A minor project report on

WIRELESS ANIMATRONIC HAND

Submitted in Partial Fulfilment of the requirements for the degree of

B. Tech In

ELECTRONICS & TELECOMMUNICATION

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CERTIFICATE

This is to certify that the project entitled

“Wireless Animatronic Hand”

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is a record of Bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Electronics & Telecommunication Engineering) at KIIT Deemed to be university, Bhubaneswar. This work is done during year 2019-2020, under our guidance.

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Prof. Satyadeep Das
Project Guide

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ABSTRACT

This report represents an overview on the recent progress and development of a wireless animatronic hand using nrf24l01 and Arduino Uno board. The main aim of this report is to highlight the fact that though the technology is advancing still humans faces innumerable challenges in a meteoric growing world where humans encounters difficulties in completing tasks. This problem can be surmounted using an animatronic hand. It can play a vital role in many industries including Military areas ,space station and medical exercises. Animatronic involves the use of both electrical and mechanical process to design systems that replicates human body movements. It is done by using the simple concept of placing the flex sensor at respective joints of human body. To implement this, the additional feature allotted with the hand is wireless communication method. The system was implemented using control glove, servo motors, nrf24l01 and arduino uno board having on board Atmega-328.

Keywords- flex sensor, servo motors, nrf24l01, arduino uno board, animatronic hand

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CHAPTER 1

INTRODUCTION

1.1. BACKGROUND

Imagination develops creativity. Creativity produce inventions. Inventions establishes technology. Technology offer developments. In that way, ROBOTICS, the emerging & developing field in almost all part of the world. But, the base root of robotics is clearly understood by means of MECHATRONICS, the study of engineering which deals with mechanical, electrical & electronics departments. Mechatronics contribute a vast conceptual idea & technologies, which can be helpful in daily life. In that, particularly **gesture controlled robotic hand** or animatronic hand concept evolves in wireless communication technology which can help physically challenged people and also applicable in industrial sectors. As theory explains, an artificial intelligence robot is far more intelligent than human being in every part of work, but it may fail in competing with the humans at receiving ability & reacting capability to an action or working situation without any delay. This problem made it possible in developing the concept of gesture controlled robotic hand.

CHAPTER 2

BACKGROUND THEORY OF GESTURE CONTROLLED ROBOTIC HAND

This chapter provides background information regarding gesture controlled robotic hand. The structure diagram of gesture controlled robotic hand along with its advantages, disadvantages, mechanism, feeding techniques and design procedure has been studied.

2.1 GESTURE CONTROLLED ROBOTIC HAND

Gestures defines the movement of hand and face of humans. Our hand is result of millions of years of evolution and adaptation. It has 34 sets of muscles which tends to move the fingers and thumb. The purpose of our project is to design a robotic hand that is basically a mechanical hand with 5 fingers (like humans have) that gives ability to grab object of various shapes which will be mutually controlled by human hand. In simple words this mechanical hand will always mimic others hand movements. This type of system is very crucial in fields of medical, defence and industrial works where delicate and dangerous task can be done from a distance without actually touching it.

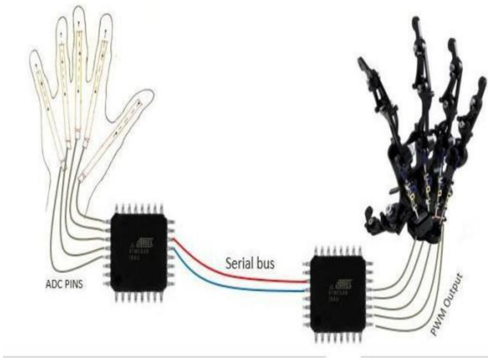


Fig: 2.1 Shows configuration of Mechanical Hand and Human Hand

2.2 ADVANTAGES OF GESTURE CONTROLLED ROBOTIC HAND

1. It is cost effective and robust in nature.
2. It is easy to fabricate using embedded technology.
3. Gesture-based interfaces have many advantages and provide the user with a completely new form of interaction.
4. Widely used in Industrial Sectors like Pharmaceutical Sectors and Medical Sectors.
5. Wireless medium, Easy to develop, Easy to access and Easy to replace.

2.3 DISADVANTAGES OF GESTURE CONTROLLED ROBOTIC HAND

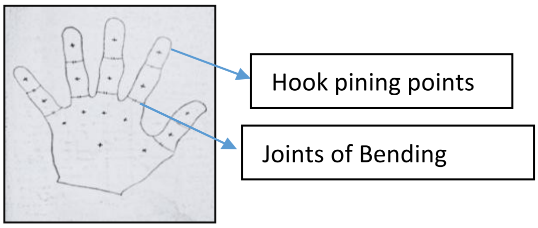
1. One issue with this kind of automatic hand that has been raised which is not relevant to traditional input is on the user's side, these problems are to study, to remember and to accurately execute gestures with proper reflex.

2. As we discuss before there are lack of accuracy.

3. Complexity of the mechanism

2.4 MECHANISM OF GESTURE CONTROLLED ROBOTIC HAND

Manufacture of robotic arm model is the replica of normal human arm & its function is produced as same as the human’s hand function. It is given through proper placing of flex sensor at appropriate location in human body joints & the servo motor connection given to the arm model.



Some Notations used in the figure

They are,

"+" –> pinning point where string is connected to pull the fingers

"//" – > joints allotted for bending.

2.5 SYSTEM OVERLOOK

The complexity of the project is reduced by properly categorizing the whole project into sub design. It help us to make a better design and work effectively with our team mates.

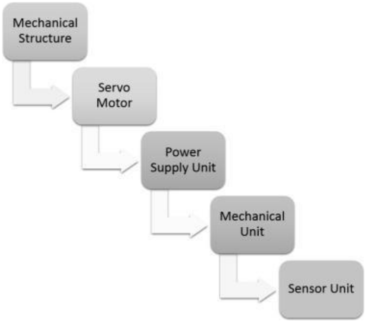


Fig: 2.2 Shows Basic Blocks of Robotic Hand

2.6 IMPORTANCE OF ARDUINO PLATFORM

Arduino is open-source, both in software and hardware specification so that the engineers or electronics enthusiasts can assemble the simplest Arduino modules themselves by hand. The most important part of the arduino platform is that it supports both a physical programmable circuit board(microcontroller) and a piece of software, or IDE(Integrated Development Environment) that runs on computer, used to write and upload arduino code to the physical board via USB through serial communication. Additionally, the Arduino IDE uses a simplified version of C++ programming language making easier for programmers to learn and carry out the program.

The development of arduino platform has attracted enormous attention among the students and global research community since last decades because of its usefulness in many industries where people use arduino to interact with GPS units, camera, motors and even smart phones or TV . The use of arduino is quite flexible since the Arduino software is free, the hardware boards are pretty cheap and robust, both the software and hardware are easy to learn which helps students to build innovative prototypes and at the same time it saves time and cost this is the reason most of the university students use arduino platform to build their projects.

CHAPTER 3

ANIMATRONIC HAND

Animatronic hand is a mechanical hand which imitates the action of human hand. The intention of this hand is to make a copy of human hand so that it can be used in the places where human intervention is needed but at the same time the presence of human being is dangerous to the health of the person who is working there.

Now, the question arises which are the places we can employ this technology.

There are many places which need human intervention such as in nuclear industries where we need human, but we all are well aware of the fact the how dangerous is radiation. Therefore, by this technology we eliminate the human presence, but still we can have our work done because the person who is sitting in a safe location can use this hand as if it’s his own hand.

The advantages of such technology is endless, but there is another thing which we can achieve through this hand is that it will also be helpful for those who has limited locomotion capabilities.

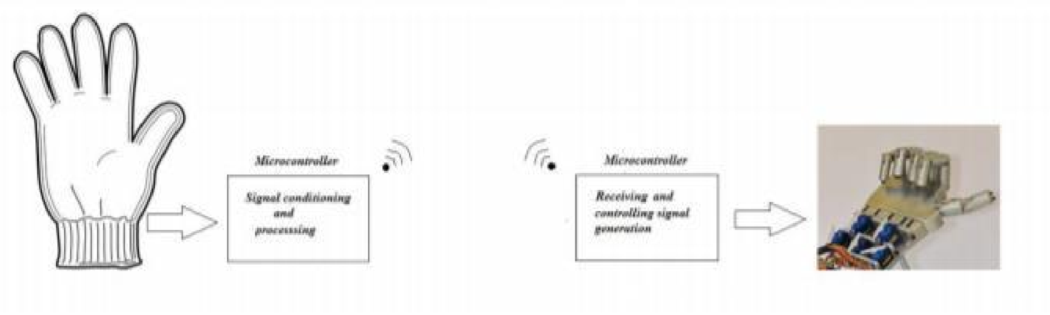

Microcontroller
Signal conditioning and processing
Microcontroller
Receiving and controlling signal generation

Fig: 3.1 Shows Basic Blocks of Robotic Hand

3.1 METHEDOLOGY

The algorithm used for the imitation of human hand movement is proposed here. The hand uses flex sensors for sensing the movement of the hand.

A flex sensor is a type of sensor in which the output voltage varies as a function of the resistance of that flex sensor.

Whenever the flex sensor is subjected to a bending force, due to stretching its resistance increases form its nominal(**the value of the resistance when there is no force**) value as a result the output voltage changes.

This change in the output voltage is noted by the micro controller present in the Arduino uno development board through analog input pin. It Converts the analog value into the specific range and send it to the receiver attached to **the Animatronic Hand** from the sender attached to glove.

When Animatronic hand's micro-controller board receives this data, the code written in this micro-controllers memory helps the servo motors connected to this micro-controller rotate in the desired manner proportional to the data received. This Servo motors are mechanically connected to the fingers of the robotic hand as a result the fingers start moving as per the wish the of the user.

Servo Motors are the special kind of motors ,which have a maximum sweep angle of 180 degree and it works in on PWM.

This process is continued continuously and thus, the motion of the hand is imitated.

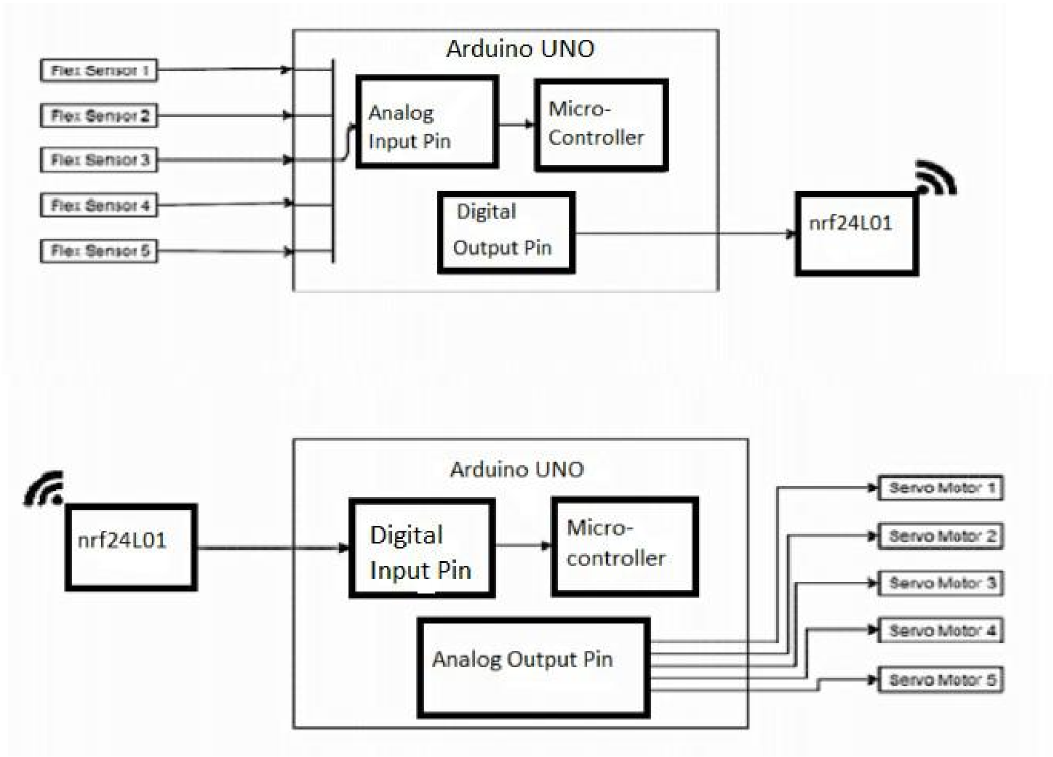


Fig: 3.2 Functional Block Diagram of Animatronic Hand

3.2 DESIGN OF ANIMATRONIC HAND

Here the design of the hand is proposed. The transmitter section consist of majorly flex sensors which is attached to each and every fingers of the gloves, and it is connected to the Arduino Uno Development board which tells the transmitter about the data to be sent for the movement of the Animatronic Hand.

The Animatronic hand majorly consist of servo motors, receiver and Arduino UNO development board. The receiver attach to the development board receive the data sent by the transmitter, according to this data, the development board instructs the servo motors which connected mechanically to the fingers of the animatronic hand to rotate in the desired manner as per the user wish.

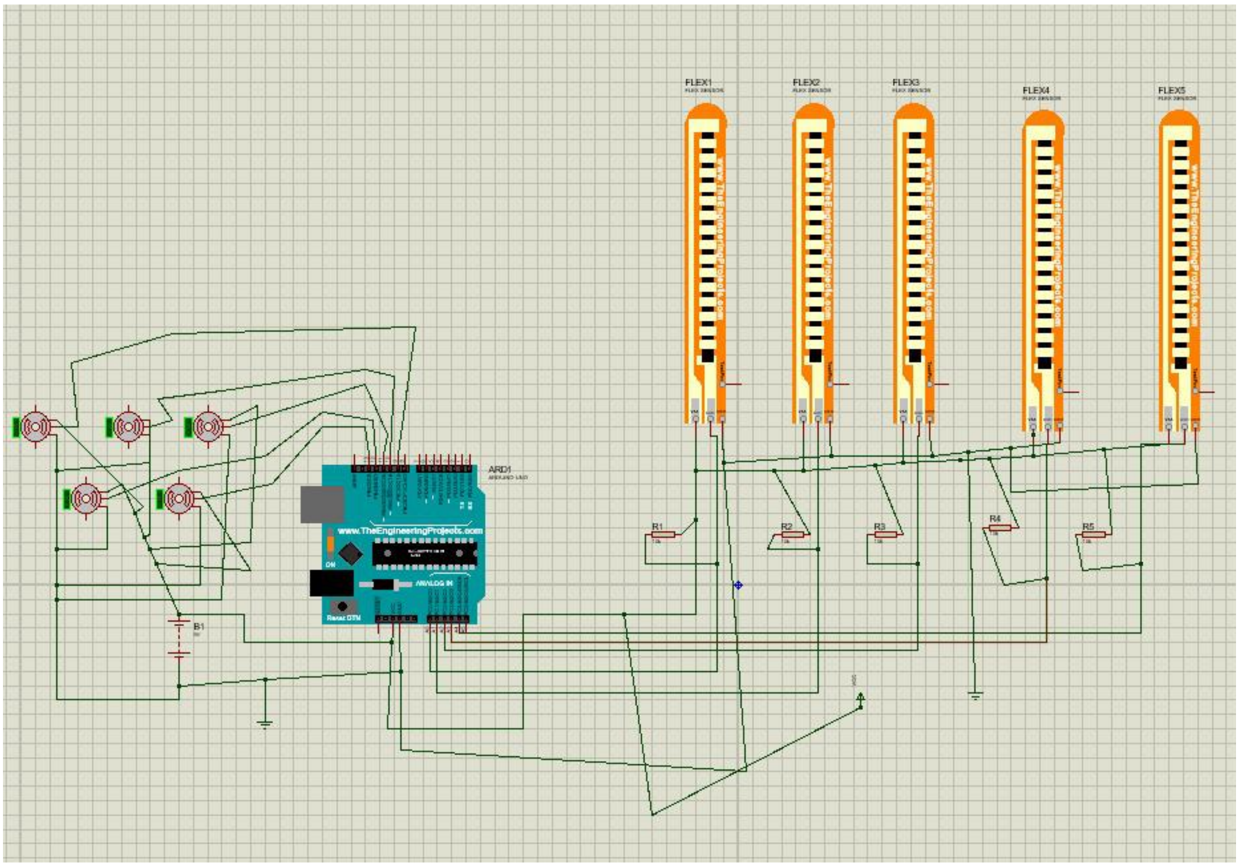


Fig: 3.3 DESIGN OF ANIMATRONIC HAND

CHAPTER 4

HARDWARE SPECIFICATION

For the implementation of the animatronic hand we need the following equipments:

1. Arduino Uno board
2. Nrf24L01
3. Nrf24L01 adapter
4. Flex sensors
5. Servo motor
6. Glove
7. Jumper wires
8. Bread board
9. Bread board
10. Battery
11. Potentiometer
12. Cardboard base

1. ARDUINO UNO BOARD

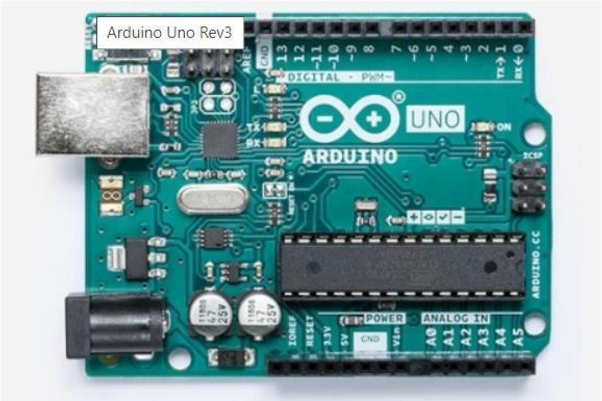


Fig: 4.1 Arduino Uno board

The Arduino Uno is a simple , cheap and yet a powerful tool for innovation and technologies. This board has an Atmel ATmega328 which operates at 5V,2kb of RAM,32 Kb of flash memory which is used for storing of programs and 1 Kb of EPROM for storing of the parameters . It's clock speed is 16 MHz. The board in total has 14 digital I/0 pins,6 analog input pins and 6 PWM(Pulse Width Modulation)output pins. It also has a USB connection for talking to the host PC and DC power jack. It has 16 MHz ceramic capacitor and a reset button. The Arduino Uno board differs from all the other boards as it does not use the FTDI USB-to-serial driver chip instead it features the Atmega 16U2 programmed as a USB-to-serial converter.

2. NRF24L01

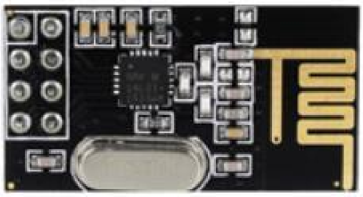


Fig: 4.2 2.NRF24L01

It is a wireless transceiver module which means each module can both send and receive data. They operate in the range 2.4 GHz. It has a nominal current of 50 mA, operating current of 250 mA and has operating voltage of 3.3 V.As these can operate at 3.3 V they can be easily used with 3.2 V OR 5V systems. These have baud rate of about 250 kbps-2Mbps and channel range of about 125 which means each module can communicate with 6 other modules therefore it is possible to have multiple wireless units which can communicate with each other in a specific area. These modules can either be used with 3.3V or 5V microcontroller but it is necessary that it has an SPI port as the nrf24L01 module works with SPI communications. They are low cost wireless solution and when operated efficiently can cover a distance of 100 meters which makes it useful for all wireless remote controlled projects.

3. NRF24L01 ADAPTER

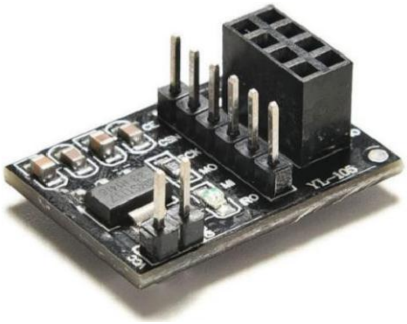


Fig: 4.3 3.NRF24L01 ADAPTER

This adapter board enables to use nrf24L01 transceivers on5V systems like the arduino. It has a input voltage of 5V DC and output voltage of 1.9~ 3.6 DC, the nrf24L01 uses Enchanted ShockBurst protocol to support the two way data communication with packet the acknowledgement, buffering and automatic re - transmission of the lost packets. Moreover it has a on-board AMS1117-3.3 chip and incorporates bypass capacitor for reliable performance. Its dimensions are 26x19x12mm.

4. FLEX SENSORS

Fig: 4.4 FLEX SENSORS

These are the sensors which are used to measure the amount of bending or defection. It is basically a strip of carbon material having metal pads inside it, as the sensor is being flexed the resistance across it increases, a change in resistance can be observed through the change in voltage between the resistors. These sensors are employed for each finger to detect the amount of bend each finger makes moreover its internal resistance changes according to the output of the microcontroller. The resistance changes as when the metal pads on the outside of the bend, this sensor works similar to variable resistance because as it twists the resistance changes .This sensor is packed in a thin plastic strip type of material with minute carbon particles layered on its one surface, this layer is divided into small sections and are connected together by a conductive layer in series.

5. SERVO MOTOR

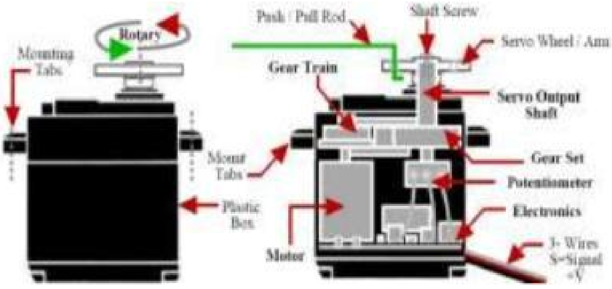


Fig: 4.5 SERVO MOTOR

These are smaller ,cheaper yet powerful motors which can be used to rotate to certain position. It consists of three main parts:1.controller 2.electric motor 3.feedback potentiometer which connects to the output shaft. This allows the motor to rotate to specific angles by keeping the track of its current angular position, it is controlled by Pulse Width Modulation. The ability of the servo motor to rotate to a certain position rather at certain speed makes them much useful in making of prosthetic devices by making accurate movements. A normal motor would require running the motor for a specific time and specific speed to derive a distance but these servo motors can directly choose a position. Inside the servo box is a DC motor which is mechanically linked to position feedback potentiometer, electronic feedback control loop circuitry ,a motor drive electronic circuit, gearbox .Servo motors are of various types such as AC servo motor, DC servo motor, brushless DC servo motor, positional rotation servo motor, continuous rotation servo motor and linear servo motor. If the controlled motor is driven by AC it is known as AC servo motor and if its driven by DC it is known as DC servo motor. The servo motors can usually turn 90 degrees in both the directions and for a total of 180 degrees.

6. GLOVE

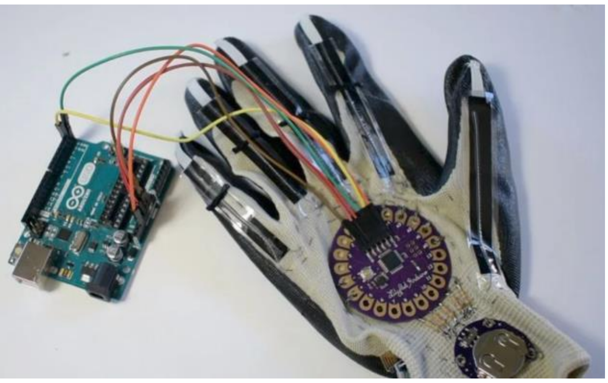


Fig: 4.6 GLOVE

The sensors and their circuits are mounted on the gloves. At first small holes are made on the plastics of the sensors by making sure that the resistive material is not being damaged, after this sew each sensors tip

to the area of the finger which is just above each of the finger nails. For each of the sensors loose loops are made around them with the help of the thread at both joints in each finger. Once each sensor is properly placed at their respective positions the loops of the thread are tightened.

7. JUMPER WIRES

Fig: 4.7 JUMPER WIRE

These are very useful components especially for prototyping, these are simple wires having connectors at their each ends because which they can be used to connect two points without even soldering them. These are available in variety of colour but the colour does not signifies anything they are simply used to differentiate one wire from the other .These wires come in variety of versions:1.male-to-male 2.male-to-female 3.female-to-female.The difference between each of them lies in their end points, male ends can plug into things while female ends are used to plug things into. Male-to-male jumper wires are most commonly used for connecting two ports on a breadboard.

8.BREAD BOARD

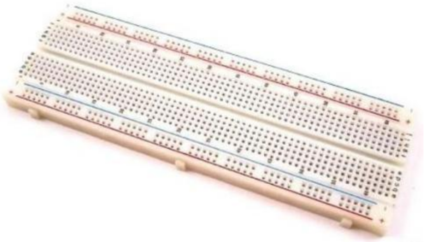


Fig: 4.8 BREAD BOARD

It is a rectangular construction base which is used for prototyping in electronics, it consists of small holes over it which helps to prototype

Electronic circuits. The connections made are not permanent and can be easily removed when required,they do not require soldering for connections. Mostly leads can fit in the breadboards because inside they contain rows of small metal clips, when components are pushed through the holes these metal clips grabs them.

9.NYLON STRING

Fig: 4.8 NYLON STRING

Nylon is basically a thermoplastic silky material which can be processed to films, fibre and any requires shape moreover it is cheap , durable and easily available. It was the first commercial synthetic thermoplastic polymer ,was first commercially used in nylon-bristled toothbrush. Here after stacking the cardboard pieces they were compiled together with the help nylon strings to arrange them in the desired and to make sure that they are securely arranged together.

10 . BATTERY

Fig: 4.10 BATTERY

Alkaline batteries were used for this project, these batteries are primary batteries

which derives its energy from reaction between the zinc metal and manganese dioxide. These are non rechargeable batteries which comes with 1.5 V and 9V ratings, the 1.5 V version batteries comes indifferent varieties such as AA(1000 mAh),AAA(less than 1000 mAh), D(around 2000 mAh),C(2000 mAh to 2500 mAh) whereas the 9V battery comes in 50 to 500 mAh range. These are cheap and are easily available.

11. POTENTIOMETER

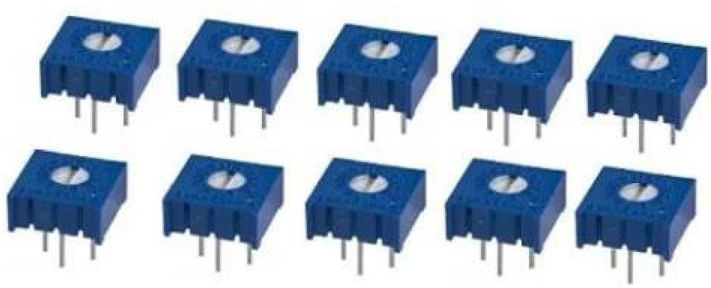


Fig: 4.11 POTENTIOMETER

A potentiometer is a 3 terminal variable resistor in which the resistance is manually varied to control the flow of current, it acts as a voltage divider. A three terminal variable resistor in which out of the three terminals two are fixed and one is a varying terminal. They are of two types linear and rotary and they usually have no anode or cathode, the resistance of the potentiometer is changed when the wiper present in it is moved over the resistive path. Its resistive element is either flat or angled, if its flat the wiper moves linearly and its angled the wiper moves in rotary manner.

12. CARDBOARD BASE

Fig: 4.12 CARDBOARD BASE

It is a heavy duty paper based product which has greater thickness, durability and cheap. These can be cut out into various desired shapes and sizes with the help of a paper cutter or any sharp cutting tool. For this project the cardboard was cut into smaller circles of 2 cm radius base block and were compiled together into a stack and were made to stick each other block with the help of glue, further these smaller blocks were assembled and proper shape was given to the robotic hand.

CHAPTER 5

CONSTRUCTION

5.1 FOR THE HAND

The hardware design of this project contains two main parts, the gesture sensing glove and the robot. For the construction of the robotic hand we required an arduino uno board,a nrf24L01 receiver and nrf24L01 adapter, jumper wires(male-to-male and female-to-female) ,bread board, nylon strings for each finger, electric tape, cable ties, glue gun, a 9V battery,5 servo motors , 5 steel coin spring and cardboard. Firstly the cardboard was cut into circular pieces each of 2 cm radius base with the help of a paper cutter ,after which they were piled and with the help of a glue they were stick together then sandpaper was used to make the surface of the fingers even and for the rest of the area of the hand the cardboard was cut into proper shape of the palm and wrist and were assembled together. After proper shape was given to the fingers ,hole was made at the center of the cardboard blocks and steel coin spring and nylon string was passed from them for each of the fingers ,after completion of this task the blocks of the fingers were covered with electric tape. The nylon string which was passed through each of the fingers were attached to the each of its servo motors ,then the bread board and the arduino uno board were placed at their respective positions and were made secure with the help of the glue gun. Now the connections were ready to be carried out, the GND and VCC of all the servo motors were connected to the VCC and GND of the breadboard and 9V battery was also connected ,the cables of all the servo motors were numbered from1-5 and were made secure with the help of cable ties. We know that 15 to 19 are digital input on the arduino board, the signal connections for all the servos were made on analog input 1 to 5 and arduino GND was connected to the other GNDs. Now the nylon string ends were connected to the servo motors which were used to control the fingers. Further the connection of the nrf24L01 was carried out,the GND and the VCC of the nrf24L01 connected to the GND and VCC of the arduino board, the CSN of the nrf24L01 was connected to the digital pin 10 ,SCK was connected to digital pin 13,MOSI was connected to digital pin 11,MISO was connected to digital pin 12.

5.2 FOR THE GLOVE

For the construction of the glove we required a arduino uno board,a nrf24L01 transceiver ,nrf24L01 adapter, glove, jumper wires(female-to-female and male-to-male),breadboard, 9V battery, glue gun,5 resistors and 5 flex sensors. The gesture control glove made by placing the flex sensors at the top of each fingers and were sewed with the glove to make sure that they remain at their respective positions. After this the connections were made , the GND and VCC were connected to the breadboard and resistors connections were made ,one of its leg was connected to VCC and the other was connected to the analog input .After this the flex sensors were connected ,one leg of the sensor was connected to the analog input and the other was connected to the GND, the nrf24L01 connections remain same as in the robotic hand. This is how the entire construction for the robotic arm and the gesture control glove was carried out, after these connections were made the working was carried out smoothly. This robotic arm was used to grab a ball, a wooden block, pen and a bottle ,hence the working and the efficiency of this robot was tested and implemented.

5.3 HOW DID THE HAND CARRY OUT THE TASK:

For the tasks to be carried out by the robotic arm a person has to handle the gestures by wearing the glove and then perform the required gestures that one needs the robot to perform. For holding a ball ,the glove was worn by a person and the fingers were moved in an inward direction on doing this the flex sensors were bend ,on bending flex sensor sends signal to the micro controller ,further it is transferred to the nfr24L01 transceiver. The transceiver sends the the data to the receiver on the robotic arm ,then the receiver passes on the data to the microcontroller through the analog output pin of the micro controller the data was sent to the servo motor and thus the fingers are driven in inward direction and the hand arm grabs the ball.

CHAPTER 6

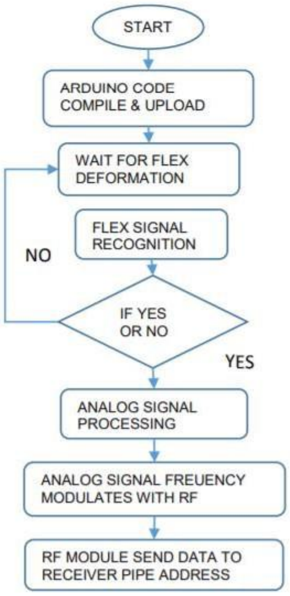
SOFTWARE REQUIRED

- Arduino software is written in C,C++ language.
- It uses Windows, mac Os, Linux

Wireless Communication Arduino-nrf24L01 code

- The code provides to access the required point of communication enrolled in the transmitter and receiver side.
- For executing the program we need RF24 library which is being installed in arduino library.

Our whole code is divided into two segments one for the transmitter part and another for the receiver part.


START
ARDUINO CODE COMPILE & UPLOAD
WAIT FOR FLEX DEFORMATION
FLEX SIGNAL RECOGNITION
NO
IF YES OR NO
YES
ANALOG SIGNAL PROCESSING
ANALOG SIGNAL FREUENCY MODULATES WITH RF
RF MODULE SEND DATA TO RECEIVER PIPE ADDRESS

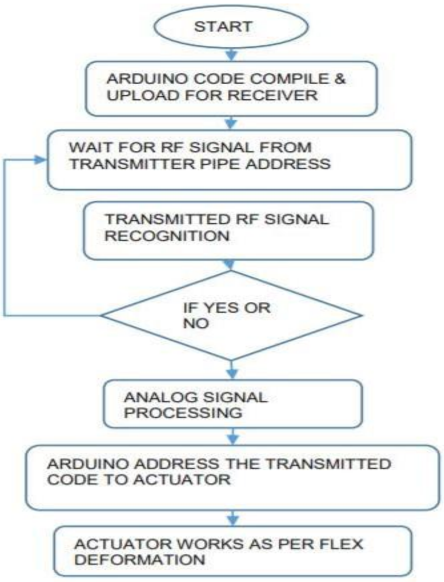

START
ARDUINO CODE COMPILE & UPLOAD FOR RECEIVER
WAIT FOR RF SIGNAL FROM TRANSMITTER PIPE ADDRESS
TRANSMITTED RF SIGNAL RECOGNITION
IF YES OR NO
ANALOG SIGNAL PROCESSING
ARDUINO ADDRESS THE TRANSMITTED CODE TO ACTUATOR
ACTUATOR WORKS AS PER FLEX DEFORMATION

Fig: 6.1 TRANSMITTER FLOW CHART

Fig: 6.2 RECEIVER FLOW CHART

Code:

6.1 Transmitter Code

We will make one device with the modem which will send the data string to the other device. The other device will send the received data back to the original device again and that will be get displayed in the Arduino serial monitor.

```
#include <SPI.h>

#include <nrfL01.h>

#include "RF24.h"
```

SPI.h is used to hadle the communication interface with the modem.

nrf24L01.h is used to handle this particular modem

RF24.h is the library which helps us to control the radio modem.

```
int msg[1];
```

The msg is used to send and receive the data from the RF module.

```
int flex5 = A5;

int flex4 = A4;

int flex3 = A3;

int flex2 = A2;

int flex1 = A1;
```

Defining the flex sensor input names where A5,A4,A3,A2 and A1 are the analog inputs.

```
//define variables for flex sensor values
int flex5_val;
int flex4_val;
int flex3_val;
int flex2_val;
int flex1_val;

RF24 radio(5,10);
```

Here we've created an object called radio which represents a modem connected to the arduino. Arguments 5 and 10 are a digital pin numbers to which the signals CE and CSN are connected.

```
const uint64_t pipe = 0xE8E8F0F0E1LL;
```

// ***const unit64_t pipe is the variable where we're storing the address of the modem that will receive data from the arduino and the address that we're using to write our data is 0xE8F0F0E1LL.***

```
void setup(void){
  Serial.begin(9600); //Serial.begin(9600) sets the baud rate with the computer
                      //via USB/COM.
  radio.begin();
  radio.openWritingPipe(pipe);
  radio.stopListening();
}
```

We call the method "radio.method()" in the setup function to activate the modem. The next method "radio.openWritingPipe(pipe) sets the address of the receiver to which the program will send data.

The last method in the setup function is "radio.stopListening()". It switch the modem to data transmission mode.

```
void loop(){


  flex5_val = analogRead(flex5);
  flex5_val = map(flex5_val, 1023, 0, 0, 10);
  msg[0] = flex5_val;
  radio.write(msg, sizeof(msg));


  flex4_val = analogRead(flex4);
   flex4_val = map(flex4_val, 1023, 0, 11, 20);
  msg[0] = flex4_val;
  radio.write(msg, sizeof(msg));


  flex3_val = analogRead(flex3);
  flex3_val = map(flex3_val, 1023, 0, 21, 30);
  msg[0] = flex3_val;
  radio.write(msg, sizeof(msg));


  flex2_val = analogRead(flex2);
  flex2_val = map(flex_2_val, 1023, 0, 31, 40);
  msg[0] = flex_2_val;
  radio.write(msg, sizeof(msg));

  flex1_val = analogRead(flex1);
  flex1_val = map(flex1_val, 1023, 0, 41, 50);
  msg[0] = flex1_val;
  radio.write(msg, sizeof(msg));
}
```

Map function is used to remaps a number from one range to another. Here in the loop function we've started by creating a message(msg) that we want to send using modem. By using the method radio.write(msg,1) we send the message through the radio to the modem. First argument is an indication of the variable that stores the data. The second argument is the number of bytes that the radio will take from a variable to be sent.

6.2 Receiver Code

```
#include <Servo.h>    //the library which helps us to control the servo motor
#include <SPI.h>      //the communication interface with the modem
#include "RF24.h"     //the library which helps us to control the radio modem

//define the servo name
Servo myServo1;
Servo myServo3;
Servo  myServo4;

Servo  myServo2;

Servo mySerovo5;


RF24 radio(5,10);
```

This object represents a modem connected to the Arduino. Arguments 5 and 10 are a digital pin numbers to which signals CE and CSN are connected.

```
const  uint64_t  pipe  =  0xE8E8F0F0E1LL;    //the address of the modem,that  will
                                              receive data from the Arduino.
int msg[1];


int data; //data variable

//int pos; //position variable


void setup(){


  //define the servo input pins

  myServo1.attach(15); //A1

  myServo3.attach(16); //A2

  myServo4.attach(17); //A3

  myServo2.attach(18); //A4

  myServo5.attach(19); //A5

  radio.begin();                    //it activates the modem.

  radio.openReadingPipe(1, pipe);
```

```
//determines the address of our modem which receive data.
  radio.startListening();           //enable receiving data via modem
  }
void loop()
{
 if(radio.available()){ radio.read
    (msg, sizeof(msg));

    if(msg[0] <11 && msg[0] >-1){
      data = msg[0], pos=map(data, 0, 10, 175, 0);
      myServo1.write(pos);
    }
    if(msg[0] <21 && msg[0]>10){
      data = msg[0], pos=map(data, 11, 20, 175, 0);
      myServo3.write(pos);
    }
    if(msg[0] <31 && msg[0]>20){
      data = msg[0], pos=map(data, 21, 30, 175, 0);
      myServo4.write(pos);
    }
    if(msg[0] <41 && msg[0]>30){
      data = msg[0], pos=map(data, 31, 40, 175, 0);
      myServo2.write(pos);
    }
    if(msg[0] <51 && msg[0]>40){
      data = msg[0], pos=map(data, 41, 50, 175, 0);

      myServo5.write(pos);

    }

  }}
```

Here if we want to find out a particular flex sensor in the transmitter part which is going to control it's respective servo motor in the receiver part then we'll use myServo.write(msg[?]) method. For example in our code, msg[0] sends the data of flex sensor5. So if we want to control the servo motor 5 with flex-sensor 5 we can do this by writing myServo5.write(msg[0]).

Due to this pandemic situation we faced a problem in implementing our project work with the said equipments for which we've created our code previously, so we're providing *our* alternative *running prototype which will work similarly without nrf module. Moreover many libraries are also not available there in proteus so we thought of changing our code little bit.*

Running Prototype

*****Code*****

```
#include <Servo.h>

Servo servo_1;
Servo servo_2;
Servo servo_3;
Servo servo_4;
Servo servo_5;

int flex_1 = A0;
int flex_2 = A1;
int flex_3 = A2;
int flex_4 = A3;
int flex_5 = A4;

void setup()
{
  servo_1.attach(9);
  servo_2.attach(10);
  servo_3.attach(11);
  servo_4.attach(12);
  servo_5.attach(13);
}


void loop()
{
  int flex_1_pos;
  int servo_1_pos;
  flex_1_pos = analogRead(flex_1);
  servo_1_pos = map(flex_1_pos, 0, 1023, 0, 175);
  //servo_1_pos = constrain(servo_1_pos, 0, 180);
  servo_1.write(servo_1_pos);

  int flex_2_pos;
  int servo_2_pos;
  flex_2_pos = analogRead(flex_2);
  servo_2_pos = map(flex_2_pos, 0, 1023, 0, 175);
  //servo_2_pos = constrain(servo_2_pos, 0, 180);
  servo_2.write(servo_2_pos);


  int flex_3_pos;
  int servo_3_pos;
   flex_3_pos = analogRead(flex_3);
  servo_3_pos = map(flex_3_pos, 0, 1023, 0, 175);
  //servo_3_pos = constrain(servo_3_pos, 0, 180);
  servo_3.write(servo_3_pos);


  int flex_4_pos;
  int servo_4_pos;
  flex_4_pos = analogRead(flex_4);
  servo_4_pos = map(flex_4_pos, 0, 1023, 0, 175);
  //servo_4_pos = constrain(servo_4_pos, 0, 180);
  servo_4.write(servo_4_pos);


  int flex_5_pos;
  int servo_5_pos;
  flex_5_pos = analogRead(flex_5);
  servo_5_pos = map(flex_5_pos, 0, 1023, 0, 175);
  //servo_5_pos = constrain(servo_5_pos, 0, 180);
  servo_5.write(servo_5_pos);

}
```

CHAPTER 7

CONCLUSION

This project was implemented through micro controller, flex sensors, servo motors in wireless mode using radio frequency. This project has a great use and scope in future ,at present this robot works efficiently and has wide range of applications .But much more modifications could be carried out with this project such as this robot could be used in distressed situations like for bomb diffusion or for very complex jobs which cannot be handled by the humans and with the gesture sensing technique it becomes much more beneficial as modification carried out on this could help control of electronic devices in a house using different gestures using the concept of IOT and could help a physically disabled who speak for his/her needs can sense hand signs as gestures and then eventually use a speaker or display medium to convey the message. For now this project could be used in industries and for medical purposes ,as we know every year a lot many people suffer through stroke which eventually might lead to partial impairment or for the ones who had suffered an accident for them this is very useful ,even for the ones working in hazardous areas who might be subjected to radiations can use this for their safety.

7.1 SUMMARY

We completed this project on the Arduino IDE. It was our first hands on experience on the arduino platform and because of different libraries for Arduino, we had a great experience while working on this project. One thing we learned from this project is the positioning of different sensors and how timing and environmental condition can lead to all sorts of undesirable readings. We also faced some challenges and problems with the performance of different sensors like servos because they require a lot of fine-tuning to get accurate readings. There was no error while operating animatronic hand thus making it a great success overall. Our Animatronic hand met all safety restriction easy to operate and is energy efficient. With more time and resources put for things like motors and base design we can carry a much larger payload and have a sturdier platform to carry things in. In the near future, we believe that this will have a greater purpose to serve in the practical life which will save countless human lives.

Some of the Application of Animatronic Hand that can be implemented are -

(a) Handling of the explosive objects.

(b) Performing various sophisticated operational jobs in the medical sectors.

(c) Industrial Manufacturing

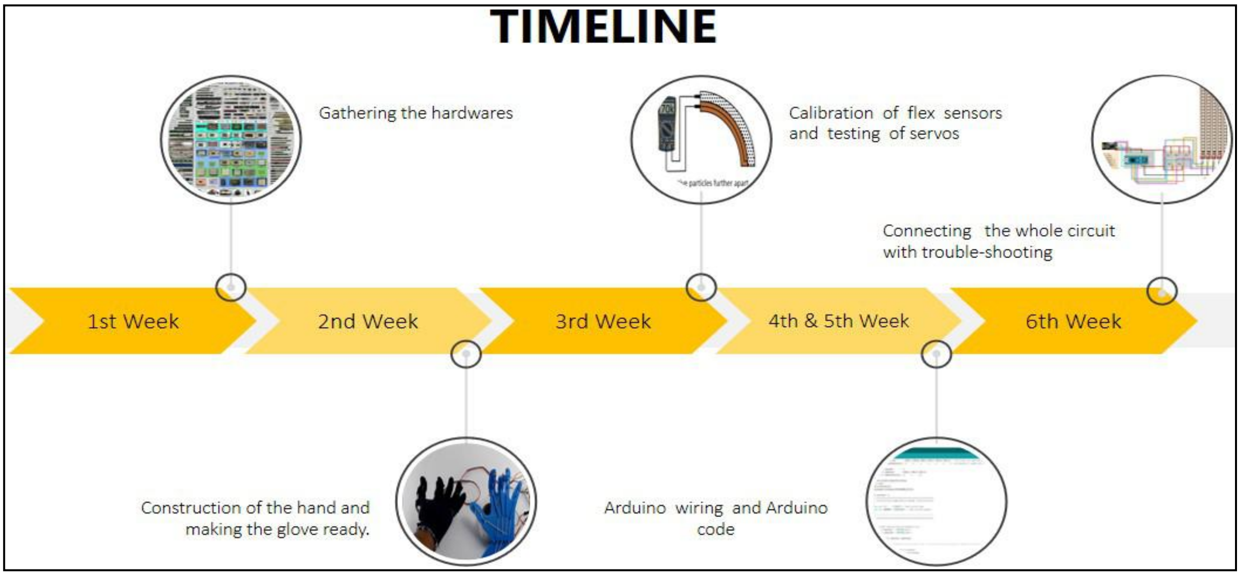
- Further much of this project could be used or improved upon by future Electronics and Telecommunication students.

7.2 COST TABLE FOR COMPONENT USED

COMPONENTS	***PRICE (IN RUPEES)***
1. ARDUINO UNO	380*1 = 380.00
2. SERVO SG90	95*5 = 475.00
3. BREAD BOARD	40*2 = 80.00
4. JUMPER WIRE	150*3 = 450.00
5. BATTERY	480*1 = 480.00
6. CHARGER	1500*1 = 1500.00
7. FLEX SENSOR 2.2	350*4 = 1400.00
8. FLEX SENSOR 4.5	600*6 = 3600.00
9. Nrf24l01+Nylon String	320
OVERALL COST =8,685	

Fig: 7.1 COST TABLE

7.3 TASKING AND SCHEDULING OF THE PROJECT -



TIMELINE

Gathering the hardwares

Construction of the hand and making the glove ready.

Calibration of flex sensors and testing of servos

Arduino wiring and Arduino code

Connecting the whole circuit with trouble-shooting

Fig: 7.2 TIMELINE

7.4 REFERENCE

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