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Robotic Hand Prototype

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Abstract: ***The project consists of designing and building a robotic hand prototype in order to be implemented as a prosthesis. This mechanism is composed of sensors known as FLEX (resistive) and Arduino CH340 cards. Also with a radio frequency device known as RF24, this is gate responsible for decoding the signals along with the HT12E gate by sending them to the servo motors. Having a cotton glove composed of the above-mentioned electronics, the robotic hand prototype mimics these movements, considering certain limitations (it does not exert pressure when contracting the fingers, among others).***

Keywords: Flex sensors, radio frequency, construction, coding

1. Introduction

Currently there is a wide variety of robotic hands designed with various technologies, with simple elements and economically accessible. The project presents a proposal for the implementation of electronic elements in order to simulate the movements only of the fingers of one hand.

The prototype aims to implement the various research made over robotic hands, carried out by various researchers, resulting in a practical and economical project available to those who need to acquire such mechanism. The design was made in the design software known as "Solid Works" and its manufacture was made with 3D printing.

This device with the objective for prosthetics is intended to be an economic element which can be improved. Reducing costs by being compared to other equipment in this branch of technology. Helping people with different capacities have a better life and emotional stability. (Montealegre, 2016)

In the construction of the aforementioned device, it is composed of a cotton glove in which five resistive Flex 2.2 sensors were incorporated, being distributed in each of the fingers of the glove, the sensors being activated send pulses to an arduino system (nano CH340) which is the receiver this sends the signal to the HT12E gate to the radio frequency module (RF24). As a result, the actuators (servomotors) are driven.

2. Inquest of literature

a) History

Prosthetic devices play an important role in rehabilitation after amputation. At a minimum, they can serve as cosmetic restoration, which can provide psychological benefit and have simple passive or opposing functions. More advanced prosthetics offer some functional restoration, enabling activities of daily living such as grooming and dressing, and minimizing injury on the contralateral side from compensation and overuse. For their turnoff basic function, body-powered prosthetics utilize movement of a proximal joint to operate a terminal device. With this method, the patient uses movement in there maiming limb to trigger a physiologically unrelated action the prosthesis shoulder flexion and extension may trigger a prosthetic pincer to open and close. Although simple and effective, this system of pulleys and cables typically allows only one joint to be operated at a time. More sophisticated function requires simultaneous articulated movements, in particular for the human hand. As such, motorized prosthetic limb shave been developed to offer greater mobility, dexterity and motor control than purely structural, non-motorized prosthetics. [1]

1) Hand

The hand is a complex limb of the body composed of five zones which are, distal phalanges, intermediate phalanges, proximal phalanges, metarcalps and carpals. Image 1.1 shows these parts.

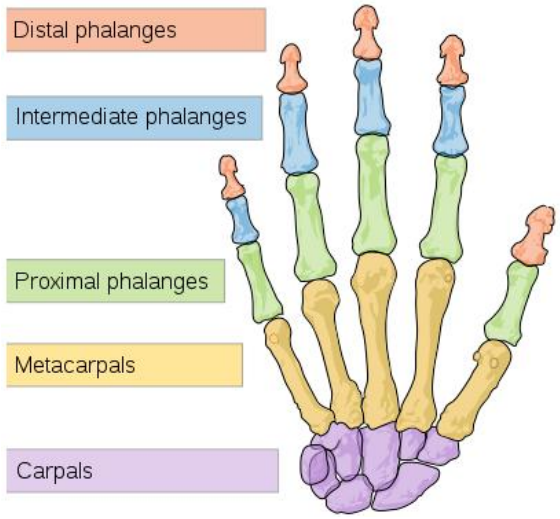

Figure 1 Parts of the hand
Source: Scheme human hand bones-en.svg

The wrist and hand are made up of twenty-seven bones, numerous ligaments and many muscles and tendons, all of which give the fingers fine motor skills. The wrist and hand house the eight carpal bones, whose proximal row is composed of the scaphoid, the semilunar, the pyramidal and the pisiform, and articulates with the radius and the ulna to create the radiocarpal joint. This is where the main actions of the wrist occur; Being a chondiloid (ellipsoid) joint, it allows flexion, extension, abduction and adduction. The combination of these four actions is called circumduction. [2]

b) Prosthesis

The fundamental mission of the upper limb is to grasp and reach objects from anywhere in space, primarily in the environment of the body itself, in order to carry out the activities of daily life. To achieve these objectives it is necessary that the hand develops not only motor functions, but also tactile (extensive and proprioceptive) and reflexes. [3]

Classification of scores for implementation of prostheses.

According to the following information there is a classification of the types of amputations and prostheses that could be placed in the hand which are:

Prosthesis for partial or total hand amputation

The amputation of the hand can be total or partial. According to loss levels, they can be classified as:

- Thumb amputation: A prosthesis will only be necessary if the amputation is at the level of the proximal phalanx. The prosthesis can be held either by means of a tape around the wrist that fixes the prophesied thumb or by means of leaflets that surround the palmar and dorsal area of the hand. With a silicone case, the natural finish of the fingers is imitated. [4]
- Amputation of one or several of the other four fingers: similar to the prosthesis by amputation of the thumb. [4]
- Amputation of the 2^{nd} to 5^{th} fingers: simple "pylon" devices can be used, these being a prosthesis made of rigid plastic materials to make the opposing base using the unscathed thumb. [4]
- Distal and proximal transmetacarpal levels. In this case, a mitt-type prosthesis (slightly flexed fingers without separation between them), or an open steel prosthesis can be placed (it has a steel rod to use the intact thumb as an opposing device). [4]

c) Classification of robotic hands

Some of the classifications of robotic hands are mentioned below.

Currently the hands for their great variety are classified into different types according to their physical characteristics which are: They are separated into three groups depending on the number of fingers they have and their configuration:

- Anthropomorphic robotic hands: all those hands that have four fingers and one thumb. Its configuration is similar to that of the human hand.
- Robotic semi-anthropomorphic hands: all those hands that lack one or more fingers. Its configuration is similar to that of the human hand.
- Non-anthropomorphic robotic hands: all those robotic hands that do not have a configuration similar to the human hand regardless of the number of fingers. [1]

1) Focus

Keep in mind that there are a wide range of prototypes of robotic hands which have different designs and characteristics. This prototype of robotic hand with the purpose of being applied as prostheses was realized with electronic elements easy to acquire besides that the hardware and arduino software are free giving the facility of the realization of this type of mechanisms.

As mentioned above, the model of the hand was designed with the design program known as "Solidworks", in the figure 2 this copy is presented.

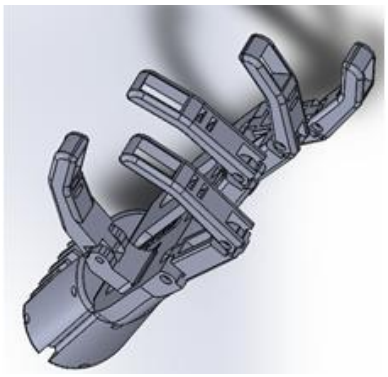

Figure 2 software prototype

The robotic hand design consists of certain dimensions throughout the prototype type, which are listed in table 1

Table 1: Dimension Table

Toes length	6 cm
Full hand length	16 cm
Toes width	1 cm
Palm width	7 cm
Hand thickness	1.5 cm

As mentioned above, it features radio frequency device known as RF24.

Many components contribute to the correct transmission and reception of an RF signal. The following figure 1.3 shows the basic components.

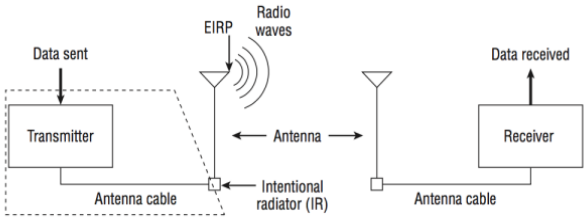

Figure 1. 3 RF basic components

The transmitter takes the data and modifies the AC signal using a modulation technique to encode the data, this AC modulated signal is now a carrier signal. In addition to generating a signal at a specified frequency, the transmitter is responsible for determining the amplitude of the original transmission, or what is more commonly known as the power level. [5]

An antenna offers two functions in a communication system. When connected to the transmitter, it picks up the AC signal it receives from the transmitter and directs or radiates the RF waves in a specific pattern which depends on the type of antenna. When connected to the receiver, the antenna collects the RF waves it receives through the air and directs

them to the receiver which is responsible for converting said signals into bytes and bits. [5]

It should be noted that this signal transmitted by the RF24 radio frequency device has a range of three meters.

The operation is explained below; the wireless receiver is attached to the microcontroller with an antenna. The radio frequency receiver that is connected to a capacitor of 104 F and a resistance of 1k ohms this to avoid failures in the second integrated circuit. The data is then sent to the Arduino nano CH340 card. To verify its proper operation a led diode was installed which is actuated when receiving the pulses, thus checking the correct operation. Finally, these signals are sent to the actuators (Sg90 servo motors) installed in your hand.

This part is electric powered by two 5v to 1 amp chargers which were modified to maintain the circuit, one of them is connected to the Arduino and the other to the protoboard tablet who is responsible for providing power to the servo motors.

3. Results / General Discussion

The project covers a general overview of the development carried out on the prototype of a robotic hand with the aim of making it a prosthesis which was, designed, assembled, in order to focus on social and educational fields.

When constructing any prototype with this type of mechanism and programming, it should be taken into account to analyze the different variables that may be presented, with the aim of not increasing costs by incorrectly implementing electronic elements for such devices.

As mentioned, the materials used for the construction of this prototype have a great advantage in terms of cost-benefit, as they have excellent mechanical and electrical characteristics.

When analyzing the different variants in addition to the chosen actuators you can realize that an analysis of forces and of how to convert the electric energy into motion is necessary.

The variations of robotic hands that are elaborates with other electronic elements and with other type of coding however the proposal presented is a different way to make a model of this large range of robotic hands.

4. Conclusion

The prototype of a robotic hand prosthesis was made which has certain limitations by the type of design and complexity when being armed. The project provides the freedom of some movements for this reason it is necessary to continue to experiment and research, thus giving rise to design innovation, application of materials, mechanisms and special structures.

The number of robotic hands designed to date means that there is a margin of innovation in the research branch of mechanisms and structures, thanks to the technology that today facilitates the design and manufacture of more sophisticated and complex structures . Similarly, the research effort of robotics focuses on the development of new integrated system planning and control techniques.

Presenting an innovative proposal which consists in the development of a prototype of robotic hand with electronic elements available to anyone who needs it, since it is a prototype of educational prostheses easily accessible thanks to its reduced manufacturing cost.

Obtaining satisfactory results since this prototype for prostheses is a functional and didactic model, in addition to having the ease of being able to be innovated depending on the needs of each person. Aiming to help people have a better quality of life as well as being another option to acquire an element of this range at a lower cost than that of their competitors.

It is a powerful project as it can be modified with other mechanisms designed in Solid Work or failing that in other design software. Once this have been said the mobility mechanism of the wrist by can be integrated by installing sensor which will allow movement, taking note that only some freedom of movement will be available, these improvements will be made depending on the consumer's needs for their comfort and ergonomics.

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