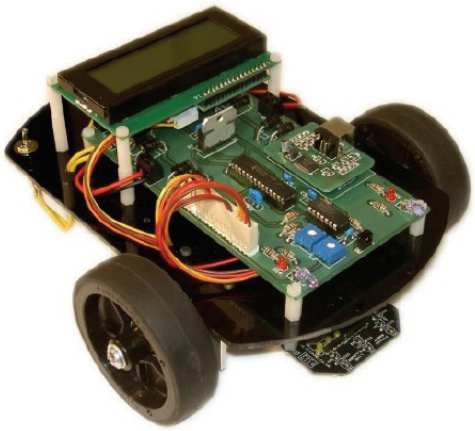

Figure 20. Fully assembled Bot'n Roll ONE

All the cables, CDs and chargers are supplied in the BOX so that the robot can start working immediately.

8.3. Robot Programming

The third step is the robot programming. The software has to be installed on the laptop computer the teams brought with them, and a manual is given to all participants with instructions on how to install it. The software also comes on the CD within the robot box. A PICAXE is used as the brain of the robot and therefore the software to use is a compiler from the PICAXE itself.

The language is BASIC style and several examples built by the development team are given to the participants so that they get easily familiar with the main instructions. One lecture is given to participants on how to program a robot and teaching the main BASIC instructions.

Taking into account their age and their short programming knowledge, this lecture was specially created with cartons and several examples in order to make it easy to understand. It describes the most basic instructions and real examples are given and followed step by step so that they don't get afraid of learning the rest of the commands. In a few minutes the participants

can experience their small projects and see the robot moving.

They get excited because the learning rate is fast. Besides, they are a group of four people and they can share their experiences and suggestions from four people make the learning process much easier and fast.

9. Results achieved

On the first edition (2007), the organization advertised RoboParty only on the city suburbs expecting to receive between 15 and 20 teams (4 participants each), but the registration had to be closed down because over 100 teams were already registered and the space available for the event was not much. They came from all around the country including the Portuguese islands. The space was re-thought of and 100 teams participated, meaning around about 400 participants plus the over 50 volunteers and organizers. Participated teams from primary schools, secondary schools, professional schools and even from universities (although just a few). It is important to point out also teams from robotic clubs and families.

The same happened on the second edition (2008), also with 100 teams (400 participants from all over the country) and the list did not grow due to lack of space.

Figure 21. RoboParty Working Area

10. Case Study survey

In order to be able to improve the event, a statistical survey study was carried out during the 2008 edition, where over 12% of the participants were enquired with 19 questions. After a careful analysis, the most relevant aspects were taken into account and these are described below:

- Ages - The youngest participant was 9 year old and the oldest was 56 years old. Without considering the adults that accompany the students, the average age was just below 18 years old. An age distribution chart can be seen in the figure below.

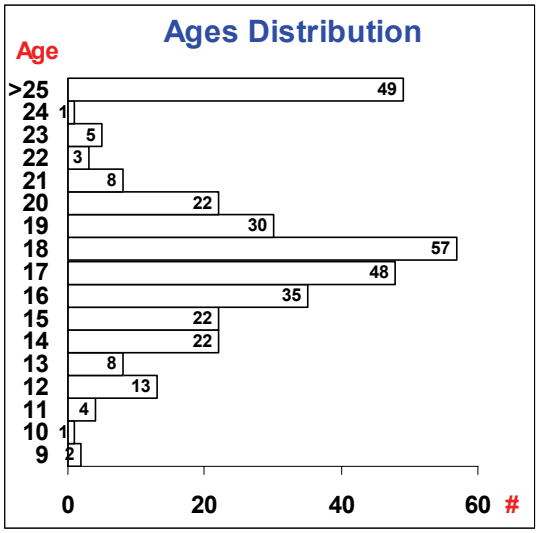

Figure 22. RoboParty participants ages distribution

- The participants come from all over the country, having a major percentage coming from the northern region.
- The degree of satisfaction was: completely satisfied (40%), very satisfied (54,5%), satisfied (5%).
- Regarding the expectations: exceeded expectations (74%), match expectations (23%), below expectations (2%).
- What they enjoyed the most: we point out just a few answers like: “The robot programming”, “The build up from scratch with the help of professional”, “speeches and training”, “the help from volunteers”, “to learn new things”, “the entertaining environment”, “the possibility of build a robot myself”, etc.
- How important has RoboParty been regarding what you know about robotics: extremely important (13%), very important (51%), important (36%), not important at all (0%).
- When the participants were asked if they would like to come and study on this University (Minho), 65% of them answered yes even though that most of them are not from Guimarães.
- Which area attracts the participant the most: Electronics (20%), computer science (58%), mechanics (3%), others (18%).

- When asked if they would continue using and playing with their robot at school or at home, around about 92% answered yes, they would.
- Where would they use their robot: At school (54%), at home (23%), everywhere (11%), no answer (10%).
- Who was the adult who accompanied the team: teacher (54%), parents (4%) and other family or friends (40%).
- Within the team, who actually put more effort on the robot built up: The enquired (15%), the other team mates (11%), all contributed (70%), the responsible adult of the team (5%).

On the enquiry, participants were asked to give some suggestions and those were taken into account and most of them were related with space for the teams, which means that the technical and functional aspects were fine.

11. Conclusions

The outcome of the event is very rewarding. No major disadvantages were found so far apart from a lot of work to organize. The main conclusions are:

- Since this event is dedicated to people who wants to start on the robotics field and they don't have much knowledge about it, many people wants to participate; teams from schools, teams from groups of robotic, and even teams made up of families (parents and kids). In most cases, the adults that come with the teams are teachers of English, Gymnastic, History, and other fields which have nothing to do with robotics.
- Primary and Secondary teachers insist this event should continue in an annual basis, which the organization is considering very seriously. The teachers also see this event as an opportunity to learn a little bit more about robotics and to improve their know-how.
- In the end everyone leaves the event physically tired but with lots of good memories, souvenirs, but especially with a robot built by them selves.
- The participants also had the opportunity to show their robots working properly on the optional com petition on the end of the event, in three different leagues. A large number of public was present to fully and strongly supporting the participants.
- The youngster's motivation to participate on RoboParty is extremely high because they learn at their own rate, they learn many different fields, they learn technology, with easy lessons, without stress, with time to relax, and they have the chance to meet new friends and practice new sports and entertaining activities.
- All robots leave the event working properly, no break downs.
- They can continue using the robot and upgrade it at home or at school, and they can also participate on national and international robotics events.
- Some school teams used this robot to participate on the Portuguese national competition and they got places in the medals and even participated on RoboCup with the kit.

8. Acknowledgements

The author would like to thank the team from SAR – Soluções de Automação e Robótica who put all efforts in developing this project. Without the University of Minho help and especially all the staff from the sports hall, nothing would be possible to organize.

All the organising committee and volunteers deserve the recognition of their work.

A special thank you to Agostinho Gil Lopes, Teresa Moreira and Angela Carvalho whom besides being volunteers they took care of the event survey.

9. References

[1] Group of Automation and Robotics, http://www.robotica.dei.uminho.pt
[2] University of Minho, http://www.uminho.pt
[3] RoboCup Federation, http://www.robocup.org
[4] RoboParty, http://www.roboparty.org
[5] SAR – Soluções de Automação e Robótica, http://www.sarobotica.pt
[6] Robot Bot'n Roll ONE, http://www.botnroll.com