ULTRASONIC VIBRATORS BELT AND HANDLES FOR BLIND

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SUMMARY.

The main objective of this work was the result of the need for independence and security in the mobility of the visually impaired person criticism, this has created a belt and vibrating handles ultrasound to detect obstacles at mid-height in three directions (left, right and front), enabling lower mobility limitations. In developing this device Myrio National Instruments card available in the laboratory of the Technical University of North-UTN was used as a central processor. The other items were purchased on the local market, thus determining the chords to the design and characteristics of the desired prototype elements. The device consists of two handles with ultrasonic sensors that detect an obstacle to wirelessly send the data to the card Myrio is located on the belt, which is responsible for activating the vibration motor according to the data received by the sensors. Performance tests were conducted in different environments: open, closed, with light and without light, which has been verified obstacle detection medium height and in three directions, notifying by vibration of the corresponding motors to each address located in belt with a variable vibration (a shorter distance greater vibration).

KEYWORDS

Visual impairment, ultrasonic vibrators, central processor, Myrio card, ultrasonic sensors.

ABSTRACT.

The main objective of This work was the result of the need for offering independence and security in the mobility of the visually impaired person, for esta reason it was created vibrating ultrasonic belt and pointers to detect obstacles at mid-height in three directions (left, front and right), enabling to decrease mobility limitations. In the development of this device, Myrio card from National Instruments was used as a processor core, Which was available in the laboratory of the Technical University of the North-UTN. The other items Were Purchased on the market place, by Which so, it was determined to the elements more appropriated to the design and Desired Characteristics of the prototype. The device Consist of two pointers With ultrasonic sensors after detecting an obstacle That wirelessly send the data towards the card Myrio Which is located on the belt, Which is responsible for activating the engine vibration data ACCORDING TO the received by the sensors. Performance tests Were Conducted in different environments: open, closed, illuminated and without light, Where it has-been verified the obstacle detection in medium height and the three directions, notifying by vibration of the Corresponding motors to each direction located on the belt with a Variable vibration (a shorter distance greater vibration).

KEYWORDS:

Visually impaired, ultrasonic vibrators, central processor, card Myrio, ultrasonic sensors.

I. INTRODUCTION

Currently technological advances have helped develop devices that can lower academic limitations of a non-sighted person, such as smart phones, computers, tablets and readers of texts, among others; but not social constraints and mobility. In recent years the social limitation has been reduced to the integration of blind people in education, employment and social sphere, but in terms of mobility and independence, it has developed various devices such as electronic canes, glasses, suits special and others to detect objects in the environment, which do not satisfy themselves mostly the needs of the blind person, due to economic factors or bring discomfort in everyday use.

a) Assistive devices developed for blind

1. Electronic Staff

The device only detects objects at a low distance and not to other heights in which there may be obstacles that cause injury to the user besides the use of the modules and RFID cards cause slight discomfort to the user due to its deficiency and difficulty reading same, and the use of various cards and prepositioning thereof by mobilization sites is required.

Figure 1 Electronic Staff

Source: [1]

2. Suit for blind

The study of this device has allowed to take some useful insights on the project and giving comfort to the user in their daily activities by improving the design of the prototype, define the safe distance obstacle detection and vibration of the DC motors must be variable for the user to determine the distance to the object is detected.

Figure 2 Suit for the blind (Runatech)

Source: [2]

3. Robot guide

This prototype robot has several advantages blind user support due to the number of ultrasonic sensors and camera positioned self-definition, the fuzzy logic programming also allows better interaction with the non-sighted person; however this prototype robot requires prior management course for use by system complexity and ongoing maintenance and calibration of the sensors and camera. This presents several problems blind because in many cases can not afford their maintenance expenses and even the acquisition cost of the robot.

Figure 3 Robot Guide. Top and side view

Source: [3]

The implementation of a belt and vibrating handles ultrasonic for the blind will target in its application detection of people, objects and obstacles halfway up in three directions: to the front through the belt, left and right with the help of independent handles on the wrist of each arm whose maximum range of detection by the sensors will be one meter away; the vibration generated by the engine to detect people or objects by the sensors will vary according to the distance at which the person or object detected (less distance, greater vibration) are. Each element of the system will have its own power supply and a button on and off.

II. MATERIALS AND METHODS

The research was carried out by personal experiences to define the characteristics of the device, which for its development was necessary theoretical research - scientific materials and components necessary to meet the requirements specified prototype, based on information from scientific articles , books for the basics of sensors, controllers and actuators used and research and manufacturers web pages for the selection of components and materials available on the market.

a) Implementaci or n or unique electronic device

For the implementation of the Myrio device as a central controller card, provided by the laboratories of the Technical University of North will be used. Other components such as ultrasonic sensors, vibration motors, micro - controllers, XBee modules, batteries, speakers sound (buzzer) and electronic items were purchased on the local market.

The device consists of two handles each containing an ultrasonic sensor that detects obstacles a arduino pro micro central processor handle a Xbee module responsible for the wireless communication of the handle to the belt, a PIC 18F2550 which checks the load battery, and a horn (buzzer) to notify the user full battery charge of 3.7 volts. In the belt we have a Xbee module receiver wireless communication connected to the Myrio card as central processor, an ultrasonic sensor that detects obstacles in front of the user three vibration motors placed on the right, left and in front of the seat belt a PIC 16F-88 that checks the battery charge of 7.4 volts and a horn (buzzer) reporting full battery charge.

1. Lis design electronic handcuffs or single

For electronic design handles previously selected components whose circuit diagrams presented below is used:

Main circuit diagram of the operation of the handle

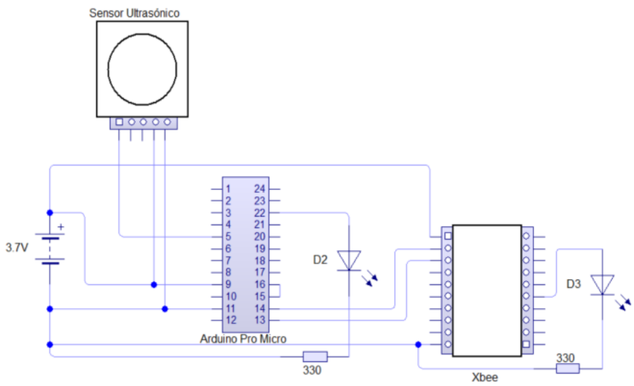


Figure 4 Diagram main circuit handle

In the diagram the components required for object detection, signal processing and sending of data to the belt is displayed, these components are: EZ4 Maxonar ultrasonic sensor, arduino micro and XBee Pro module.

Diagram battery charging system

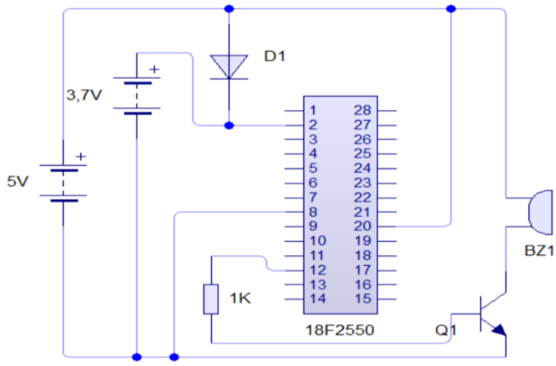


Figure 5 System Diagram battery charge

In the diagram the components required for the charging system battery 3.7 V handcuffs seen as the main component the PIC 18F-2550 which is responsible for checking the voltage level of the battery and a horn sound (chicharra) to notify the user full battery charge.

Full electronic diagram

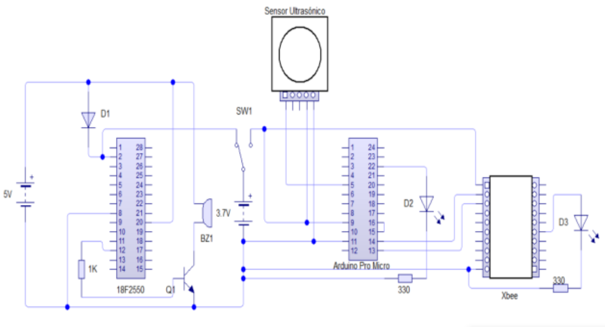
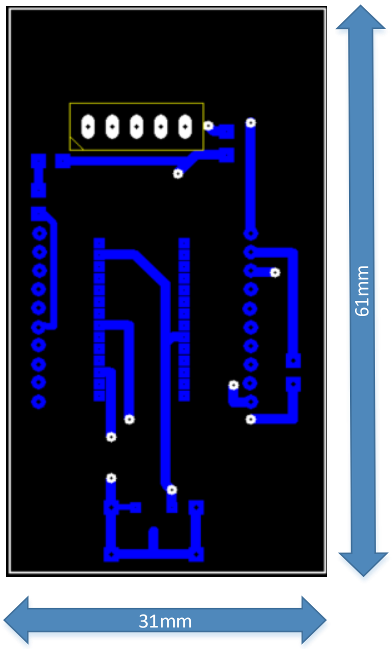


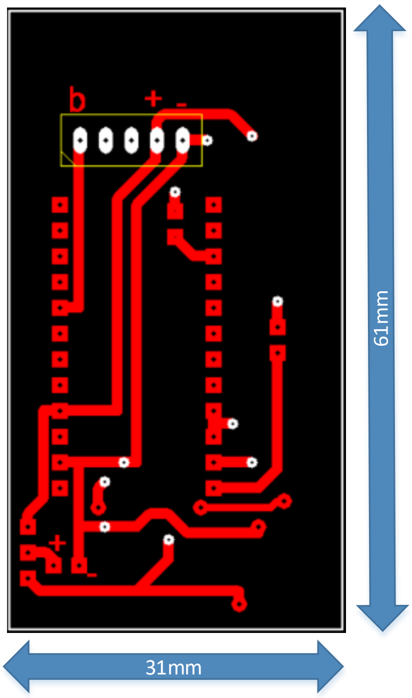
Figure 6 full Diagram handles

Power, battery charging and off: The diagram shows the complete electronic circuit handles interlaced by a 3-position switch allows the user to select the operation of the handle type is displayed.

2. Implementation of plates handcuffs



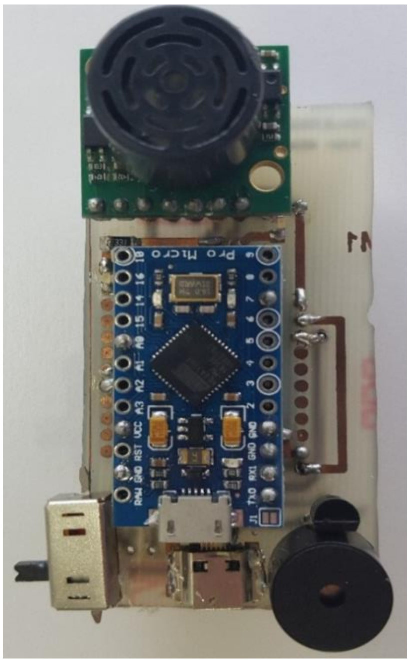
7 tracks Top View handles plates



8 tracks handles plates Rear View

In the images the design of the plates is observed with the dimensions that have the bakelite once completed, Bakelite is double-sided: in the upper ultrasonic sensor is placed, the arduino pro micro, PIC 18F-2550 and horn or cicada; on the lower side is the Xbee module.

3. Plate finished handles



9 Top view plates ending

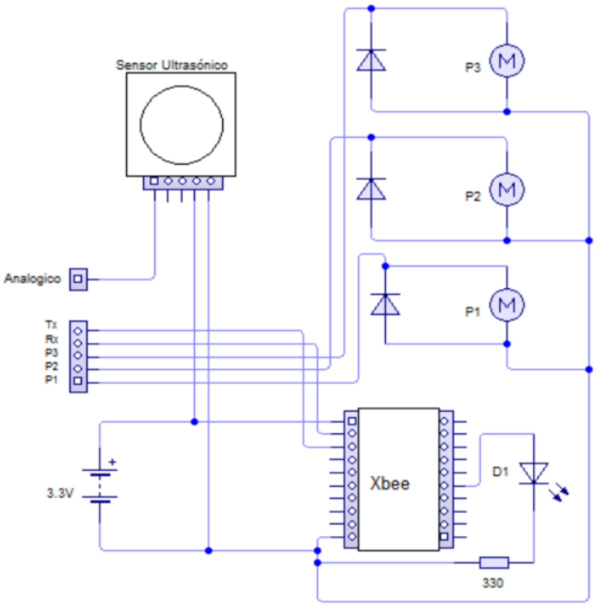


Figure 10 Rear View finished plates

4. Electronic design belt

For electronic components belt design previously selected whose circuit diagrams presented below is used:

Circuit diagram of the main operation of the belt

Figure 11 Main circuit Belt

In this electrical diagram Xbee connections receiver module as power, output connections to Myrio card, motor connections P1, P2 and P3 to Myrio card and connections thereof to the output of the circuit it is presented; also connecting the supply output and analog output of the ultrasonic sensor to Myrio card.

Electrical circuit diagram of battery charging belt

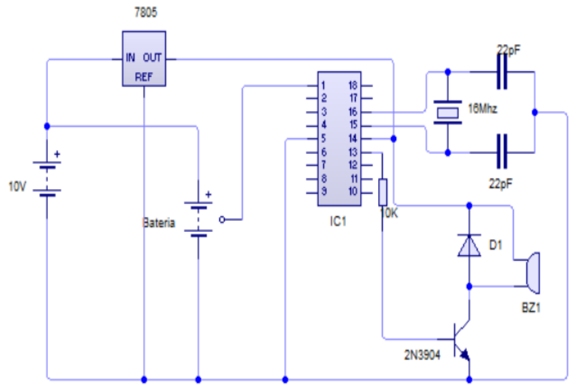


Figure 12 battery charging circuit Belt

The electrical diagram shows the connections charging system battery belt has a micro processor PIC16F-88th responsible for verification of battery charge, a horn sound responsible for notifying the user full battery charge and connectors for the power source battery.

Full electronic diagram

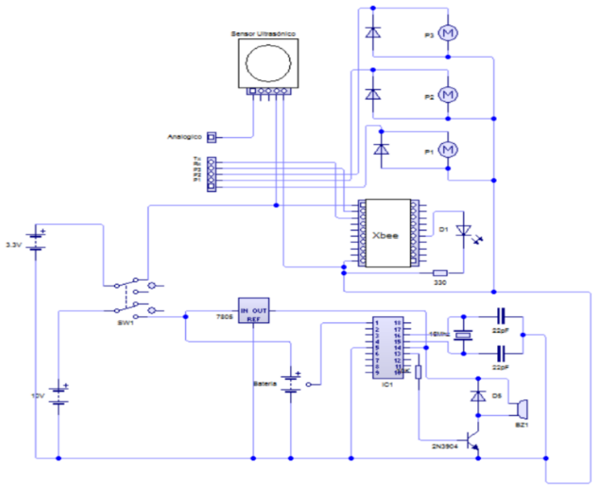


Figure 13 complete electronic circuit diagram belt

The diagram shows the complete electronic circuit interlaced belt by a 3-position switch allows the user to select the operation of the belt on, battery charge-off rate is displayed.

5. Implementation of the plate belt

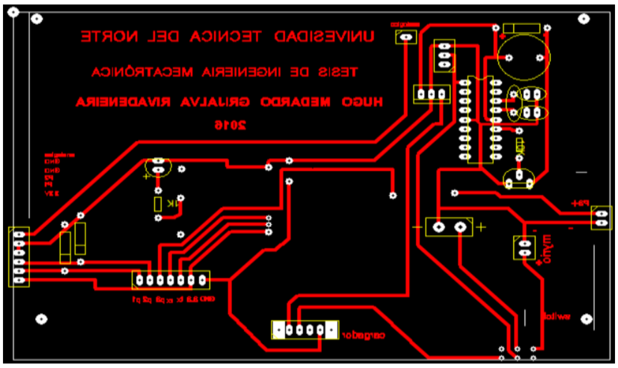


Figura14 Vista plate belt tracks

In the graphic design of the tracks Bakelite belt is observed, it is one-sided in which are the elements thereof.

6 Plate finished belt

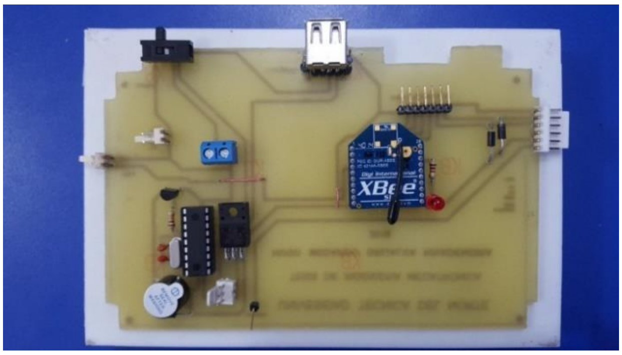


Figure 15 finished belt plate

b) Design of housings

1 Layout handles cases

For the design of housings handcuffs taken into account the dimensions of the plates and electronic components thereof; already obtained measures of boards and components housings handles the following requirements is designed:

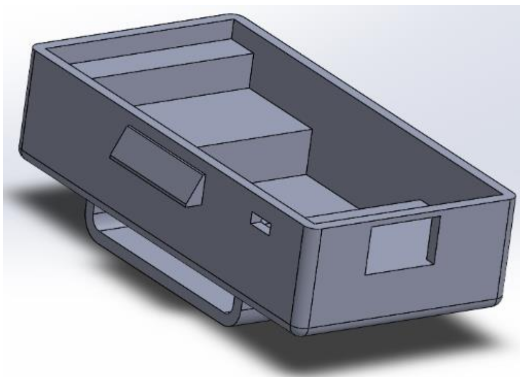
Lower housing

Required dimensions

- Length 70.90 mm
- Width 35.50 mm
- High 16.48 mm

Dimension of holes

- Hole for swich on and off 5 mm x 2 mm



- N port or USB connection for charging batteries í 13 mm x 8 mm
- Pin 37mm x 35mm strap x 4 mm

Figure 16 lower housing isometric view handles

Top shell

Required dimensions

- Length 70.90 mm
- Width 35.50 mm
- Alto 8.00 mm

Dimension of holes

- Say to orifice meter for the ultras single sensor or 17mm
- Space for battery í to 16.50 mm x 3.80 mm x 40 mm
-

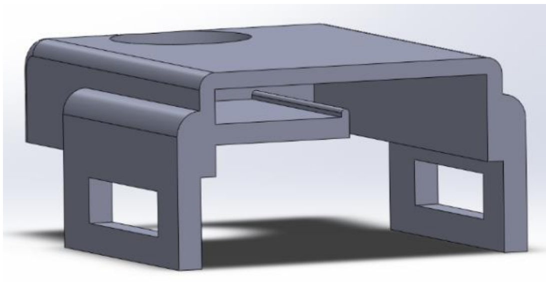


Figure 17 top isometric view handles housing

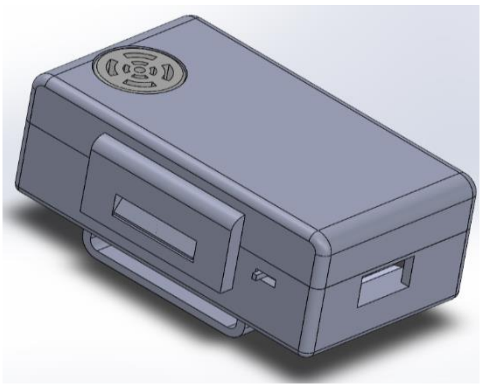


Figure 18 isometric housing handles

2 Designing belt housings

For the design of housings belt draws on the size of the Myrio card as the main component of the upper housing.

Top shell

Internal dimensions

- Area for Myrio card: 142 mm x 90 mm x 24 mm
- Rea for energy feeder to the Myrio í: 17.5 mm x 72 mm x 24 mm
- Area cable connection to the plate: 124 mm x 17.5 mm x 24 mm

External dimensions

- Width: 168 mm
- Height: 112 mm
- Depth: 26 mm

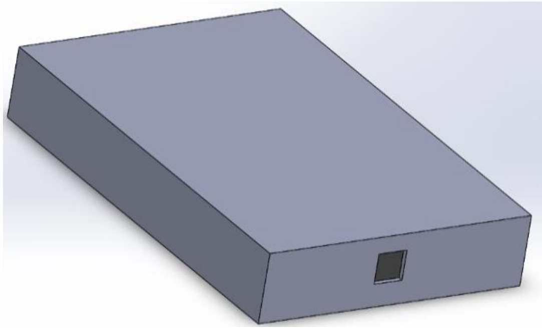


Figure 19 Isometric upper shell belt

Lower housing

Internal dimensions

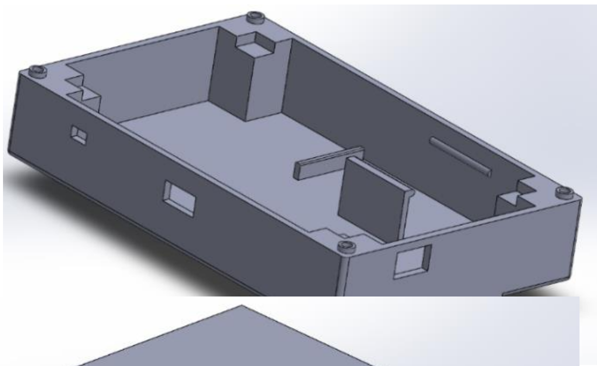
- Rea for plate: 142 mm x 90 mm x 3 mm
- A rea of the battery ay 79 mm x 36 mm x 21 mm

External dimensions

- Width: 168 mm
- Height: 112 mm
- Depth: 30 mm

Dimension of holes

- Dimensions for connection or n motor of the belt right side or n: 7 mm x 8 mm
- Dimensions for connection or n engine left side of the belt or n: 16 x 10 mm
- Dimensions for swich on and off: 7.5 mm x 4.5 mm
- Dimensions for connection or n USB (charg í a): 15 mm x 8 mm
- Dimensions of pins or n belt: 50 mm x 40 mm x 4 mm



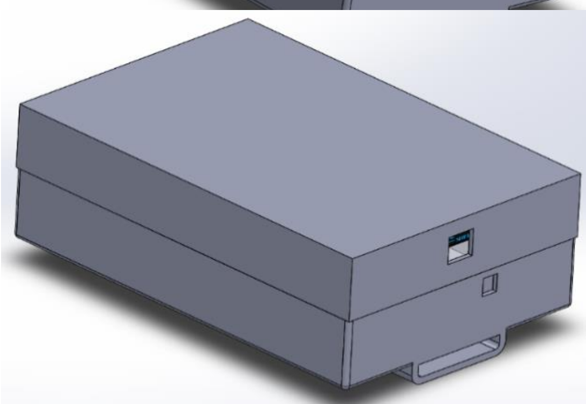


Figure 20 Isometric lower housing belt

Figure 21 isometric view complete belt housing

3 Design ultrasonic sensor housing front

For the design of the casing of the ultrasonic sensor located on the front of the belt should consider the following dimensions:

Dimensions of the ultrasonic sensor

- Base: 20 mm
- Width: 22 mm
- Height: 16 mm

Dimensions of openings in the cabinet

- Ultras hole or single sensor: 16 mm di Subway
- Hole for connection cables or n: 8 mm x 6 mm
- Strap pin: 40 mm x 38 mm x 6 mm

Based on these dimensions is determined, the 3D design of the sensor housings.

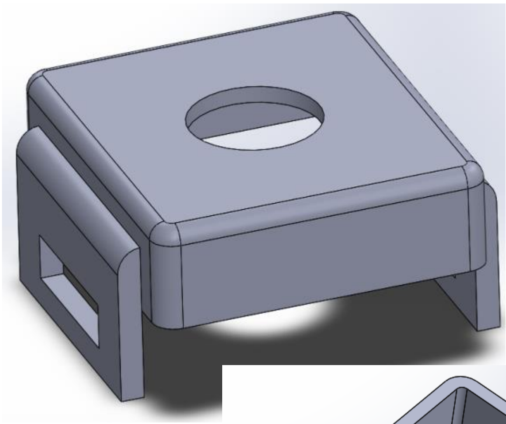


Figure 22 top housing front sensor

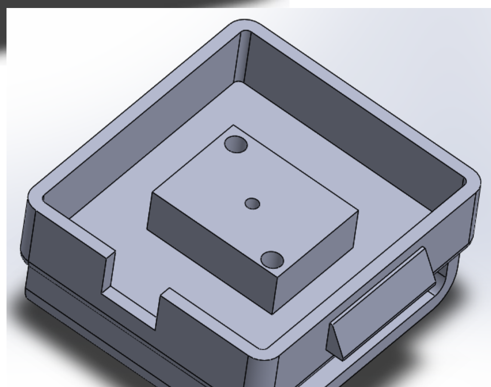


Figure 23 lower housing front sensor

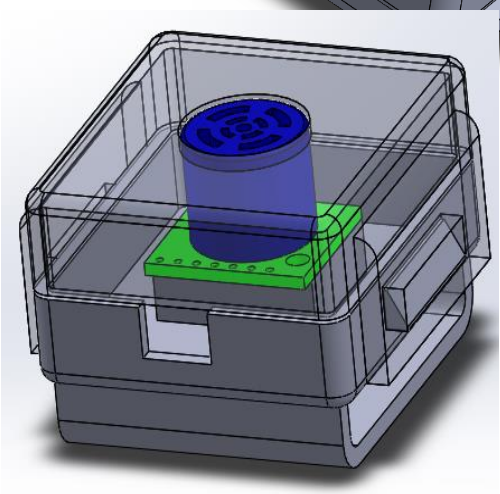


Figure 24 front view sensor housing complete

4 Material selected for the preparation of carcasses

Material PLA

As for physical, chemical and mechanical aspects, the tensile strength and modulus of PLA is also comparable to that of polyethylene. However, it is more hydrophilic than polyethylene because it has a lower density. It is also stable to UV light being harder discoloration. As for its flammability, it is too low.

The PLA may be formulated to be rigid or flexible and may be copolymerized with other materials. The PLA can be done with various mechanical characteristics depending on the manufacturing process followed. (HEXXON-engineering prototyping and 3D printing, 2015)

***Table 1** Characteristics of the material PLA*

- Density	1.4 g / cm3
- Modulus of elasticity (Young)	3.5 GPa
- Elongation at break	6%
- Flexural Modulus	4 GPa
- Flexural	80 MPa
- Cutting Module	2.4 GPa
- Strength- to -weight ratio	40 kN-m / kg
- Tensile strength (UTS)	50 MPa
- Thermal conductivity	0.13 W / mK

Source: (HEXXON-engineering prototyping and 3D printing, 2015)

c) Assembly device

1 Assembly handcuffs

3D impression made housings proceeds to implement the plates of the handles with batteries as follows:

Each lower housing is held by their respective belt having edges velcro for easy fixing and retirement doll hands providing convenience to the user.

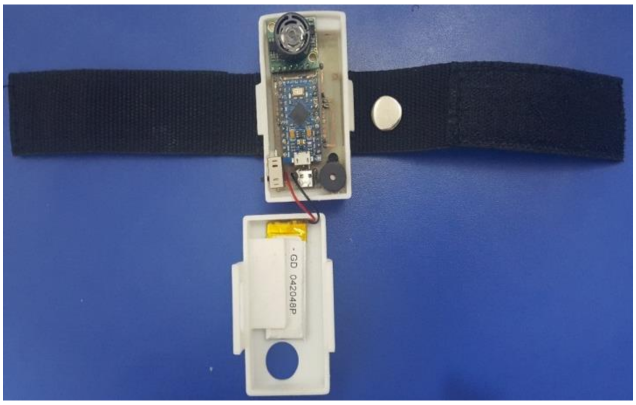


Figure 25 Photo housings handles with plate and battery

Figure 26 Photo handcuffs finished

Assembly belt 2

For assembling carcasses belt the following process is performed:

the strap is passed through the lugs of the lower housing fixing to not move, the cables engine vibration and the ultrasonic sensor belt on the inner side of the belt is placed in the upper housing the Myrio card is placed and the lower housing the battery plate screwed to the.

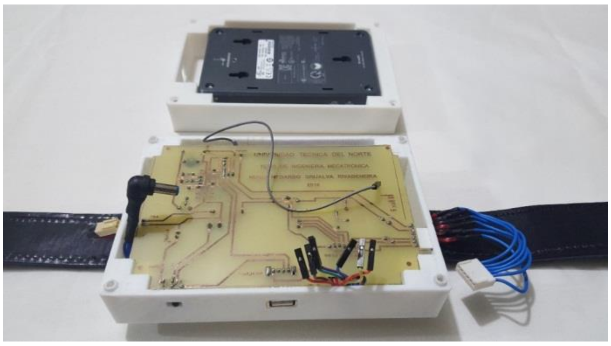


Figure 27 Implementation belt plate

Placed the plate proceeds to close the housing with screws and fixing them in the front of the seat belt housing front ultrasonic sensor, same that can be placed or removed from the belt for greater user comfort is placed.

In this way it is obtained and implemented the entire device, belt and handcuffs

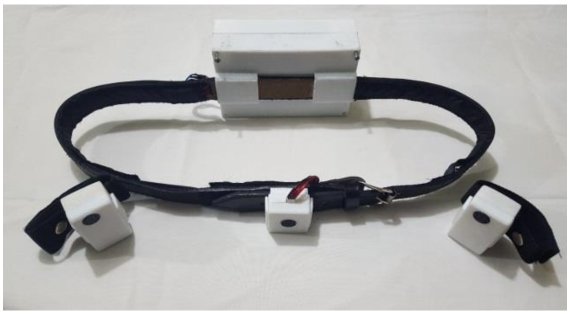


Figure 28 Complete Prototype

III RESULTS

a) Performance testing

It finished the prototype device proceeds to perform functional tests to verify its scope, limitations and malfunctions. These tests are conducted in two operation stages classified as follows:

1 Tests internal operating

At this stage of testing the operation of handcuffs and belt to detect objects or people in closed places and outdoor environments, with light and dark and verified three different distances. For these tests ten trials of three ultrasonic sensors verifying that the respective vibration motors are activated to their respective power upon detecting an object or person at a distance of 25cm, 50cm and 80cm are performed.

These tests measured the power level of vibration of the engines in a range of ten points.

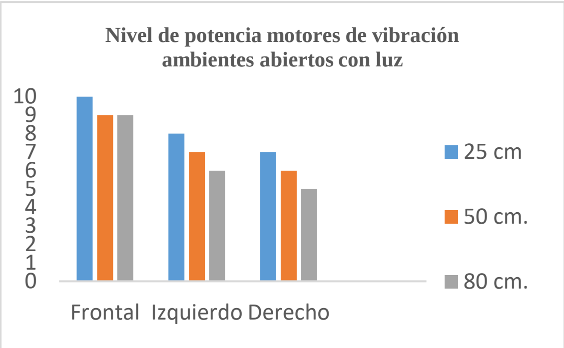


Figure 1 Level power engine vibration environments closed with light

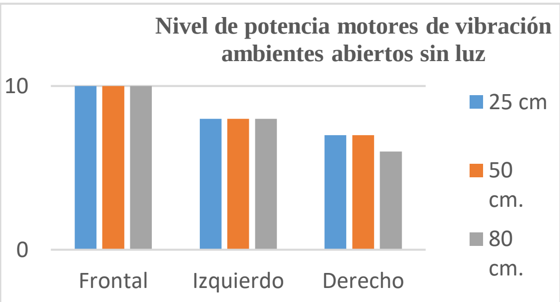


Figure 2 engines power level vibration environments open without light

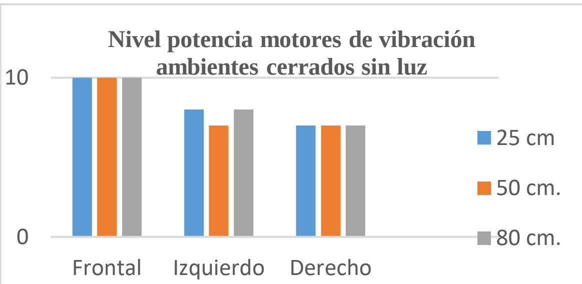


Figure 3 power level vibration motors closed environments without light

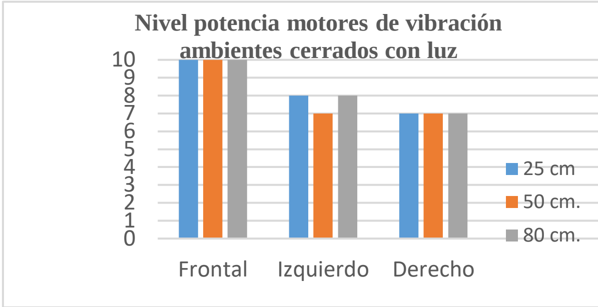


Figure 4 engines power level vibration environments open with light

Analysis of results

Conducted performance tests of ultrasonic sensors and vibration power engines in four rooms and three different distances obtained the following results:

- The ultrasonic sensors detect obstacles or without problem some people in the four environments except light open environment where there is a slight variation

- The power of vibration motors if you have variation depending on the distance that is the obstacle

- The front engine vibration has better performance in power levels of vibration in nearly all environments except where light open with a slight variation at distances greater than 25 cm arises.

- The power levels of the left and right motors have lower power than the engine front three distances despite being programmed with the same parameters

- The response time of the engine front relative to the detector vibration front sensor is almost instantaneous producing a good performance for the user

- The response time of the left and right engines with respect to the sensor detection in their handles is approximately one second because the wireless data distances and processing them in Myrio card.

2 Tests Field

In this stage testing operating environment will be held in public: neighborhood, city center, shopping malls and Technical University North to verify the functionality of the device to detect objects or persons impeding the user mobility in their daily activities.The graph shows the efficiency of the device to detect people and obstacles in a range from 0 to 10 respectively valued.

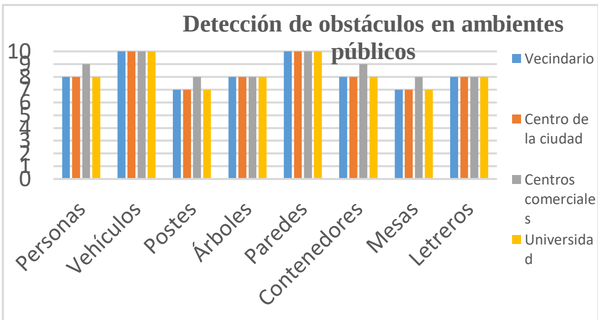


Figure 5 Detection of obstacles in public environments

Analysis of results

I conducted performance tests of the device in everyday life frequented most common public environments was obtained as results:

- The device has greater range of detection of large objects

- Any object that is within the detection range of the sensors are reported to the user via vibration motors

b) Performance testing battery

These functional tests consist of checking the duration and battery charging handcuffs and belt during use of the device using several performance tests shown in the following tables:

1 Time of battery life handcuffs

These tests verified the duration of the batteries in continuous operation indoors as open, with the following data:

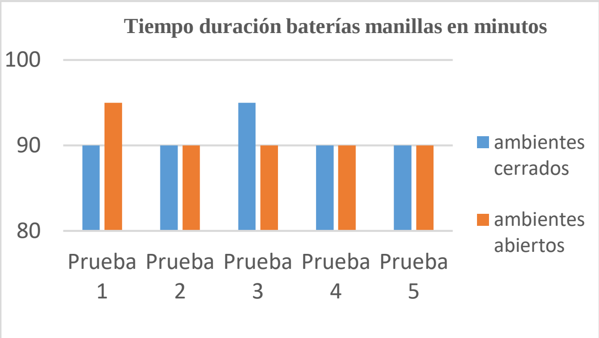


Figure 6 Running time battery handles

Running time 2 battery handles load

These tests verified the charge time batteries obtaining the following data:

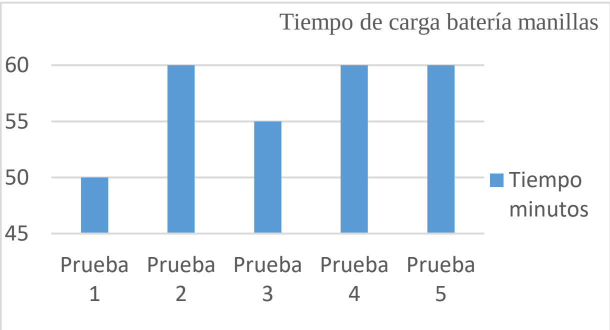


Figure 7 Charging time battery handle

Analysis of results

Tests conducted duration and battery charge could be determined the following results:

- The duration of the batteries is according to the average time a blind person mobilized during the day in open and closed environments

- The charging time is short battery recharge allowing the user for immediate use

- The battery charge can be performed via a USB cable, giving greater comfort to the user

3 Time duration battery belt

These tests verified the duration of the batteries in continuous operation indoors as open, with the following data:

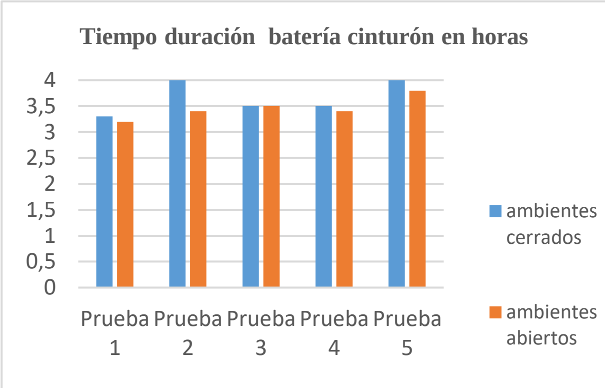


Figure 8 Batery belt

4 Time of battery life belt load

These tests verified the charge time batteries obtaining the following data:

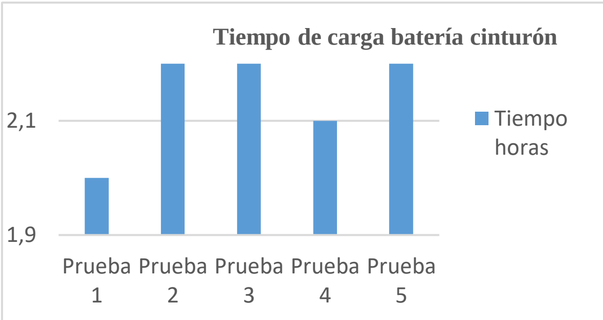


Figure 9 Charging time battery belt

Analysis of results

Tests conducted duration and battery charge could be determined the following results:

- Batteries are long lasting batteries compared with handcuffs

- Due to the length of time your battery charge time is greater

- The duration of the batteries in open environments is slightly smaller in relation to time indoors

- The variation between the times of battery life in open and closed environments in use does not affect or bother the user

IV CONCLUSIONS

- For the preparation of device it was determined that a variety of elements that meet the required features available in the market, selecting the most appropriate options to the user due to price, availability, size and weight suitable for the device

- The three ultrasonic sensors detect any object or person is within its detection range at a maximum distance of 80 cm. and a minimum distance of 13 cm. in closed environments with and without light, while in open environments have a small light variation detection in the maximum distance of its range.

- The selected prototype design has advantages in size and weight compared to other existing devices themselves do not provide user convenience

- The response time of the engine front vibration with respect to the signal outputted by the ultrasonic sensor belt is almost instantaneous due to its direct connection to the Myrio card, while the response time of the engine right and left vibration and respect to the signal sent by the ultrasonic sensors each handle is between one to two seconds due to sending and receiving data with the Myrio card and debugging data distances performs the same. During the delay the vibration of the engines with last value of the previous detected distance until the end of the delay changing the vibration according to the new distance detected

- By implementing the optimal design of the device could determine its size and actual weight according to the elements and materials used for housings. Because the dimensions of the device Myrio card sized and greater weight to the desired

- The power levels of vibration of the left and right engines from the front engine is less than 40% even being its programming parameters the same

- The average duration of the batteries of the handles is 1 hour and 33minutos and the average duration of the battery belt is 3 hours 50 minutes meeting the desired specifications of the prototype

THANKS

The Technical University, North, Dr. Miguel Naranjo Toro Rector, Eng. Milton Gavilánez Dean of the Faculty of Applied Sciences (FICA), and Eng. Diego Ortiz Coordinator of Career Mechatronics for allowing expand and develop my knowledge and professional future.

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