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ROBOTIZED PROJECT CELL FOR PALLETISING

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Abstract: *In the globalized market, companies, in order to become more competitive, need to reduce their costs. One way to reduce costs is direct related to labor through the operation automation, mainly, those that do not aggregate value to the final product such as parts' handling.*
With the popularization of microcontrollers, the robotic unit construction became more economically viable. The construction of a robot involves the usage of related concepts with hardware, software and mechanical work, which need to be integrated through a microcontroller to coordinate the robot's peripheries. This paper developed a project and the assembly of a small robot controlled remotely, utilizing an Arduino platform, capable of completing manual tasks. Besides the multidisciplinary aspect, the project solidifies countless concepts of computer aided manufacturing.

Keywords: *Arduino, robotic, microcontroller, interdisciplinary, computer-aided manufacturing.*

1. INTRODUCTION

The project consists of constructing an articulated manipulator with 3 degrees of freedom and software that controls its movements, which processes within its terminal body a mechanical arm also articulated. Through a communication system, the software storages within its memory the details of the route that will be taken by the mechanical arm, when the software is running, the computer will send a signal activating motors that move the arm and the actuator at the extremity of it.

2. JUSTIFICATION

The purpose is to replace human beings in tasks that they wouldn't be able to perform because of their own physical limitations or by involving uncomfortable or extreme conditions. The utilization of the robotic arm contributes in many factors such as technical factors (flexibility in range of manufactured products, precision increment, power, speed, uniformity and support to hostile environment, increment of the increase in quality scores and rejected parts), economical factors (efficient usage of intensive production units to increase productivity , reduce manufacturing time of preparation), sociological factors (reduction of accidents number, removal of human beings from hazard places for health, reduction of working hours, increase in purchasing power).

3. HISTORY OF ROBOTICS

The precursor of the term robot (Groover, 1988) was Karel Capek, novelist and writer of a Czechoslovakian play, who used for the first time, in 1920, the word "robota" originating the word "robot". Several science fiction movies display robots developed with the behavioral and human shape, bringing several adolescents to research and develop their own robots into the real world. With the appearance of computers in the half century, speculations commenced to rise about the capacity of the robot to think and behave as a human being. Nonetheless, robots were, during this period, created specially to execute tasks that are difficult, dangerous or impossible for human beings to accomplish. On the other hand, robots are programmed with the capacity to create or execute procedures that are not taught or coded to perform. Therefore, the industry was the largest beneficiary with the development of robotics, increasing the production of products and diminishing difficult tasks, before they were done by humans.

In modern robotics, there are researches ad developments of robots entitled humanoids or anthropomorphic. These are created with similar human appearance and with the capacity to interact with the environment, such as Honda Motor

Co. building the Asimo. It is worth mentioning several articulated toys with features that resemble pets such as dogs, and that are purely meant for entertainment. However, such robots are incapable to perform any task, and only respond to external stimulus.

4. HARDWARE

4.1. The Arduino

Arduino is a physical computer platform composed by microcontrollers of single board and by a developing environment to code to the boards. It can be used to develop interactive objects, entering a variety of sensors and keys and controlling several lights, engines and other physical outputs. Both hardware and software are open source, which means the developing environment source code and the board schematics are available freely.

Physical computing: the computing area that treats the system construction that, through the usage of software and hardware, perceive the analog world and respond to it.

Single board microcontroller: a microcontroller used in a single printed circuit board, which contain all components and circuits necessary to the functioning of the first.

4.2. Robotic

It is possible to define robotic as the control of electrical mechanics through a computer, transforming itself into a machine capable to interact with the environment and execute tasks decided by software created by the programmer started by these interactions.

A way to exemplify the usage of robotics in known areas is in the engineer field, where robots dive deep into the ocean to aid petroleum platforms, in the medical field, robots already aid doctors in high-risk surgeries. Other applications can be less seen, such as the printers, which are also robots.

4.3. Mechanical Arm Anatomy

The arm consists of elements denominated links unifies by a relative movement joint, where the triggers to perform these individual movements are attached, gifted the sensorial capacity, and instructed by a control system. The arm is linked to one side of the base and to the handle on the other side. The handle consists of several joints next to each other that permit the conduction of the terminal body (hand or tool) intended to perform the required task.

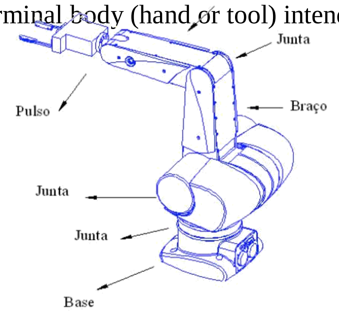


Figure 1. Joints and Links of the Mechanical Arm.

In any joint, the closest link to the base is titled input link. The output link is the one closest to the terminal body.

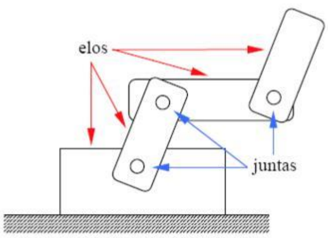


Figure 2. Full Robotic Arm Structure.

5. ROBOTIC FEATURES

One robot has some important features that shall be taken account when it is being specified as followed :

5.1. Joints and Terminal Body (Claw)

The joints used in our work are the rotational type, where it gyrates around a stationary imaginary line titled rotational axis. It gyrates as a swivel chair and open and close like a hinge.

In robotics, the terminal body is used to describe the hand or tool that is connected to the handle, such as a soldering gun, claws, ink pulverizing, and so on. The terminal body is responsible to perform the manipulation of objects in different shapes, forms and materials, yet this manipulation depends on the application to its destination.

The terminal bodies require care when projected, since it is necessary to control the power being applied on the object. Thereunto, certain terminal bodies are gifted with sensors that provide information about the objects.

5.2. Freedom Degree and Work Volume

The freedom degree (FD) determine the robotic arm movement in the two-dimensional space or three-dimensional. Each joint defines one or two freedom degrees, and, therefore, the number of the robot's freedom degrees is equal to the sum of the freedom degrees of all the joints. For instance, when the relative movement occurs in a single axis, the joint is equal to two freedom degrees. It can be observed that the more freedom degrees we have the more complicated the cinematic, the dynamic and the control manipulator are.

The work volume is a term that refers to the space that a determined arm can position its joint. This volume, in general, is established according to its imposed limitations imposed by the structural arm design, there is, the physical configuration of the robotic arm, the joint movement limits and the size of the body, arm and hinge.

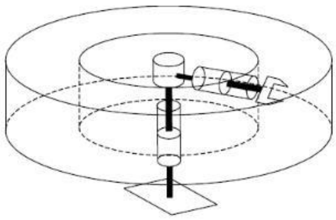


Figure 3. Work Volume.

The work volumes are measured in volumetric units, yet, it doesn't augment the selection of the arm for the determined application. The manufacturers of robotic manipulators provide the work volume in term of arm reach in one or more plans. The volumes, reach or work areas must be expresses without the presence of the terminal body, since it can significantly modify such values, depending on the application.

5.3. Robotic Arm Dynamic

The dynamic performance of the robotic arm is associated with the response speed, stability and precision. The response speed refers to the dexterity of the robotic arm to move from one position to another in a short period of time. The stability can be estimated based on the time required to dampen the oscillations occurring during the movement from one position to another. The precision is related to the speed and stability, since it is an error measurement of the terminal body starting position.

6. SOFTWARE

The software used for the robot programming was the C++ and the control is described as following :

6.1. Control System

The control system of any robot is performed by software and hardware. This software process input and output signals and converts these signals to an already programed action.

The software can be coded in a personal computer or in a microcontroller. In this aspect, it must be considered the weak and strong points of each possibility. The microcontroller reduces the project cost, is fast, and dedicates to only controlling the robot; however, possess limitations in relation to its size and software. On the other hand, the personal computer has a processing high rate and larger space for software allocation. Additionally, it is possible to implement a mixed solution, in which the lighter part (the software) stays in the microcontroller and the processing art is done by the computer

The hardware system can consist, for instance, of step motors, cables, input devices, sensors and power amplifiers.

O sistema de hardware pode constituir, por exemplo, de motores de passos, cabos, dispositivos de entrada, sensores e amplificadores de potência.

7. ARDUINO BOARD USED

Arduino Uno: this is the last revision of the Arduino USB baseplate. It connects itself to the computer with a standard USB cable and contains everything needed for coding. It can be extended to a variety of ‘Shields’ (customized boards with certain specific characteristics).

Figura 4. ArduinoBoardUNO.

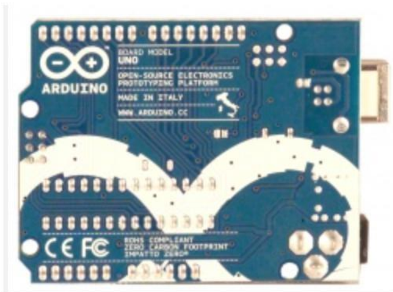


Figura 5. ArduinoBoardUNO.

8. METHODS AND MATERIALS

It was decided to begin the assembling of the prototype to kick start the kit model for the construction of small robotic manipulators. The chosen kit was the Robot Arm MeArm V0.4 Kit, chosen for already containing the components needed for the construction of a desired similar arm: acrylic material, servo motors, electronic components, et cetera.

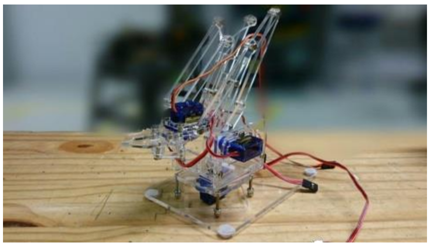
The project was divided in several parts, such as: mechanical, actuation, circuits, communication with the computer and the software control.

The prototype must perform small tasks such as gripping of small objects from one position to another, all of it through an automated system.

The robot is actuated by three servo motors, devices that integrate a motor CC, with a box of reduction gears.

Table 1. Materials used in the process of project assemble.

Items	Quantity
Robot (Mechanical Arm)	1
Servomotor	3
Protoboard	1
Potenciometer	4
Arduino Board	1
Jumper Cables	-
Knobs	4
Power Supply	1



9. RESULTS

The developed robotic manipulator arm satisfies the project’s initial goals: it has a compatible structure of rapid movement, which allows demonstrating the full functioning of an industrial manipulator robot; it is easy construable, allowing its mass production. It has open architecture: documented hardware and software to be used in the research of future manipulator arms, has available software for several platforms; and is low cost (less than R$300.00 or US$75.00).

10. CONCLUSION

About the robotic arm, it can be said that the structural part supports the ideal proposition desired in the beginning of the work, alongside software (interface) and the control system.

Each group member learned and developed crucial skills, such as: time management, task organization, commitment, deliver by the deadline and so forth.

Some difficulties were encountered by the group, for instance, during the assembling of the robotic arm some pieces were missing; the cables were short; finding an adequate object for the robotic arm to handle became a difficult assignment. Thereby, some adaptations had to be made; the battery was substituted by a power supply; the cables were switched and/or elongated; the group adapted a light object with certain adherence to be better handled, because the prototype was small and light.

Based on this, the mechanical arm project was concluded in time, but with certain improvements to be made, bettering and adding to other functions.

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