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EDUCATIONAL HUMANOID ROBOT USING A SENSORING FUSION THROUGH ARDUINO

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This paper describes the use of NAO robot, a humanoid robot and the use of Arduino in education for final engineering projects in the area of engineering. This learning approach was implemented in the final project of the Biomedical Engineering degree. The objective this project is the sensorial extension of the NAO platform, integrating a set of sensors that allow not only to analyze multiple vital parameters in a passive way but also to obtain a more precise contextual information.

Keywords: NAO robot, Arduino, Humanoid robots, Education, Sensory Fusion

1. Introduction

Over the years robotics has made great progress and nowadays robots begin to be part of the life of any person, designated social robotics [1]. For this reason, robotics has become a common subject in engineering courses, such as biomedical, computer, electrical, mechanical and electromechanical. Humanoid robots are fascinating and have several advantages, such as they can work in places where there is a risk of contamination, risk of health, danger of life, places

that are difficult to access [2]. They also are able to access different types of terrain and to climb stairs [3].

The behavior of humanoid robots produces feelings that facilitate the communication between machine and man. There are many cases where you need a machine similar to the man to be able to replace it in your work environment [4].

Robotics courses embrace diverse areas such as, kinematics, programming, sensors, and artificial intelligence. However, in recent years, social robotic has seen the emergence of sophisticated humanoid robots, which makes it impossible to obtain funding for the latest and most developed robots on the market. For this, the use of the NAO robot was chosen.

NAO that is currently the humanoid platform with high sensory capacity that it has lower costs in the market. This robot is similar to the human in order to have a more real and natural interaction with society. NAO is a good platform for software development because it is easy to learn how to program and it has a high sensory ability.

Students during the degree acquired a lot of knowledge in electronics, which makes it easier to use different sensors and their integration into Arduino. Students also learned different programming language, such as C language, C ++ language, MATLAB, LabView, among others, which makes it easier for students to program the NAO robot. However, students will work in a more motivated, fast and effective way because they will be working with a humanoid robot, capable of walking, communicating with people, and being able to be programmed by the students to do any task like a human. Students will not only learn theoretically and with a simple robot, but with a humanoid robot currently used in research in the field of robotics.

NAO robot is only a tool in which educational theory can be applied and developed, learned during the course that will make all the difference in the development of the project using the robot.

This paper analyzes the educational approach adopted for the final project of Biomedical Engineering course. This paper is organized as follows. Section 2 shows objectives of this project and the work plan during 9 months. Section 3 presents NAO robot has a humanoid robot that will be used in this project and it different applications. Section 4 will be described the different programming tool that it is useful in this project. Finally, section 5 presents the evaluation of the course.

2. NAO robot and a sensorial fusion

The content of the curricular unit of the final project, of the Biomedical Engineering Degree of the Engineering Institute of Coimbra (ISEC), is organized according to the area of interest of the students, and what is currently being developed in the world of scientific investigation.

The objective of this project is the sensorial extension of the NAO platform, integrating a set of sensors that allow not only to analyze multiple vital parameters in a passive way but also to obtain a more precise contextual information, thus accomplishing the fusion of all this information.

The project is aimed at a group of 3 students, so that they can interact. The project is multidisciplinary, which may include students interested in the area of programming and electronics which makes it possible to complement during this project.

The final course project lasts 9 months. The work plan will be divided as follows:

- Familiarization with the NAO platform and first tests with the hardware (1 month);
- Acquisition and development of sensors for passive monitoring of vital signs (e.g., heart rate, body temperature) (2 months);
- Acquisition and development of sensors to monitor contextual quantities (e.g., surrounding temperature, humidity, among others) (2 months);
- Sensory integration (e.g., using Bayesian networks) (2 months);
- Tests, tests and possible system improvements (1 month);
- Writing of the project work report (1 month).

3. NAO robot – a humanoid robot

In recent years, social robotic has seen the emergence of sophisticated humanoid robots, as Honda, Asimo and NAO [5]. NAO robot (figure1) is currently the humanoid platform with high sensory capacity that it has lower costs in the market. This robot is similar to the human in order to have a more real and natural interaction with society.

NAO is a good platform for software development because it is easy to learn how to program and it has a high sensory ability. It has been used in different applications, such as: sports and interaction with humans [6].

It can help people in rehabilitation. By cameras robot can see the movement of patients and avoid them if the movement are correct or no [7]. NAO is able to replicate the movement of humans, so it can explain to patient how to the correct

movement [8, 9]. NAO robot has been used to help autistic children in improving their behavior [10, 11]. The studied cases show that children suppress the autistic behavior during human-robot interaction and they can maintain visual contact with NAO [12]. NAO robot participate in RoboCup (the World Championship of Robotics) as a soccer playing NAO robot. It has been the star of the Standard Platform League where robots are expected to operate fully autonomously [13, 14].

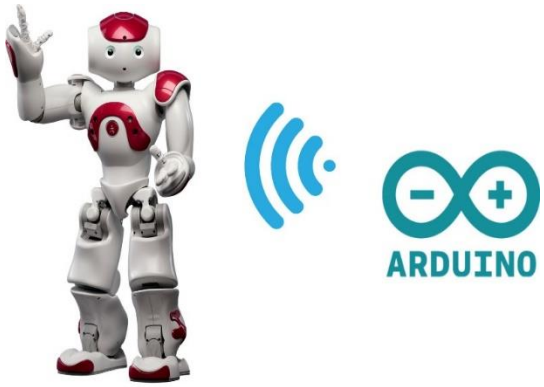

Figure 1- NAO robot

It is important for students to understand that this robot is a tool of great interaction potential with humans. This robot is able to walk, speak and act as a human if it is programmed. At the end of the project students should be able to develop various programs for the robot in order to perform different tasks with humans.

The main objectives of the final course project are based on a deep understanding of the fundamental principles of the use and programming of humanoid robots. Another objective is to develop students' practical and autonomous sense, in which the teacher will simply have the purpose of guiding only the students. The work carried out by the students promotes different autonomous and team research, leading to greater learning, as the students devote more time and have greater involvement in it.

4. Programming Tools

The university has an NAO robot that is available in the laboratory so that the students can do experiments and get to know the robot better, in order to implement the project more efficiently.

The program used to program the robot NAO is called Choregraphe. The figure 2 shows the virtual robot and the graphical environment of the software simulator, a software very intuitive and identical to the real system. This simulator allows the students to develop all the work in the place that they want without the use of the robot, not having to be constantly in the laboratory of robotics.

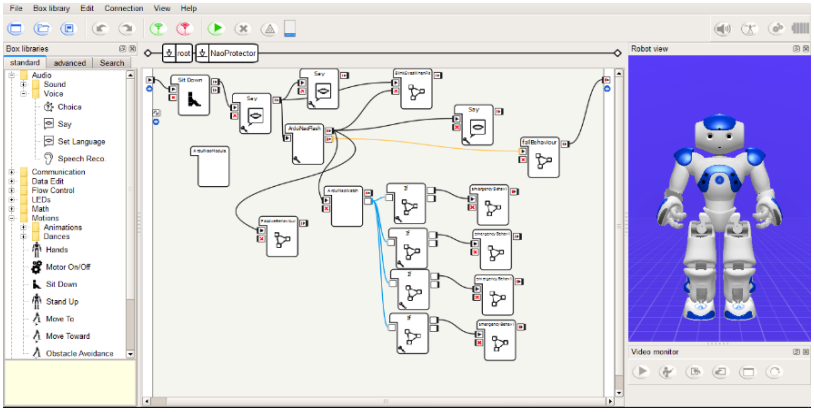

Figure 2- Choreographe program

Arduino, Wireless Proto Shield and several sensors, such as a light sensor, a temp sensor and a gas sensor are available to students. If students need other materials or other types of sensors, it will be made available to them. Students will not have difficulty in using / programming the Arduino, since they already have some notions of programming seized during the course. The programming language used in Arduino is C ++ (with small modifications), which is a very traditional and familiar language. In the internet there are different forums in which are made available several programs and libraries already made for Arduino in which students will have easy access and quick learning in the use of it. With the use of Coreographe and Arduino programming students will see that programming is simple and they will be more motivated because they get faster results. Despite this, students find it simpler, more intuitive and more interactive the programming in the Choreographe.

The sensors are integrated into the Arduino, it is receiving the values of the sensors continuously, it reads and analyzes the values that the sensors transmit and sends an alert to the robot via Wifi, if it justifies, and if there is in the presence of a situation of danger. The robot must find people to communicate the programmed alert.

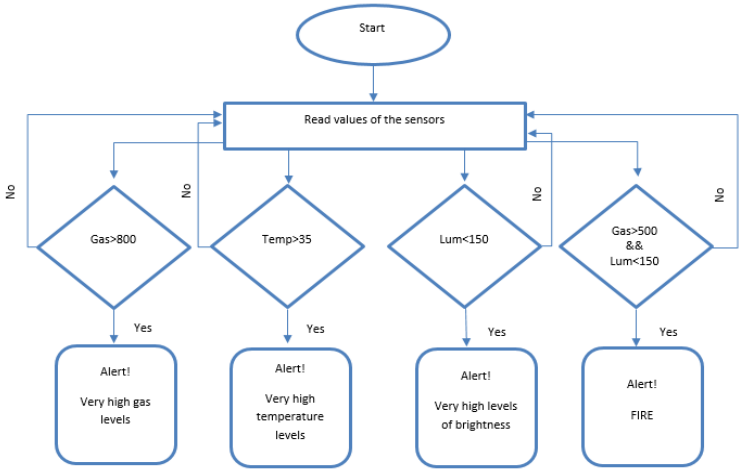

Figure 3- Flowchart of Operation

The figure 3 shows a flowchart, that is, a diagram of how the sensors work and how they are programmed to issue the alert. The robot must find people to communicate the programmed alert. For example, if the temperature sensor measures more than 35 ° C, the robot is programmed to raise an alert because the temperature level is too high.

5. Course Evaluation

Students have all the help of the guiding teacher, meeting with the same every week. These meetings have the purpose of the students to show weekly the work developed, to ask questions, and so that the teacher can guide them in the best way. Students will be able to attend the robotics lab whenever they request and put questions with the teacher outside the meetings, through the email. Students are required to take at least 15 hours per week to make the project robust and recognized by the scientific community.

The final year project is projected with 14 ECTS (European System of Transfer and Accumulation of Credits). It is through the evaluation of the results of the final project that one can recognize the benefits of the humanoid robotics approach and all the content taught during the course. Through evaluation, the teacher should be able to evaluate the student's attitudes regarding the ability to investigate, develop and implement each proposed task during the development of the project autonomously.

There are different approaches to evaluating students' learning outcomes, using the following methods:

- Project report, where the student report includes the written designation of the state of the art, the work done, the conclusions and the future work;
- Writing an article at a conference about the project developed;
- Oral presentation, where a jury composed of 5 teachers will be present.

This oral presentation is divided in two phases, the first phase: the students present the project developed through a Power Point presentation and present the development prototype, with a duration of 20 min; the second phase: the different members of the jury ask the students several questions about the project developed and what they think is operative in relation to the humanoid robots. The members of the jury are composed of the teacher of the students, a professor from another university who is related to the area and by three other teachers, one from the electronic area, another from the programming area and another from the robotics area. The final course project offers students an opportunity to interact with humanoid robots, thus allowing them a greater motivational dimension. Students demonstrated that using this type of robot learned faster and more efficiently the knowledge acquired during the course and that are able to integrate new technologies. Students demonstrated that this is a developing area and of interest in the area to continue in the master's degree.

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