ISSN: 0975-766X
CODEN: IJPTFI
Available Online through *Research Article*
www.ijptonline.com

WIRELESS PROSTHETIC HAND WITH RF433MHZ AND ATMEGA328 ARDUINO CONTROLLER

P. Dass
Assistant Professor, Dept. of ECE, Saveetha School of Engineering, Chennai- 602 105, Tamil Nadu, India.
Email: dasseie@gmail.com

Received on: 15.08.2016 *Accepted on: 20.09.2016*

Abstract:

Accidents are occurring everywhere nowadays. Many people become are becoming as Amputees. Some people suffer from psychological difficulties and some from physical difficulties because they are unable to use their extremities. Some amputees had lost their hand in severe accidents or either they have born without hands. To get relief from their extremities by acquiring a replacement of their hand at possible cost, we developed a prototype of wireless prosthetic hand using 3D Printed hand model, Arduino which is an open source microcontroller and RF 433MHz transmitter and receiver module [1].

Keywords: Arduino controller, Flex Sensors, Servo motors, RF 433 MHz Transmitter, RF 433 MHz Receiver.

1. Introduction

Today so many accidents takes place everywhere. Many people lose their body parts which are very essential for them in their day to day life. Some people had born with inter muscular psychological difficulties. To compensate those peoples who lost their hand, we have designed a prosthetic hand which gives ease to such amputees by replacing their lost hand at reduced cost. To evade expensive methods, we use flex sensors that allows the amputee to perform the movement of hand by themselves [1]. The flex sensor control is given to a transmitter Arduino which encodes it and sends the encoded information via RF 433 MHz Transmitter module. Another Arduino acts as a receiver which receives the decoded information through RF 433 MHz Receiver module, decodes the encoded information and control the servo motors. The simple construction and economical material costs, and also the use of miniaturized devices, aids amputees to get rid of their lost hand and achieve access to new prosthetics with ease.

2. Tools Used

A. Hardware Tools Used:

- 3D printed Prosthetic Hand.
- AT Mega 328 microcontroller based Arduino.
- Flex Sensors.
- Servo Motors.
- RF 433 MHz Transmitter and Receiver module.

B. Software Tools Used:

- Arduino IDE open source software.

3. Circuit Diagram

Transmitter Circuit:

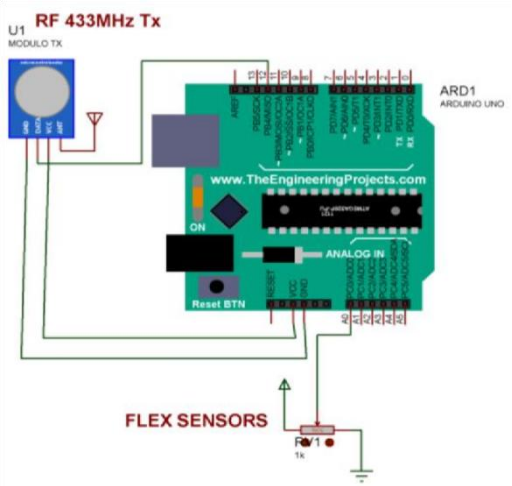


Fig. 1 Transmitter Circuit.

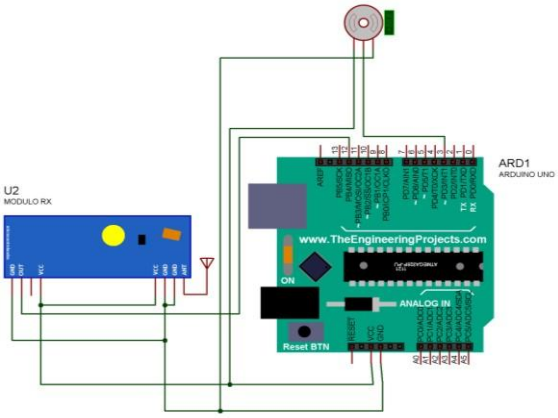


Fig 1.1 Receiver Circuit.

4. Description

A. Arduino

Arduino is an open-source computer hardware and software [3].The Arduino Company designs and manufactures microcontroller-based kits for building interactive objects that can sense and control objects [3].

Nowadays, Arduino comes with AT Mega 328 microcontroller. For programming the microcontrollers, the Arduino software provides an Integrated Development Environment(IDE) based on the Processing project. This software includes support for the C and C++programming languages [3] [4].

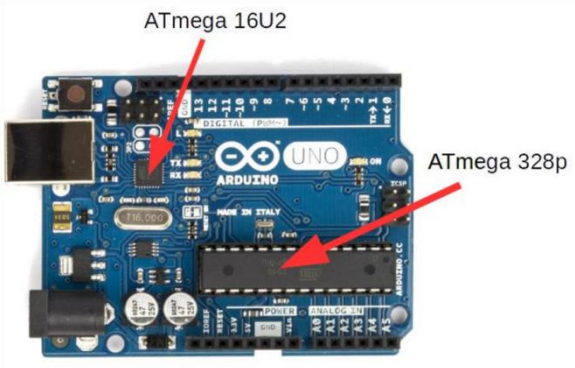


Fig 1.2 Arduino Controller.

B. Flex Sensor

A Sensor is a convertor which is capable of sensing and measuring a physical quantity and converts them into a signal. i.e. it is a device that converts physical varying parameters to digital form.

Flex sensors is a type of sensor that gives varying resistance values on bending. i.e. They are resistors that can be used to detect bending.

Fig 1.3 Flex Sensor.

It uses a conductive foam or carbon on plastic strip to act like a variable resistor. We can able to change the resistance value by flexing (bending), instead of changing the resistance by turning a knob [4]. A bidirectional Flex sensor bends in both direction and its resistance value gets increased as much it gets bended.

The position of the servo motor is controlled by the amount of bending of the flex sensor.

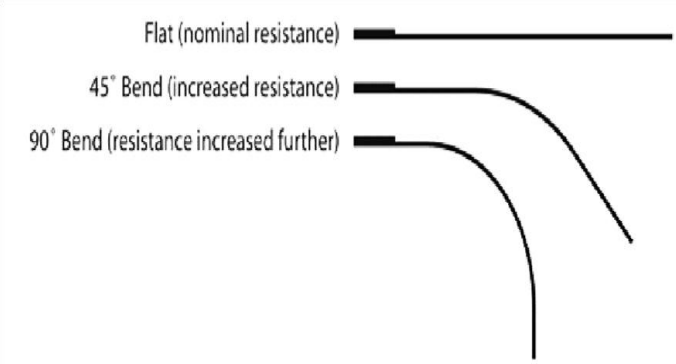


Fig 1.4 Flex Sensor Working.

The advantage of flex sensors is that, they are not too costly and also those sensors can be done by ourselves. The flex sensor circuit is similar to a voltage divider circuit. The only thing is that, its resistance values differ with the amount of bending of the flex sensor. The resistance produced by the flex sensor will be given to the ADC pin of Arduino board, where the analog signal is converted to a digital signal.

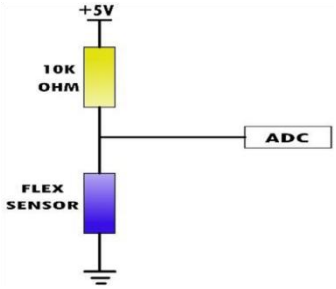


Fig 1.5 Circuit Diagram of Flex sensor to Arduino.

C. Servo Motor

A Servo motor is a small device that has an output shaft which can be positioned to precise angular position. By sending the servo motor a coded signal, its position can be controlled. The servo motor will retain its position of the shaft, as long as the coded signal exists. When the coded signal applied to its input line changes, its angular position of the shaft changes [5].

Fig 1.6 Servo Motor.

As we see inside the servo motor, there will be a quite simple set-up which contains a DC motor, potentiometer and a control circuit. The motor is attached to the control wheel by gears. When input is applied, the motor rotates and the resistance of the potentiometer changes, so that the control circuit can exactly control the movement and the direction.

Fig 1.7 Inside a Servo motor.

The servo motor is turned to the appropriate direction until the shaft of the motor is not at the desired position. The position of the servo motor is controlled through electrical pulses given to the signal wire.

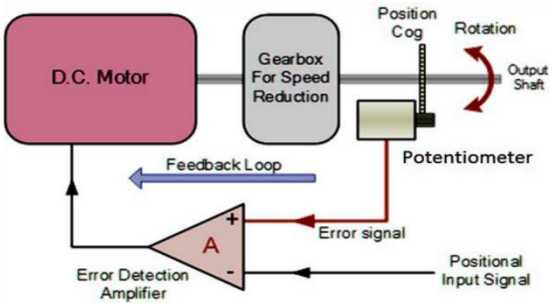


Fig. 1.8 Control Mechanism of a Servo Motor.

The speed of the motor is proportional to the difference between its actual position and desired position. This means that if the motor is close to the desired position, it turns slowly, otherwise the motor will turn fast. This is known as proportional control. Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is the used here to encode the flex sensor's resistor value into a pulsing signal. The PWM is one type of modulation technique used to control servo.

The pulse applied to the servo controls its position.

- A pulse of 1 millisecond moves the servo to 0°.
- A pulse of 2 millisecond moves the servo to 180°.
- And a pulse width of 1.5 milliseconds shift's the servo to 90°.

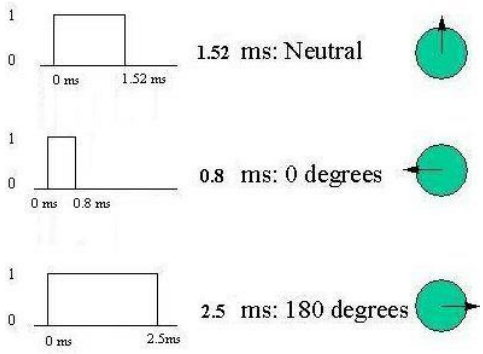


Fig 1.9 Figure of Pulse Width/Duty Cycle.

D. RF 433 MHz Transmitter and Receiver Module:

RF transmitter module:

RF transmitter modules are small PCB subassembly which are capable of transmitting radio waves and modulating that wave to carry some data.

Fig 1.10 RF 433 MHz Transmitter Module.

Specifications of Transmitter Module:

Working voltage: 3V - 12V; maximum of12V.

Working current: maximum of less than 40mA and a minimum of 9mA

Resonance mode: (SAW)

Modulation mode: Amplitude Shift Keying (ASK)

Working frequency: 433MHz

Transmission power: 25mW

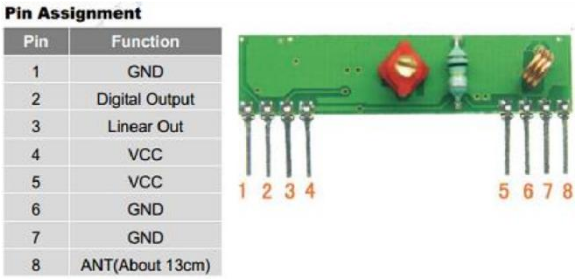
Frequency error: +150kHz (max)

Velocity: less than 10Kbps

This module can able to transmit signals up to 90m in open area.

RF Receiver Module:

RF receiver modules are capable of receiving the modulated RF signal, and they will demodulatesit [8].



Pin Assignment

Pin	Function
1	GND
2	Digital Output
3	Linear Out
4	VCC
5	VCC
6	GND
7	GND
8	ANT(About 13cm)

Fig 1.11 Receiver Module.

Specifications of Receiver Module:

Working voltage: 5.0V DC Working current: Maximum of ≤5.5mA

Working method: OOK/ASK

Working frequency: 433.92MHz

Bandwidth: 2MHz

Sensitivity: excel –100dBm (50Ω)

Transmitting velocity: <9.6Kbps Using an antenna will increase the effectiveness of the wireless communication between them [10].

E. Prosthetic Hand:

One of the most common control system used nowadays is electromyography which is a medical technique in which electrical signals are read from the remaining forearm muscles of an amputee by a device attached to the muscle and the actions are imitated by the prosthetic. The use of Electromyography can be difficult for people without any functional forearm muscles [7]. Therefore we developed a 3D printed prosthetic hand that imitates the movement of other hand with commonplace products such as flex sensors and servos that is vital for an average amputee.

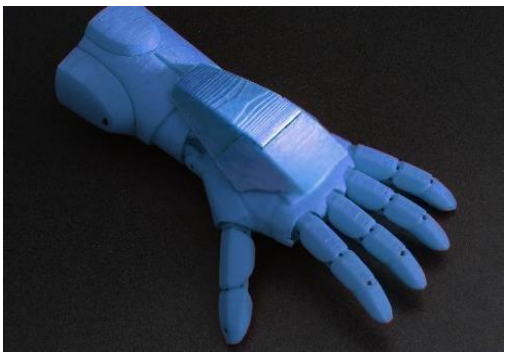


Fig 1.12 Prosthetic Hand Model.

5. Working

Programming is done in Arduino board using the Arduino software. The RF transmitter module is connected to the data pin 12 as by our program. +Vcc and ground of RF transmitter module is connected to the same Arduino board. Flex sensors are connected to the analog pins A0-A5 of the Arduino Controller.

The reason for connecting the flex sensor to the analog input pins of Arduino is that, the resistance value of flex sensor keeps on changing. i.e. if we bend it, its resistance value increases and if we release, its resistance value decreases. The below graph shows the flex sensor values which we have observed.

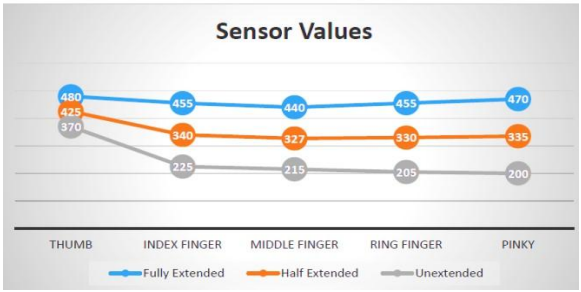


Fig 1.13 Flex Sensor Values.

By the above graph we have programmed the Arduino such that, if the value is greater than 470, the transmitter should send the value '1'.If the value is below 380 it should send '2'. Thus the transmitter Arduino was programmed to send values by the detected flex sensor values. The same procedure is done for all the fingers, by its measured flex sensor values. In the receiver side the Arduino was programmed in similar way like the transmitter Arduino, such that, if the received value is '1' servo motor should remain in 0° position. If the received value is '2' it should rotate 180°. Similarly for all the fingers, according to the values received from the transmitter. The prosthetic hand is fixed in the receiver side Arduino controller. The movement of the prosthetic hand can be done by attaching a string in its palm side as shown in figure 1.14.

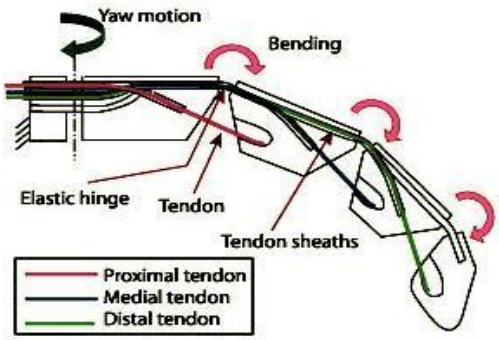


Fig 1.14 Prosthetic Hand Movement Mechanism.

All the three tendon are connected to one servo for controlling its motion either to release or to pull. To make the hand to release or come back to its original position we have connected an elastic/rubber band at the back side of the finger. We can also use ZigBee which is a most widely communication device in Arduino. But the disadvantage of using ZigBee is, separate module is needed for controlling ZigBee; and also programming ZigBee is somewhat difficult than our RF 433 MHz Module. This RF 433 MHz itself a module and does not need any extra elements for interfacing them with Arduino. RF 433MHz module is easily available in market, very cheap and compressed size.

6. Uses

Prosthetic hand is very useful for amputees and physically challenged peoples. Since many people is losing their hands nowadays. Controlling them is very easy and error checking is also easy.

It is useful for playing cards, to solve a Rubix Cube.

Fig 1.15 Prosthetic hand application.

It is useful for amputees who needs to type in a Keyboard, to play musical instruments such as drums.

Fig. 1. 16 Prosthetic hand for typing, Playing Drums.

It is useful in picking up or holding objects which are given in Figure 1.17.

Fig 1.17 Uses of Prosthetic Hand.

7. Advantages

RF433MHz transmitter and receiver module is widely available in markets, cost efficient and reduced in size. Usage of servo motors comparing to DC motors gives precise and proper control of movements. It has higher degree of accuracy.

8. Future Scope

Most myoelectric prosthetics gives six degrees of freedom in finger movement. But a human hand has twenty seven degrees of freedom. Degrees of freedom are low in our prosthetic hand. So the degrees of freedom in prosthetic hands can be improved. Accelerometer /Gyro sensor can be added to this project to control wrist and forearm motions.

9. Conclusion

Thus the prosthetic hand can be controlled wirelessly with the help of Arduino and RF 433MHz Transmitter and receiver module. Servo motors gives precise control of movements. So the amputee can use this hand without any difficulties. In future it can be improved with some more facilities.

10. References

1. "Robotic Hand in Motion Using Arduino-Controlled Servos" by Nicholas Bonini, NithyaIyer, David Kim, Katherine Mathison and Lauren Wellons from New Jersey Governor's School of Engineering and Technology 2014.
2. Wong Guan Hao, Yap Yee Leck and Lim Chot Hun."6- DOF PC-Based robotic arm (PC-roboarm) with efficient trajectory planning and speed control" 2011 4th International Conference on Mechatronics (ICOM), 17-19 May 2011, Kuala Lumpur, Malaysia.
3. Frequently Asked Questions," Arduino, http://arduino.cc/en/Main/FAQ.
4. ArduinoUno-R3," Sparkfun, https://www.sparkfun.com/products/11021.
5. Joseph T. Belter, Jacob L. Segil, Aaron M. Dollar, Richard F. Weir, "Mechanical design and performance
6. What's A Servo?," Seattle Robotics Society, http://www.seattlerobotics.org/guide/servos.html.
7. Joseph T. Belter, Jacob L. Segil, Aaron M. Dollar, Richard F. Weir, "Mechanical design and performance specifications of anthropomorphic prosthetic hands: A review", JRRD, 50, p. 611, 2013.
8. Myoelectric Prosthetics 101," Ottobock, http://www.ottobockus.com/prosthetics/info-for-new-amputees/prosthetics-101/myoelectric-prosthetics-101.