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PREPARE A BIOLOID HUMANOID ROBOT TO COMPLETE THE TASKS OF THE CEABOT COMPETITION

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Abstract—In the present article are described the proceeds of how the BIOLOID PREMIUM humanoid robot is prepared and adjusted to complete the tasks of the CEABOT competition. The different tasks of this competition are: obstacles avoiding, walking up and down stairs, fighting in combats between two adversaries and artificial vision with reading code QR for positioning. Setting the different functionalities for the accomplishment of the tasks, the robot is able to interact with the environment of autonomous form. Using several coordinated devices a major autonomy is obtained and the performance is improved, reducing the time of reaction.

Keywords— artificial vision, CEABOT, humanoid, Raspberry, robotics, robotics competition, QR codes

I. INTRODUCTION

People who have worked with humanoid robots will agree that one of the most laborious tasks is programming the robot movements. They can basically be classified into two types: movements that are produced by a mathematical equation previously studied, developed and programmed and movements that are produced by the temporal interpolation of a series of positions previously stored [1].

This article focuses on the second type of movements, which are used in the humanoids robots to produce movements required in the competition. Such actions are normally executed in open loop, i.e. without the need to correct in all moment the trajectories of arms and legs. A classic technique for programming these movements is to decompose them in intermediate positions, which are obtained by the programmer and subsequently tested by a temporal interpolation.

Movement present in humanoid robots is similar to the human movement and they have capabilities with great potential for exploitation. In this article is presented an example of the importance that a vision system has to increase the autonomy in a robot and to interact with the environment and also shows the possibility of improving the control of the process, because much more information are gotten via processing images.

II. OBJECTIVES

The main objective is the preparation of the BIOLOID robot for the tasks of the CEABOT competition. The competition shows the skills that each humanoid robot possesses through the development of several tasks that will be carried out separately. Below are described the main objectives of the tasks:

A. Obstacles avoiding

The robots will go from one end of the field to the other, and turned to the beginning point, walking forward. The robot will have to avoid the obstacles, without throwing them nor displacing of his position. The robots will go out from the central zone, placed in the Zone of Exit, must come to the Zone of Partial Arrival. Once there, the robot will have to go back autonomously, since passing completely the line of the Zone of Partial Arrival. To increase the score it will be considered the elapsed time, the distance, and the number of penalties.

B. Walking up and down stairs

To pass this task, the robots will have to reach the indicated zone, going up three steps and going down another three steps. This task will be punctuated depending on the number of steps overcome and the time used for it.

C. Fighting

In this task, two robots of two different teams fight inside the Combat Area according to the established procedure. In addition, the competitive behavior of the robot is valued, there being able to be penalized passive and immobile attitudes.

D. Decoding information with Artificial Vision system

The goal of this task is that teams can demonstrate the skills and abilities programmed on the humanoid robot using a camera. The score will reflect the greater difficulty of the first case. The robot will start the task from the center of the field, facing the first marker, which contains a QR code. When the robot is in front of it, it must decode it and interpret it to get to the next one.

The robots use additional devices to be able to control the integrated vision system, so it is necessary to achieve coordination between the devices used to perform in the task.

III. EXPERIMENTAL METHODOLOGY

The Type A Bioloid humanoid is a low cost commercial robot kit. It measures 397 mm of height and its weight is 1.7 kg. It’s independently powered by a Li-Po battery type of 11.1 V and 1000 mAh.

Also, it's integrated with a central control module CM-530 capable of controlling the actuators Dynamixel AX-12, the infrared sensor DMS, the gyro sensor of 2 axis and other sensors adapted for optimum performance, such as infrared sensors for hands and feet, a compass for its orientation and an ultrasonic sensor on the head. This robot has 19 digital servomotors to emulate the articulated movements of the human body general structure [2].

The programming of this robot is carried out through its own program called RoboPlus. This program has multiple windows, such as the RoboPlus Motion window, where articulated movements of the whole body of this are programmed and another window called RoboPlus Task, which is programmed with its own language and very visual with basic structures the execution of movements above programmed, too the control conditions programmed using sensors [3].

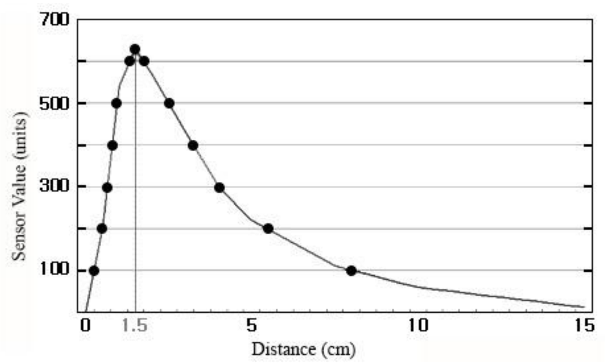

Fig. 1. Relation between distance and IR sensor value

The figure 1 representing a rough estimate of the IR sensor value’s changes from the white object’s distance. The sensor’s value is subject to change depending on the object’s color and surrounding environment.

The IR sensor is divided into a receiver and transmitter. When an object is too close, the angle where the reflected infrared light comes is not even making it difficult to know the area which the sensor value decreases. Also, it can barely detect object further than 15cm [2].

To perform management vision system has been used Raspberry, as it is necessary to use a device that lets it store and analyze images obtained by the camera. We opted for this device for ease of integration and low consumption. Between the supported operating systems, has been chosen Raspbian (operating system based on Debian, optimized for Raspberry), since it makes possible the required functionality. They have made the necessary settings to use scripts developed using C++ and Python.

We used a camera with conection CSI (Camera Serial Interface) compatible with Raspberry. This type of cameras use a 15-pin flat cable and the transmission rate is higher than that obtained using USB communication. This is possible to get better performance, achieving further optimization.

QR codes are useful elements currently, any of their capacities are increased data storage (a certain quantity of information encapsulated in a small area) or the added security encryption (used in stenography and processes encryption information) [4].

The humanoid robot has the capacity to move around the environment and detect some elements, avoiding collisions. The Raspberry, meanwhile, has the ability to use the camera, get information and analyze. Cooperative methods provide improved behavior of automated systems, as influencing other devices and better behavior or performance is achieved in different situations and/or conditions [5].

Serial communication is very important and represent a fundamental role in the development of applications related to microcontrollers [6]. To control communication is typically used the master-slave method, which acts as a master device requesting information. On the other hand, other devices, which are known as slaves, are available to the master to respond by offering an adequate response to requests received [7].

IV. RESULTS AND DISCUSSION

Different sensors are required with customized settings to participate in the competition’s tasks.

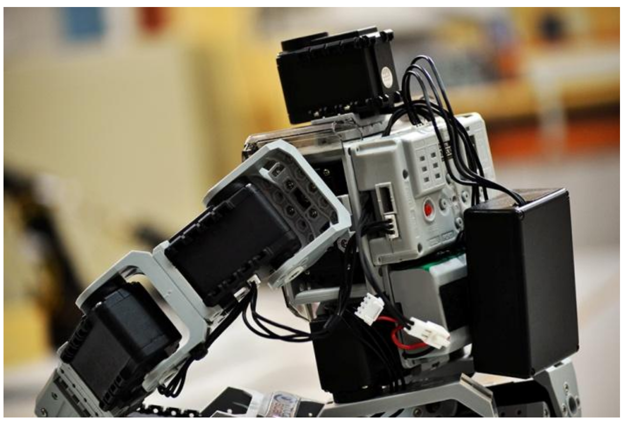

Fig. 2. Compass located in the robot’s backside

A compass has been used in the tasks. It adds an important ability to control the robot’s direction and it allows increase accuracy of movements programmed with the software (Figure 2).

In the obstacles avoiding task, some distance IR sensors was arranged in the robot, specifically in his hands, chest and head (Figure 3). The sensor, located in the robot's head, was used at the same time that a motor in a linear movement.

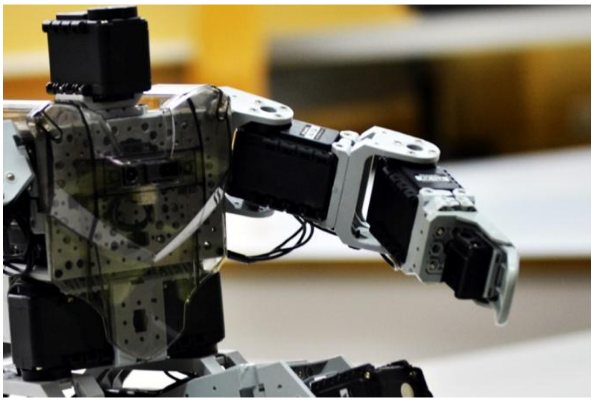

Fig. 3. Installed sensors in robot's arms and chest

The main objective in this task, where the robot interacts with environment, is obtain the best control about movement skills. A solution to prevent wrong distance's measures is very important in the optimal robot's behavior. With different sensors it is possible to obtain a correct control closed-loop between sensors and CPU.

In other task, the robot must go up and down the stairs. Four sensors was installed in a circuit which was connected over the robot's feet. Three sensors have oriented facing the ground to detect limits about bottom stair and the other sensor has oriented in forward direction to control the distance about next step (Figure 4).

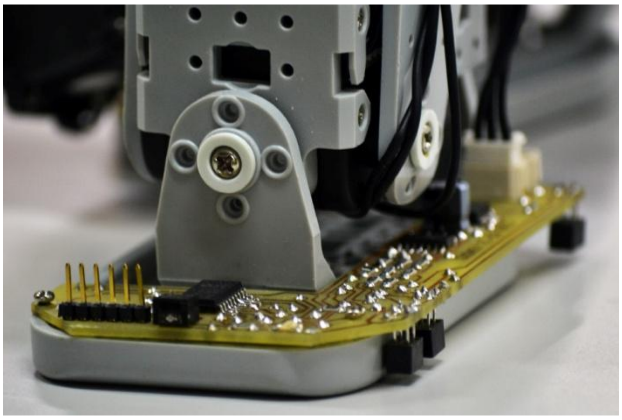

Fig. 4. Electronic circuit with installed sensors in the robot's foot

In the third task, robots fight. The robot are configured with a custom strategy using sensors to detect opponents around the environment. An important objective is that the robot has installed a minimal number of sensors to prevent possible problems and have an optimal performance during the combat.

The battery would be a problem in this task because the robot has different combats. Each combat consists of some assaults and each assault may continue for five minutes. It reflects the importance about low energy consumption with mobile devices.

Other important point about fight task is the robot's stability. Therefore some modifications have been carried out in the robot's feet. In other words, the objective is that the robot execute the routines with the best stability.

In the fourth competition's task the robot must detect and decode some QR codes located in a specific area. In this task is necessary a vision system therefore a Raspberry was interconnected with a USB camera. The Raspberry has been installed in the robot's chest with an independent battery (Figure 5).

The Raspberry decodes each QR codes, we can obtain the new direction which is sent to the robot with serial communication using a script. The robot's CPU CM-530 receives the message and it search the next QR code.

The main objective is obtain images and information about elements around the humanoid. Some proofs have been executed obtaining information about different QR codes, and we have extracted interesting data to send.

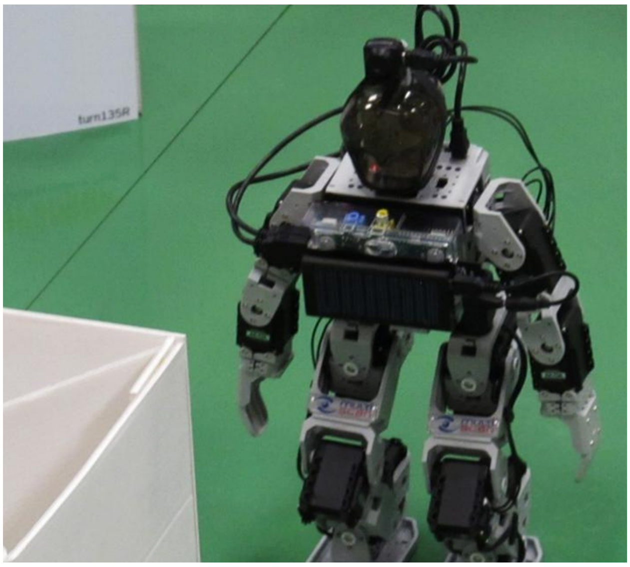

Fig. 5. Raspberry installed in the robot's chest with a battery

The next example shows an image obtained with Raspberry, this image was analyzed to retrieve the address, concretely direction and angle where other QR code is located:

Fig. 6. Obtaining an image with QR code to analyze

The Figure 6 shows an image created with low quality and small size because process time is important, and high quality images are not necessary to detect information in QR codes. Other basic step is the data identification which is stored codes within.

TABLE I
EXTRACTED DATA ABOUT QR CODE

Processed image	Obtained information
ImgQR.jpg	Turn45R

When data about QR code has been obtained, treatment that information is needed to send the next robot's movement. In the information we can retrieve the direction, L (Left) or R (Right), and the angle (We have obtained 45 degrees in the previously example). There are not a lot of combinations, and a code has been established to send for each instruction.

TABLE II
EXTRACTED DATA AND DEFINED CODES TO SEND

Obtained information	Code
Turn45R	1
Turn45L	2
Turn90R	3
Turn90L	4
Turn135R	5
Turn135L	6
Turn180R	7
Turn180L	8

V. CONCLUSION

In this document, some adaptations and specifications have been defined about different sensors, which we have realized the tasks in the CEABOT competition. Other objective is present a strategic perspective about movements and functionalities, which we have been defined in the robot's memory for the established tasks.

Vision systems are very important elements to obtain a complete and reliable information about environment. With this sensors the robot obtains more autonomy, because it manage more information about some important objects causing a different performance.

Some devices like Raspberry may act in recognition systems, with certain limitations complying with some requirements.

An encryption system is possible using QR codes. This system would provide a layer of information security and communication methods would be developed between robots [4]. The used devices could be controlled better.

When we use a communication method, like master-slave, the order is maintained in the sequence about requests and answers during tasks execution [7]. For example, in a first step the slave device is waiting to receive an answer about a previous request, when that device receives the request it executes a concrete movement.

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