Summer on Campus - Learning Robotics with fun

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Abstract. *After the academic year, summer comes and students spend some time at home without anything to do. It is time to rest but summer is long. In order to prepare youngsters for the future, the University of Minho organizes short courses (one week long) called "Summer on Campus", on which students can work on the university laboratories, feeling the excitement of working in such places, tutored by a Professor, in small groups of 10-20 people. On these courses, they spent the mornings on the labs and the afternoons on cultural or sportive activities. They meet new friends, they learn new things and they have some fun at a University.*
One of those courses is called "Robotics for Juniors – come and build your own" and teaches how to build a robot.
In this course the students are first introduced to the most basic electronics components, then they are taught the basics for programming. They are given a robotic Kit Bot'n Roll which they have to assemble, soldering the electronic components, program it and they participate on small contests with the robots. The experience is well appreciated by all. This paper described this robotics course in detail and the results obtained.

Keywords. Mobile and Autonomous Robotics, Events, Learning experience, Science, Youngster, Hands-on, Science

1. Introduction

It is important to keep the youngsters active and busy during their spare time, like the summer holidays. Even though they also deserve some rest from the academic year, the 3 months holiday is a long lasting resource in time, which they can use to enrich their knowledge. Apart from keeping them busy, they learn and enjoy themselves, when well orientated for science crash courses.
There are many events on which they can participate in many universities, so that they start discovering what a university is and also how it works in general.
There are many options on which they can spend their time and one of them is to learn how to build mobile autonomous robots.
Nowadays, Robotics field is seen as a field of the future. Youngsters like robotics because they see it as a very futuristic area and also because they can see it has a bright future. It is a very appealing area of science and they enjoy building robotics since they can apply and test some of their knowledge and skills.
Building a mobile robot is a multidisciplinary hands-on project which at early stages can enrich their skills and allow them to feel and experience the difficulties of a real challenge.
With a robotics project, students acquire knowledge in various areas such as electronics, programming, communications, mechanics, etc., Above all they can experience many things like working in group, developing a real physical prototype built by themselves, and having the possibility of participating in robotics competitions with other teams and getting the possibility of comparing their work and discussing it with other people. Above all, this is easily become in the end, a rewarding learning experience.
This paper describes the original experience of learning how to build a mobile autonomous robot in a week crash course.

2. Motivation

It is very simple for a youngster to start a robotics project. In fact it is easier for a student rather than for a teacher. They see many videos on the web of robots carrying out some tasks and they get so involved that they do not realise the complexity of those projects. To convince a teacher is much more difficult, since they are aware of the difficulties and of the multidisciplinary areas involved.
There are many robotics competitions on which they can start participating and some of them are described by Fernando Ribeiro on [1].

A. Fernando Ribeiro & Gil Lopes (2010). Summer on Campus - Learning Robotics with fun M. Kalogiannakis, D. Stavrou & P. Michaelidis (Eds.) *Proceedings of the 7th International Conference on Hands-on Science.* 25-31 July 2010, Rethymno-Crete, pp. 451 - 459 **http://www.clab.edc.uoc.gr/HSci2010**

This paper describes the basic competitions and respective requirements.
There are also many books which they can read but the hands-on experiences are much more rewarding than just the reading. There are also some robotics events which are not competitive but just tutorials for a robot build up, like RoboParty [2] held at University of Minho [3] in Portugal, described by Fernando Ribeiro on [4].
The budget is becoming less a problem since the actual robotic kits are becoming extremely cheap and also simple to build.
Also, even though there are many robotics events for youngsters, they need some support from an adult and therefore we should encourage, motivate and accompany them. The expenses will be very much rewarding in the future when we realise how much the youngster knows about robotics.
It is also important to point out that participating in competitions dignifies not just the team but above all the school which they belong too. When a team has the robot built, they can participate in competitions and the name of the school will be used.

3. The week Robotics Crash course

Following the experience of organizing the RoboParty (www.roboparty.org) and since many students decided to participate on summer activities at University of Minho, it was decided to create a crash course on robotics during the summer holidays. This is held in July, it is called "Summer on Campus – Learn how top build a robot" and lasts one complete week. The students spend the mornings on the robotics laboratory and the afternoons on leisure/cultural activities on the cities of Guimarães and Braga (where the two university campus re are located).

3.1 Advantages

This way, the students can enjoy a campus experience, can discover how a research centre laboratory works, they learn how to do research and how to work in group, they learn how to build a robot with hands on, learn how to assemble a robotic kit and how to program it and above all with lots of fun and accompanied by adults which can guide them on the learning side and on the leisure side.
Another major advantage is that the students come to this activity to learn and not to compete. While in a robotics event the students have to build the robot in school or at home and bring the already built robot to the event, in this case they do not have the stress of the competition itself. They learn how to build a robot in a relaxed environment, with people guiding them all the time, without any kind of stress.

3.2 Modus operandi

This crash course is carried out with only 20 students maximum, in 5 groups of 4 students each. These students don't know each other and this is a good experience to meet new people and to learn how to work in group.

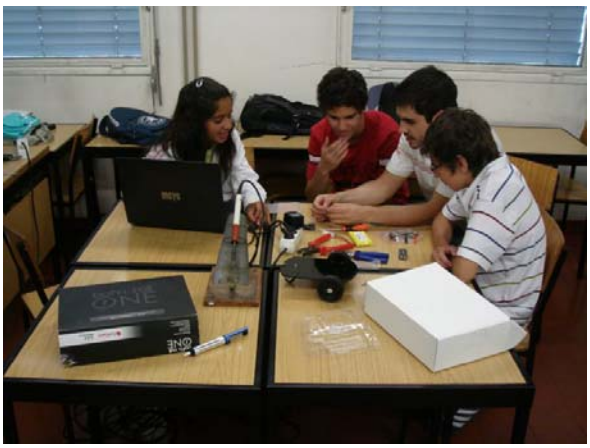

Figure 1. Each group has four participants

Each group is guided by a robotics experienced tutor, normally an industrial electronics university student belonging to the robotics group and with practical experience. This guaranties the participants proper guidance, even though academic staff is present at all time.

Figure 2. One Tutor on each group

To each group is given a robotic kit called Bot'n Roll [5], developed by the University of Minho and the SAR – Soluções de Automação e Robotica [6], which is a spin-off company of the university of Minho. This kit comes with all the mechanical and electronic components, with a manual and software for its programming, and a DVD with instructions how to assemble and program the robot.

Figure 4. Bot'n Roll

There are other robotic kits [7] [8] [9] [10] [11] [12] [13] [14], but Bot'n Roll was the preferred one.

Figure 1. LEGO robot - RCX controller

Figure 5 LEGO robot - NXT controller

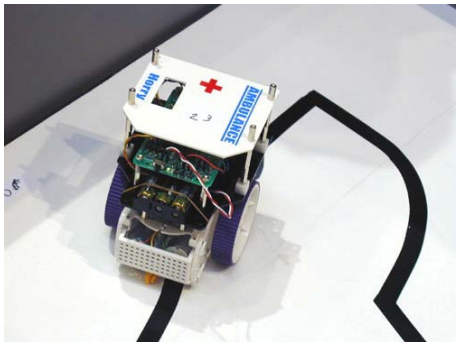

Figure 6. Soccer robot 915 from ELEKIT

3.3 Learning Robotics

The course is lectured by two academic staff and 4 industrial electronics students to guide them during the build up, programming and competitions tasks. The students are never left alone so that whenever they have any doubts they are immediately assisted.

On the first day the students are taught about robotics history, their practical applications and the Bot'n Roll kit is introduced. Then they have to solder the electronic components on the main board and assemble the mechanical parts. On the third day they learn how to program the robot and on the fourth day they start some indoor competitions and on the last day they complete the competitions and have a time to ask some more complex or they can ask for help on some other projects they might be developing in school or at home.

Since youngsters from 11 years old participate on this activity, the lectures have to be very

accessible to every one. Therefore, lectures were specially prepared for people who do not know anything about robotics and even their knowledge on programming or electronics is very reduced.
As an example, cartoons are used to teach robotics programming, and some other simple techniques are used to teach electronics, for example the similarities between electricity and water were used to teach what each electronic component is used for.

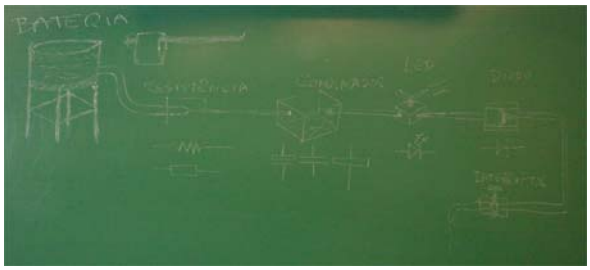

Figure 7. Electronic components explained

The electronic switch is compared to a water tap, the resister is compared to a thinner pipe, a battery compared to a water reservoir, a capacitor to a bi-level water container, etc… This way the students get an idea of how things work.
After teaching them the basic principles of electronic soldering, they have to solder the supplied robot components on the main board of the robot and some tutors guide them during this process. They take one morning to complete the board but they get good hands-on experience on soldering.
The mechanical assembling of motors and wheel on the main chassis is also carried out but them but always guided by the tutors.
The next step is to teach them the basic programming commands. Since the robot brain of the Bot'n Roll is the PICAXE, the programming language used is BASIC. First the students learn the concept of the main programming instructions like cycles, conditions, reading, writing, mathematical operations, etc… Animated cartoons are used to explain that clearly. Only then, they are taught the respective commands in BASIC language.
At first, some examples are given to them so that they can edit existing code, as first task, but soon they want to create their own programs.

In order to write code, we ask the students to make the robot to perform some pre-known tasks, like avoiding obstacles, following a certain target, running as fast as possible, etc.
They have some time to write those commands and afterwards, they can download the code created to the robots and then they can test in practice what the robots really do.
This practical testing is the part they like the most because that is when they start understanding the meaning of each command. They have to fix the code according to the behaviour of the robot.
In the last day, a few challenging tasks are given to the participants such as:
a) Proximity challenge – where the robot has to be programmed to go as close as possible to a wall but without touching (otherwise it is out). In this task the participants have to calibrate properly the infra-red sensors.

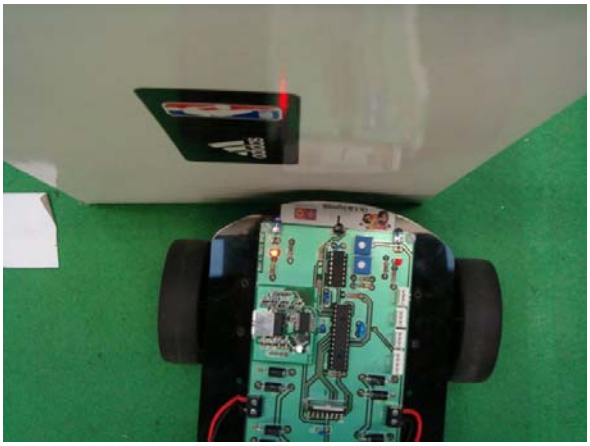

Figure 8. Proximity challenge

b) Race with obstacles avoidance - all the robots are placed on the track at the same time. Each robot is supposed to reach the arrival line in first place overcoming all the other robots. The track is a few meters long and it has bends and obstacles. The other robots also work as obstacles, which make the task even more complex.

Figure9. Race challenge

This is one of the most expected challenges by all participants.

c) Maze – this is a very simple maze which the robots have to come out. They need to use the infra-red sensors and to overcome a few obstacles to make the task more difficult. In order to avoid that the participants pre program the robots, some toothpick are placed on the track as well as some straws. This makes the traction more complex and the software cannot be pre-programmed.

Figure 10. Final Maze

After the challenging tasks, the participants are taken to the robotics laboratory [15] and the academic staff makes a demo of all the robots built. The participants like very much this demo because they can see real and large robots carrying out some real tasks.

Figure 11. Participation certificates and awards handed in

Also, in that appealing environment, the participants receive the participation diplomas, an award from their results on the competitions they just participated on and a souvenir from the robotics lab.

4. Building the Bot'n Roll robot

Each team is given a Bot'n Roll robotic Kit, which comes with all the electronic components, mechanical parts, batteries and charger, a DVD with software, drivers and a video of a robot build assembled.

Figure 12. RoboParty Box

The required tools are supplied by the robotics group, like screw drivers, soldering guns, etc.

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

4.1. 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.

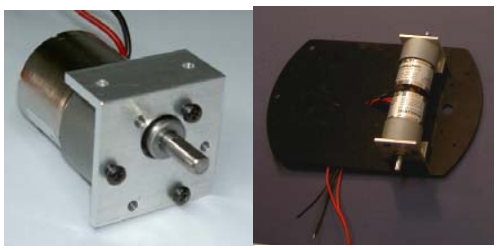

Figure 13. L shape Motor support (left) and robot base with two motors on (right)

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

Figure 14. Robot Wheel

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

Figure 15. Caster wheel

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

4.2. 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.

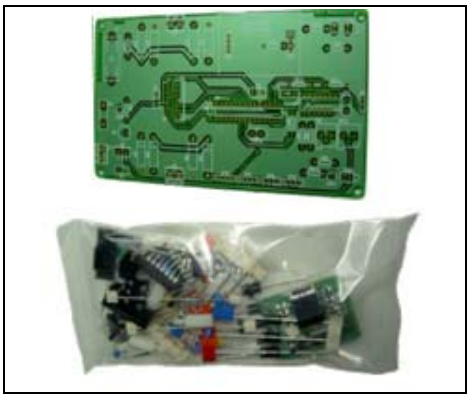

Figure 16. Electronic board (top) and electronic components (bottom)

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.

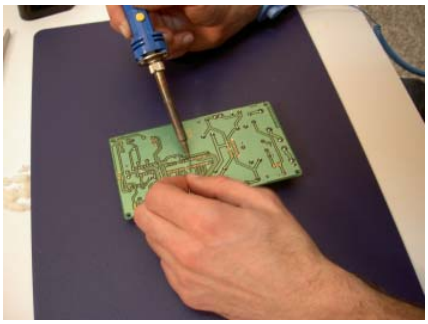

Figure 17. Soldering task

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.

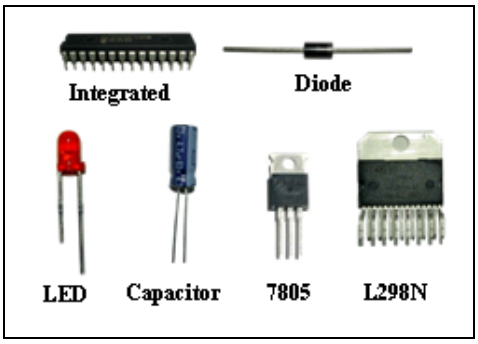

Figure 18. Major components

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

Figure 19. 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 20. 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.

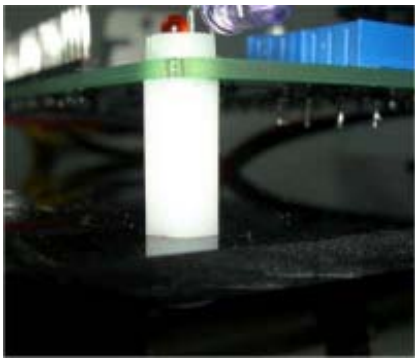

Figure 21. Board supports

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 22. 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.

4.3. 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 DVD 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 cartoons 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 can share their experiences and suggestions within the group making the learning process much easier and fast.

As bottom line the participants learn and build robots, learn many areas of knowledge, met new people, get souvenirs, met the facilities at the University of Minho (including cultural and sport facilities), and take a robot home with them. Some of these robotic platforms are used in national and international robotic competitions (like RoboCup and Robótica) which means that the students continued developing the robots and improving the software to their needs.

5. Conclusions

It is important for young students to start working with science and robotics due to its multidisciplinary. Areas like mechanics, computer science and electronics are the most essential to build a robot and they are necessary to any technological challenge.

Mobile robotic competitions are important because students get very much involved on the subject, they work in group, they compare their work with other teams, etc. A competition is a good work form as it provides students a specific and stimulation goal. The projects are fun and stimulating so that the motivation and desire to make an effort in the course is high.

The main advantages in short term are that they participate in educational projects, students get more motivated to continue learning and they get competences in different scientific areas.

In long term, probably more students decide to continue their studies (at University level), there will be more chances of blossoming technological companies, new technological solutions in civil areas, etc.

Participation on this kind of events is relevant not only for students but also for teachers. It is also important to point out that motivated students are easier to teach.

This activity is already on its second edition.

Acknowledgements

The authors would like to thank everyone in the Robotics Laboratory at University of Minho for all the support given in the organization of many events. A special thanks for all the staff at the SAR – Soluções de Automação e Robótica.

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

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