

Robotic hand prototype as a didactic model.

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Abstract - This work presents the development of a robotic hand prototype as a didactic model. The objective is to motivate students to carry out innovative tasks and to use robotics as a support for the improvement of knowledge.

The design was made in a 3D CAD modeling software, programs that allowed dimensioning the mechanical structure.

The electronic control was carried out through an ATMEGA 328P microcontroller, which makes it possible to read the status of the sensors, in this case flexo resistors, while generating the signals to control the servomotors responsible for the movement.

The final version was built with available materials, resulting in the prototype of the robotic hand as a didactic model.

It can be used as a motivational tool for learning microcontroller programming. A pilot test was conducted at the Technological University of Tlaxcala. We worked with 5 eighth semester students, together with the head teacher of the Integrator course.

The implementation was accompanied by several classroom plans and didactic aids, whose purpose consisted of the theoretical explanation of the concepts that were worked on and the application of these on the robotic hand. As well as a bit counting sequence.

It is important to note that, before implementing the didactic prototype in the classroom, the students acquired previous knowledge about electronic components and also about programming. In contrast; as for the teacher, in order to implement the prototype.

Consequently, the robotic hand executed a sequence of bits, programmed by the students, thus evidencing learning in the area of robotics.

Key Words: Robotics, didactic model, programming, microcontroller.

Introduction - This prototype will be used as didactic material to learn and to know about robotics. Emphasis is placed on previous knowledge such as programming. Subsequently, a didactic model will be used which is projective, that is, in order to carry out an idea applied by the students and investigated autonomously, with only the help of the teacher for its proper execution.

So in this work, it is proposed the develop of a robotic hand prototype. The design will be done in a 3D CAD software for the modeling of the parts, then exported to a 3D printing software, thus making accessible and interactive the contact of students with the programming of the robotic hand by means of an ATMEGA 328P microcontroller. In this way, it is expected to increase the educational motivation of skills and knowledge of the students of the Technological University of Tlaxcala in the area of technologies with different projects related to robotics.

Methodology

The robotic hand prototype as a didactic model is to teach in an interactive way and make students have motivation to acquire knowledge of the branches of automation, mathematics, analog components, to name a few, which is a support to get into new technologies, making didactic knowledge. As a didactic model, a programming of a binary counting, supported by the robotic hand, was made.

A. Didactic model and projective model

According to the objective of this study, which is to create the didactic model based on an automated hand, the research method used is Research, development and execution of this model.

[1]. The teaching model used for development in the projective model is research and learning, making the teaching model and the projective model hybrid.

This model employs a resource management strategy, the most appropriate teaching methods and the means to use and achieve the determined objectives.

Below is a Table.1 in which a teaching plan for the adequate learning of each of the topics can be observed.

The topics that are addressed is to be able to have a complete interaction with the components.

Guide	Subject	Objetive	Competence
1	Introduction to electronics.	Learn the handling and operation of the breadboard. Identify basic electronic components..	Recognize and identify basic concepts of electronics.
2	Introduction to micro-controllers	Identify the main characteristics of micro-controllers and their development environment.	Understand the programming interface of the board and its applications.
3	Digital inputs and outputs	Identify the digital inputs and outputs of the micro-controller board. Binary digital signals. Design schematic diagrams.	Identify PinMode functions.
4	Analog inputs and outputs	Identify the analog input and output pins on the microcontroller	Determine concept, operation and application.
5	Servomotor operation	Understand the operation of servomotors in the use of micro-controller.	Application of previous concepts for problem solving.

Table. 1 Structure of learning guides. Retrieved from: "ESPACIOS"

Topics such as Introduction to electronics, introduction to micro-controllers, analog and digital inputs and outputs, servomotors management are explained.

According to each objective and competences to be acquired with the applied thematic we can program in a correct way our prototype.

B. Hand model design

In order to properly generate a hand, we had to make a design, then the idea was taken to the modeling in a 3D CAD software, and then exported to a 3D printer, which printed each part of the hand Fig. , the physical structure that was printed with PAL material, the material is light and ergonomic.

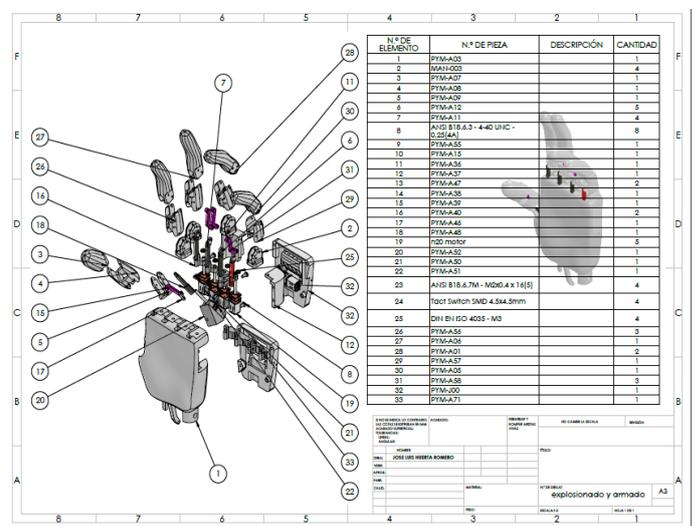


Fig. 1 Hand structure. Source: own.

As shown in Fig. 1, we can observe each of the parts modeled for the hand, ensuring the development and functioning of the hand.

C. Program design for sequence execution

So that the hand to perform movements, the hand was assembled with different components that would help its mobility making it an automated hand.

The components that were used were servomotors that help to control the position in an exact way, by position (0° to 180°).

Jumper cables (male / male) that are necessary for the connection that was made from the ATMEGA 328P board to our PROTOBOARD.

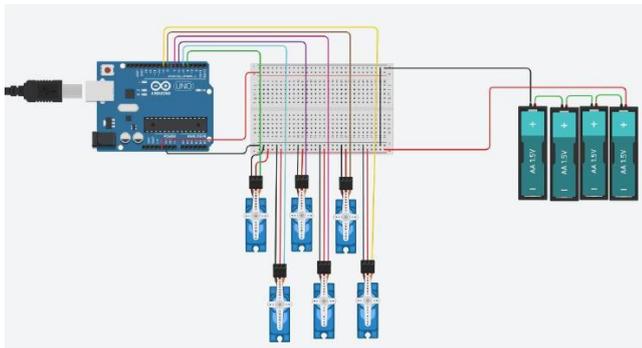


Fig. 2 Connection of electrical components to boards.
Source: own.

It can be seen in Fig. 2, each of the components was connected to both the PROTOBOARD and the ATMEGA 328P microcontroller, each of the servomotors used to move the fingers of the hand.

In an open source electronics creation program, which is based on free, flexible and easy to manipulate hardware and software, the programming was carried out and exported to the ATMEGA 328P microcontroller.

The programming was carried out for the execution of tests, in order to check the operation of the robotic hand prototype.

Results

The prototype of the robotic hand was made during a four-month period in the CAD 3D software, where the mechanical structure could be dimensioned. After that time, it was agreed that the prototype could work with servomotors that would give them mobility making it an automated hand. The servomotors were placed in the front of the hand, along with wires that were attached to each servomotor and at each end of the fingers, which provides the mechanical tension necessary for the movement of the structure.

A programming with a binary count was made using 4 bits as a didactic model that involves teaching with the hand that is why this simulation was made to be attractive to students. When performing the practices a test was made with a stopwatch and it was found that the prototype did not meet the established movement times and affected the flexibility of the fingers, Although the prototype is made of a light material (PAL) that is used for 3D printing, it was heavy for the return of the fingers to their initial position due to the type of material when tightening the elastic thread of each finger.

ROBOTIC FINGERS	PROGRAMMING TIME	ROBOTIC HAND TIME
Pinky	2 seconds	2.5 seconds
Ring	2 seconds	2.4 seconds
Middle	2 seconds	2.6 seconds
Index	2 seconds	2.3 seconds
Thumb	0 seconds	0 seconds

Table. 2 Times it takes in programming and physics of the robotic hand. Source: own.

The table 2, shows the operating times of each of the fingers, with the middle finger being the most difficult to open for the counting operation and in most cases remaining in the initial position (closed).

Conclusion

This work presented the development of a robotic hand prototype as a didactic model. The objective was to motivate students to carry out innovative tasks and to use robotics as a support for knowledge improvement. The implementation was accompanied by several classroom plans and didactic aids, whose purpose consisted of the theoretical explanation of the concepts that were worked on and the application of these on the robotic hand. As well as a bit counting sequence. It is important to note that, before implementing the didactic prototype in the classroom, the students acquired the necessary knowledge about electronic components and also about programming.

Consequently, the robotic hand executed a sequence of bits, programmed by the students, resulting complicated for the students since we were presented with errors at the time of uploading the program to the ATMEGA 328P microcontroller, it was possible to solve the problem thus demonstrating a learning in the area of robotics and electronics.

Unfortunately, the main idea of the mobility of the fingers could not be fulfilled due to the type of material used for the flexion of each of the fingers (transparent elastic thread) since it was weak to lift the finger to its counting position (open) was caused because the finger was heavy and it was difficult to make all the flexibilities that performs these pieces.

The objective of having the students learn to count binary numbers with the automated hand was successful because they found it very attractive and paid as much attention as possible to the movement of the fingers of the robotic hand.

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