
**UNIVERSIDAD TÉCNICA DEL NORTE**

**APPLIED SCIENCES ENGINEERING FACULTY**

**MECATRONIC ENGINEERING DEGREE**

# DESIGN AND IMPLEMENTATION OF A VOICE COMMANDED CONTROL TO A WHEELCHAIR

**TECHNICAL REPORT**

**AUTHORS:**

ANDRÉS MARCELO ALTA ANDRANGO

JÉSSICA KARINA GUIJARRO REVELO

**DIRECTOR:**

Ing. Carlos Obando

**Ibarra – Ecuador**

**2014**

# “DESIGN AND IMPLEMENTATION OF A VOICE COMMANDED CONTROL TO A WHEELCHAIR”

*Jéssica Guijarro[1], Andrés Alta[2], Carlos Obando[3]*

Applied Sciences Engineering Faculty, Mecatronic Engineering Degree, Universidad Técnica del Norte, Ibarra, Ecuador

jessitost@gmail.com, andyy-13@hotmail.com, cobando@utn.edu.ec

**Abstract.** This article comprises the implementation of a voice commanded system for a conventional wheelchair, this system allows the user to move with autonomy and comfort in a plain surface with 360° of free rotation, it has proximity sensors, which alert users of obstacles and at the presence of stairs totally paralyzing the chair. The voice recognition is made by an electronic module called Easy VR and the data processing and commands for the actuators and brushless motors is made through the ARDUINO platform.

## 1. INTRODUCTION

Nowadays, about 600 million people in the world have different physical conditions, most of them are from undeveloped countries. (World Health Organization, 2005), among them, there are motor disabilities which limit people’s ability to move, this is the case of quadriplegia, mainly generated by spinal cord injuries caused by accidents like car crashes, falls, sport injuries, etc. (Lema, H y Pérez, P, 2010) this condition inhibit superior and inferior limb movement, and the handling and control of translation devices as the classic wheelchairs, relegating the person to a total dependence for the performance of simple processes of movement and contributing to the emotional depression for the incapacity. This problem also affects the whole family of the person with special needs. Furthermore, our country does not have this kind of technology, and the importation of a voice-commanded chair is highly expensive, being forgotten the immediate need of accessing to these devices.

Currently, there are electric and joystick commanded wheelchairs which help some disabled people, but they do not give a complete solution for quadriplegic people, since their only possible movement ability is on their head, so they cannot command this kind of wheelchairs and still depend on another person to move.

An automatic voice-commanded wheelchair will give people with special needs bigger autonomy grade for the movement of. Commanding the chair will be very easy, since it do not requires any physical movement or the assistance of another person, letting the user to move where he needs; besides, it will provoke a big social impact because it will not only improve the life quality of disabled people, but also of the people that surround them. This device will be of a great help for quadriplegic people and also for

paraplegics, elderly people, children with brain paralysis, etc. Giving all of them much more facility and comfort.

## 2. PROCESS DESCRIPTION

For the wheelchair movement execution. It is performed a logic sequence like the one following described:

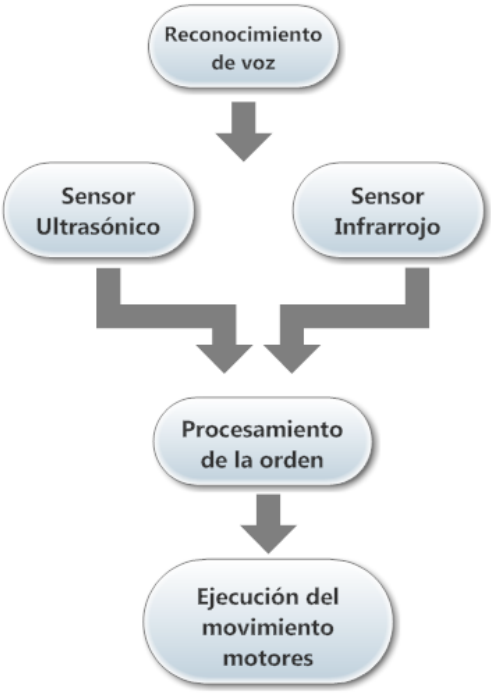


**Figure. 1.** System blocks diagram.

### 2.1 WHEELCHAIR

The International Normalization Organization (ISO) proposes ISO 7176 international norms for wheelchairs, the specific terminology series, testing methods to evaluate the wheelchairs' performance, size, resistance, durability and security. The wheelchair models vary considerably according to the users diverse needs; nevertheless the basic function of this wheelchair is allowing the users to have a more active life, with comfort, without causing a negative effect on their health or on their safety.

The collapsible wheelchair "Century Medical" brand, whose model is 5MMCR10 is used to implement this project, is designed for temporal use and for determined time lapses. It meets general standards of design and has a good postural support, aluminum structure, back, headrest, armrest and adjustable and removable foot rests for the users comfort.

**Figure 2.** Wheelchair

The incorporation of additional devices, mainly motors and batteries, located near the two supporting points (wheels) do not affect the wheelchair static and dynamic stability.

### 2.2. ULTRASONIC SENSORS

They are proximity detectors which work free of mechanical friction, and detect objects. The sensor emits a sound and measures the time the signal takes to come back, that is to say, the signal reflects on an object and bounces and the sensor receives the produced echo and turns it into electrical signals. These sensors work only in the air, and they can detect objects with different shapes, colors, surfaces and materials. The sensor selected for this application was the US-020, whose characteristics are the following:

- Stable and accurate operation.
- Operating voltage 5VDC.
- Static Current: <3mA
- Sensor Angle: 15 degrees
- Detection distance: 2cm – 700cm
- Accuracy: Until 0.3cm
- Sensor size: 45x20x1.6 mm Aprox.

For the correct operation of the devise it is necessary to generate a time impulse of a minimum of 10us, at the same time, the emitted signal must be monitored. The distance calculated by the sensor corresponds to this formula:

Distance = ( Impulse width * Sound speed) / 2

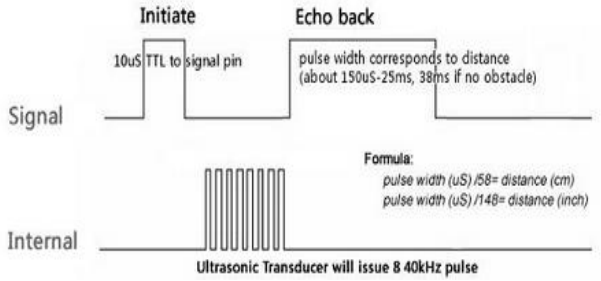


**Figure 3.** Ultrasonic sensor operation.

## 2.3. INFRARED SENSORS

The E18-D80NK sensor is an infrared transmitter and receiver which together make a photoelectric sensor, it uses a modulated infrared ace. This sensor has a screw adjust, to regulate the distance it uses a digital output, which is activated when an obstacle is detected in the specified range; it presents a great functionality, handling, size and a reasonable price.

Its features are:

- Output Current 100mA/5V
- Current consumption: <25mA DC
- Response time: 2ms
- Detection Angle: 15 degrees
- Adjustable distance: 3cm – 80cm
- Diameter: 18mm
- Sensor length: 45mm


**Figure 4.** Infrared sensor E18-D80NK.

The moderated-impulse infrared sensor responds only to the ace of light emitted by its own source.

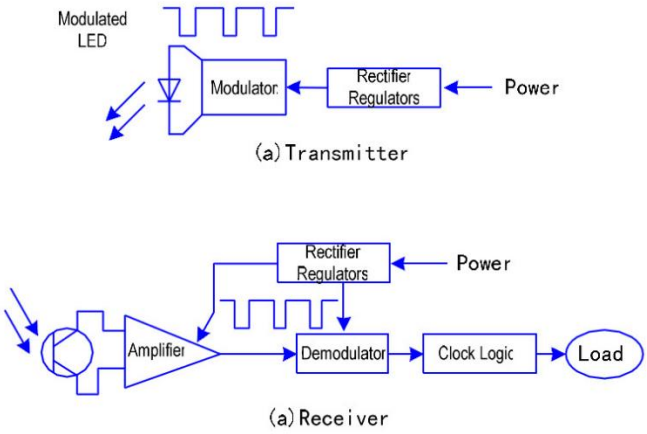


**Figure 5.** Infrared sensor operation.

## 2.4. ARDUINO MODULE

It is an open electronic platform for prototype creation based on flexible and easy-to-use hardware and software, It takes the information from the environment and from a variety of sensors, it can affect objects around it controlling lights, motors and other actuators, the Arduino board is programmed by Arduino language (based

on Wiring) and the environment based on Processing.

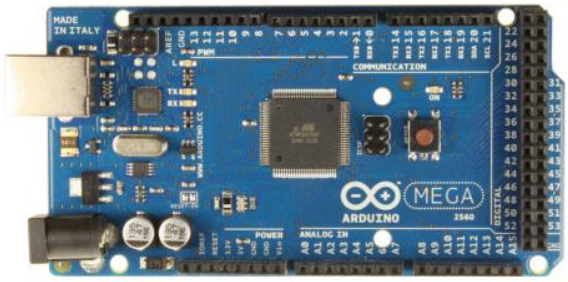


**Figure 6.** Arduino Mega 2560

Arduino Mega was used in this Project, its features are:

- Microcontroller: ATmega 2560
- Operating voltage 5V
- Recommended input voltage: 7-12V
- Maximum input voltage: 6-20V
- Digital pins I/O: 54 (15 have PWM output)
- Analogic E pin 16
- Pin current: 40mA
- Pin current 3.3V: 50mA
- Flash memory: 256 KB
- SRAM: 8KB
- EEPROM: 4KB
- Clock speed: 16 MHz

## 2.5. VOICE RECOGNITION MODULE EASY VR

It is a powerful module for voice recognition and sounds player, the voices to be recognized can be predefined and internally recorded. This are called independent microphone sounds (SI), for this application there are also voices microphone dependent (DC), which are supposed to be "taught" or recorded in the internal module memory.


**Figure 7.** Easy VR Module

Within its main features:

- 26 voice pre-programmed commands (SI).
- Supports until 32 commands and its correspondent voices defined by the user (SD).
- SD commands can be organized in a maximum of 16 priority groups.
- Power supply needed 3.3V y 5V.

## 2.6. BRUSHLESS MOTORS

These motors design is coupled to the wheelchair rims and spokes. The motor has 36 slots for easy coupling and can transmit 250 Watts of power for the wheel spin and its movement with a 36V supply.

**Figure 8.** Brushless motor coupled to the wheelchair rim.

## 2.7. BREAK SYSTEM

Breaks to be implements are the normal for bicycles, these are lateral action rim breaks, which will receive the necessary force for their activation through a 50 kgf.cm servomotor.

**Figure 9.** Lateral action rim break.

## 2.8. BATTERIES

Lithium batteries were acquired for this application because of their advantages against conventional batteries, they give more energetic intensity, less sized and weight. The batteries features are the following:

- Model: BT90
- Voltage: 36V
- Ah: 10 Ah
- Dimensions 32*10cm
- Weight: 2.10 Kg
- Autonomy: 45-55 km

**Figure 10.** Ion Lithium battery.

## 2.9. SYSTEM FLOWCHART

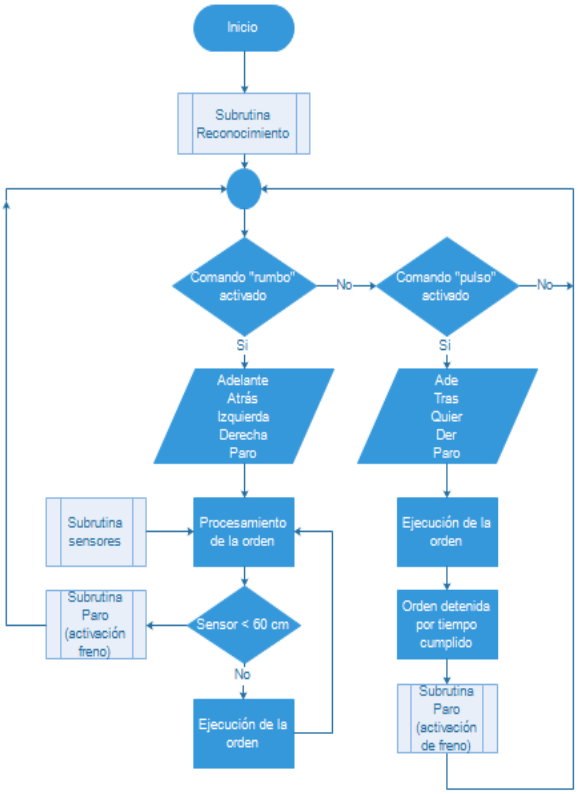


**Figure 11.** Basic system flowchart

## 3. CONCLUSIONS

The user of the voice-commanded wheelchair becomes a more active person moving by will and own means, making the wheelchair an inclusive transport mean and improving the user emotional health. This translates into a technologic innovation which foster the social inclusion and the movement of vulnerable people in the country.

The wheelchair implementation comprises multiple criteria which depend on the users physiological characteristics, the technological, economic and cultural context where they develop; however the main criteria are comfort and safety.

The use of Arduino as hardware platform allows this project to be implemented and improved by other researchers in the future whose purpose is solving similar problems.

It was possible to achieve the fundamental objective which was to maintain the wheelchair shape and own features, that is to say, the wheelchair can still be disassembled and folded for easy movement from one place to another one.

.

The system reliability is 94.37% in closed places and 85.14% in open environments where there is not strong sunlight, this means, when the sunlight is not in its zenith to avoid excessive heat and luminosity which can notably affect the system in general.

## 4. RECOMMENDATIONS

It is recommended that the wheelchair user do not have more than 105 pounds of corporal weight, since this can produce irreversible damages to the system.

Avoid exposing the system to extreme weather conditions like: rain, dust and high temperatures.

Elicit the voice commands as fluently as possible with the same voice tune used for recording them when the module was trained.

Take into account that the wheelchair is designed for using in spacious and clear places, with totally plain surfaces.

It is also recommended to charge the batteries after the system has worked for three hours.

## 5. BIBLIOGRAPHIC REFERENCES


Amarilla, J. (1995). *Baterías de iones de Litio. 34*(5-6). Madrid: Instituto de Ciencia de materiales de Madrid, Sociedad española de Cerámica y Vidrio. Recuperado de http://boletines.secv.es/upload/199534463.pdf

Calle, L., Guaraca, P. y Guzhñay, A. (s.f). *Motores Brushless DC.* Cuenca: Universidad Politécnica Salesiana. Recuperado de https://es.scribd.com/doc/100367501/Motor-Brushless#scribd

*Guía rápida del módulo de reconocimiento de voz VRBot.* (s.f). España: Microsystems engineering. Recuperado de https://es.scribd.com/doc/213589342/EasyVR-Guia-Rapida.

Henao-Lema, C. P., y Pérez-Parra, J. E. (2010). *Lesiones medulares y discapacidad: revisión bibliográfica.* (Spanish). Spinal Cord Injuries and Disabilities: A Review. (English), 10(2), 157-172.

Navarro, D., Rios, L. y Parra, H. (2004). *Sensores de ultrasonido usados en robótica móvil para la medición de distancias.* (25). Pereira: Universidad Tecnológica de Pereira. Recuperado de http://revistas.utp.edu.co/index.php/revistaciencia/article/view/7183/4207

*Adjustable infrared sensor switch manual.* (s.f). Recuperado el 12 de febrero de 2014 desde *mcu*: http://dl.btc.pl/kamami_wa/e18-d80nk-ds.pdf

*ARDUINO MEGA 2560.* (s.f). Extraído el 12 de enero de 2014 desde http://arduino.cc/

*Infrared Distance Sensor Type E18-D80NK*. (s.f). Extraído el 18 de Abril de 2014 desde Wikispaces: http://arduino-info.wikispaces.com/InfraredDistanceSensor

## 6. AUTHOR BIOGRAPHIES

**Author.- Jéssica Karina Guijarro Revelo.** Born January 27, 1991 in Tulcan. She had her secondary school instruction in Sagrado Corazon de Jesus High School obtaining the degree in Physic-Math and winning the national flag. Currently, she finished the Engineering in Mechatronic carrier of Universidad Técnica del Norte in Ibarra. She was part of the student Leardership in the previous mentioned carrier and was elected as member of the FEUE of the same university. She participated in the Campus Party in Quito in 2014 representing Ibarra. Interest Areas: Automatizing and industrial control, PLCs, Microcontrollers, Electronics and Robotic.

**Autor.- Andrés Marcelo Alta Andrango.** He was born in Cotacachi on February 13 1991. He received his secondary instruction in "Instituto Tecnológico Otavalo" obtaining the degree in Physics-Math. He was First "Escolta" of the National flag. Currently, he finished Engineering in Mechatronic carrier of Universidad Técnica del Norte. He introduced in the leadership of the carrier previously mentioned, and was elected as member of the FEUE of the same University He participated in the Campus Party in Quito in 2014 representing Ibarra in Interest Areas: Automatizing and industrial control, PLCs, Microcontrollers, Electronics and Robotic.

**Tutor.- Carlos Obando.** He was born in Ibarra on October 8th, 1986 He received his secondary instruction in La Salle School, where he obtained the degree in Physics-Math. He studied in Universidad Ténica del Norte obtaining the Engineering in Mechatronics in 2011. He as president of the UTN Robotics Club. Currently he finished studying the Masters degree in Technology and Practical Teaching Management in Pontificia Universidad Católica del Ecuador. Interest Areas: Robotics, Industrial Automatizing, PLC's, microcontroladores,