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Advanced Robotic Arm Control using Human Arm Movement

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Abstract -In India about 6 million people are suffering from speech impairment and hearing impairment. People with speech impairment use sign languages to communicate with the society which is difficult for normal people to understand. Thus communication between deaf-mute people and normal people had always been a challenging task all over the world. Sign language is the only solution to this problem which helps deaf-mute people to communicate. The aim behind this work is to develop a flex-sensor based gesture recognition module which converts sign language to speech output. The glove is embedded with flex sensor and accelerometer. The voltage signals will then processed by microcontroller and sent to text to speech module where the outputs are stored and produce appropriate voice with the help of speaker.

Key Words:speech, gesture, recognition, sensor, microcontroller, signals

1. INTRODUCTION

The field of robotics is very interesting to anyone that curious about how living things or organisms (including people) interact with the real world. Robotics is a very comprehensive, applications-oriented field of study. A complete understanding of robotics involves many different technical areas such as electrical principles, electronic devices, digital principles, electromechanical fundamentals, basic programming techniques, hydraulics, pneumatics, and basic manufacturing process. Generally, robots had been created for certain purposes or agency. A robot has artificial intelligence programmed which running by its own or control by a controller. Now a days, the robotics development is increasing day by day and the scenario is changing as per the technological development where robots is playing an important role for developing the product, Carrying Goods, Defense, Home Application etc. The most challenging job for the robot in these development is to lift goods, where various parameters is to be studied to lift goods smoothly. Taking in action all these parameters the developed animatronic hand is developed which will lift goods easily. The technologies used for developing this robot is advanced as compare to the other technologies. The controlling is based on servo motors and flex sensors whereas for establishing the wireless communication UART transcreceiver is used, working on 2.4GHz bandwidth.

As developed animatronic hand which lifts particular goods but our motto is to developed a robot to help/get involved in many of the industries where human hand is must to complete the required task; but it may harm human skin or bones. Here, instead of using actual human hand, we can replace it by this wireless robotic hand. We may allow this robotic hand to complete the same task so that the risk will be avoided and obviously, required task can be achieved. For example, consider a chemical industry where highly hazardous chemicals are to be handled every day. In this case, to handle extremely hazardous substances like Allylamine, Bromine chloride, Methyl isocyanate etc. if we will allow this wireless animatronic hand, it will be safer for everyone. Also this hand can help paralysis patients who can't move from the bed. Consider a paralysis patient wants to switch ON the fan; but he can't get up from the place where he is and he is alone at his home. In this case, a robotic hand is there, so that by moving a control glove, he can easily push the switch by using a wireless robotic hand. which is used for lifting recurring loads like books, food grains etc.

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2. COMPONENTS USED FOR IMPLEMENTATION

2.1 ARDUINO – UNO :

The Arduino Uno is a microcontroller board based on the ATmega328 . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to

the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2.

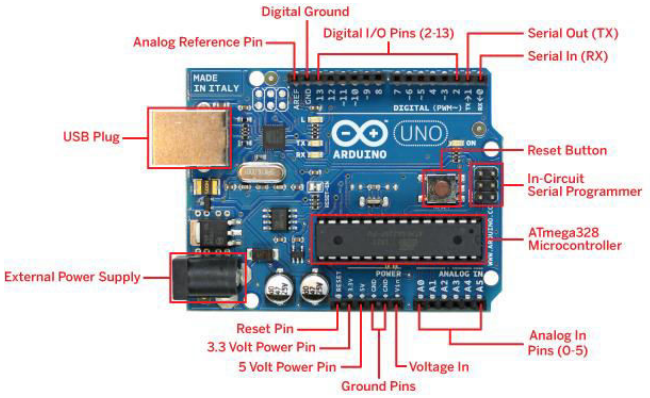

Fig –1: Arduino front view

2.2 Flex Sensor

A mechanical device which provides a variable resistance values after bending it; is known as a flex sensor. Using a flex sensor, it is possible to measure the amount of resistance which is produced by a flex sensor by passing particular amount of a voltage through a flex sensor and into an analog input on Arduino UNO board. A flex sensor is also known as a potentiometer or a variable resistor. Flex sensors are basically made up of resistive carbon elements. A flex sensor has a great form factor on a flexible thin substrate, as a variable printed resistor. When the substrate is bent, potentiometer or a flex sensor produces the output resistance as per the bent angle.

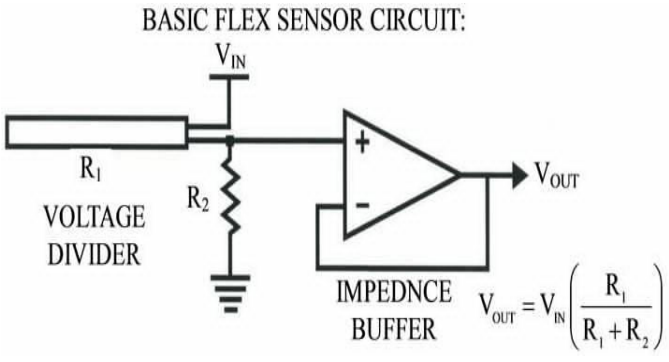

Fig –2: Basic flex sensor circuit

Working of Flex Sensor :

The flex sensor detects higher resistance when it bends. It usually has about 30k ohms at rest and will increase up to 50k ohms at a maximum angle, which is 90 degrees. ... The resistor for the flex sensor is 10k. A flex sensor or bend sensor is a sensor that measures the amount of deflection orbending. Usually the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. Since the resistance is directly proportional to amount of bend it is used as goniometer, and often called flexible potentiometer.

2.3 UART TRANSRECEIVER MODULE

A UART (Universal Asynchronous Receiver/Transmitter) is the microchip with programming that controls a computer's interface to its attached serial devices. Specifically, it provides the computer with the RS-232C Data Terminal Equipment (DTE) interface so that it can "talk" to and exchange data with modems and other serial devices. As part of this interface, the UART also:

- Converts the bytes it receives from the computer along parallel circuits into a single serial bit stream for outbound transmission
- On inbound transmission, converts the serial bit stream into the bytes that the computer handles
- Adds a parity bit (if it's been selected) on outbound transmissions and checks the parity of incoming bytes (if selected) and discards the parity bit
- Adds start and stop delineators on outbound and strips them from inbound transmissions
- Handles interrupts from the keyboard and mouse (which are serial devices with special ports)
- May handle other kinds of interrupt and device management that require coordinating the computer's speed of operation with device speeds

Serial transmission is commonly used with modems and for non-networked communication between computers, terminals and other devices.

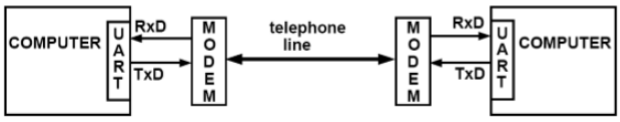

Fig-3 : Serial Data Transmission of UART

2.4 SERVO MOTOR

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consist of a suitable motor coupled to a sensor for position feedback.it also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNS machinery or automated manufacturing.

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal(either analog

or digital) representing the position commanded for the output shaft.

The motor is paired with some type of encoder to provide position and speed feedback.in the simplex case , only the position is measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

3. SYSEM DESIGN

3.1 PCB Fabrication :

PCB fabrication includes following steps:

1. Layout of the circuit
2. Artwork of designing
3. Printing
4. Etching
5. Drilling
6. Mounting of component and soldering
7. Finishing

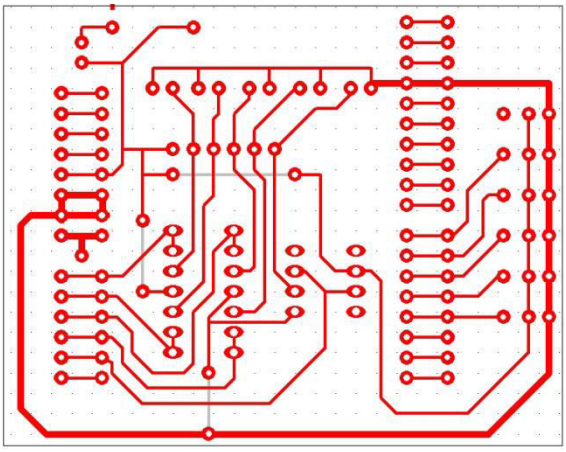

Fig-4. PCB design for Transmitter

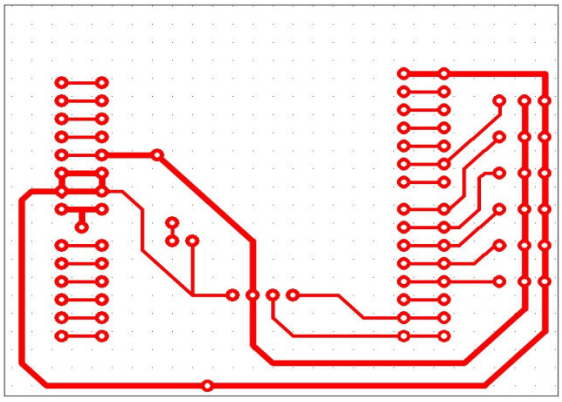

Fig-5. PCB design for Receiver

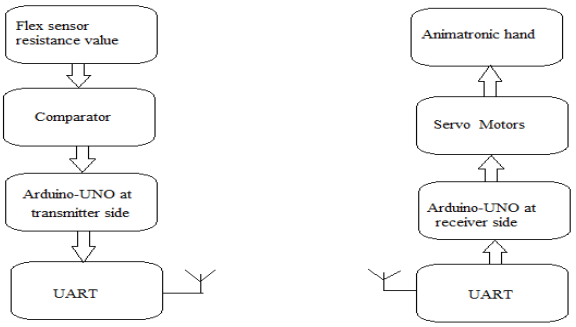

Fig-6. Flow Diagram of the Proposed System

The whole working of project is divided into two parts i.e., transmitter and receiver. As far as transmitter is concerned, there are four main stages which are flex sensor, comparator circuit, arduino-UNO and UART transreceiver module. Initially flex sensor is mounted on cotton or woolen gloves, A mechanical device which provides a variable resistance values after bending it; is known as a flex sensor. Using a flex sensor, it is possible to measure the amount of resistance which is produced by a flex sensor by passing particular amount of a voltage through a flex sensor and into an analog input on Arduino UNO board. A flex sensor is also known as a potentiometer or a variable resistor. Flex sensors are basically made up of resistive carbon elements. A flex sensor has a great form factor on a flexible thin substrate, as a variable printed resistor. When the substrate is bent, potentiometer or a flex sensor produces the output resistance as per the bent angle as shown in fig.

From the above figure , it is clear that as the bend angle of a flex sensor increases, resistance goes on increasing. Nominal resistance is present at a flat position of a flex sensor. Smaller the radius, the resistance will be higher. Output voltage is measured by using a mathematical formula. This formula is a voltage divider formula (figure 4.3) using which, corresponding variable voltage will be measured which will be given as an input to the Arduino-UNO.

As shown in the figure , variable output voltage can be measured for different bent angles. It is up to the user to find out required number of voltages. If you want five different bent voltages or ten or twenty different voltages using one flex sensor, it is always possible to measure it using a same formula. Here, five flex sensors are used. So, three voltages are measured for each and every flex sensor.

To handle the finger movements and rotations, micro servo motors are being used in this project. A rotary actuator that allows for a precise control of velocity, acceleration as well as an angular position is known as a servomotor. Servomotor is a motor suitable for use in a closed loop control system. It includes suitable motor

coupled to a sensor to get a position feedback. It need a relatively sophisticated controller, often a dedicated module which is designed specifically for use with servomotors. servo motor gives different angles for different duty cycles. In this project, at the receiver side, these five motors are connected so that, we can achieve a smooth movement of a finger of a robotic hand.

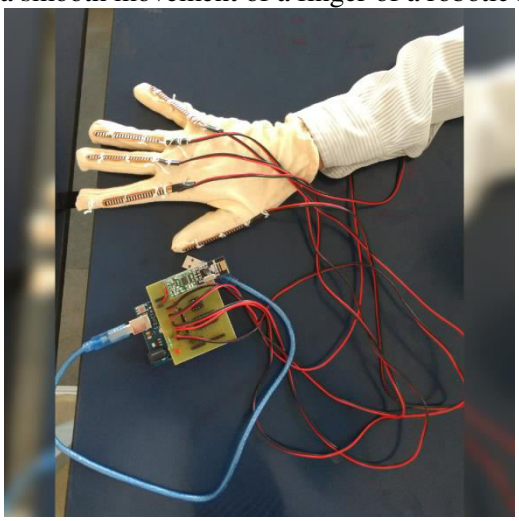

Fig.7 Actual Robotic hand at Transmitter End

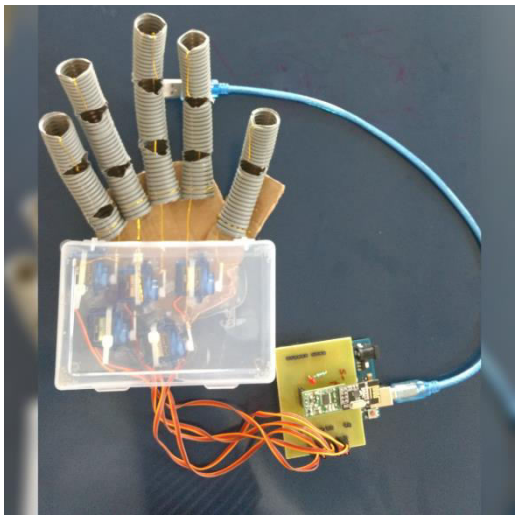

Fig.7 Actual Robotic hand at Receiver End

4. PROPOSED METHODOLOGY

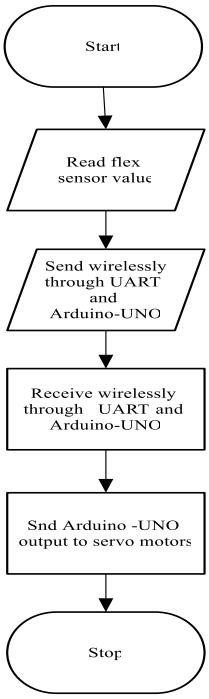

Fig.8. Flow of the Proposed System

Proposed Algorithm

1. Start
2. Get the analog output from flex sensors.
3. Convert into digital form and send it to UART.
4. Send data wirelessly through UART on transmitter side.
5. Receive the data wirelessly UART on receiver side.
6. Give the output to the servomotors accordingly.
7. Stop.

5. RESULTS

A wireless animatronic hand was first tested with a single finger. It was observed that after bending the single flex sensor at the transmitter side, the corresponding robotic finger moved in the same direction and same angle.

Servo motor causes the movement of a robotic finger. With reference to this, all five servo motors moved by five flex sensors on a cotton or woolen glove. In this way, a wireless communication has been achieved successfully. So, now it is possible that a man can control a robotic hand from a distance wirelessly.

This robot offers an interactive learning experience and teaches us essential skills such as Mechanics, electronics, programming, critical thinking, problem solving and teamwork,

Taking an idea and executing into real work will be hour prime motto of these project.

Thus we have successfully built animatronic hand using arduino.

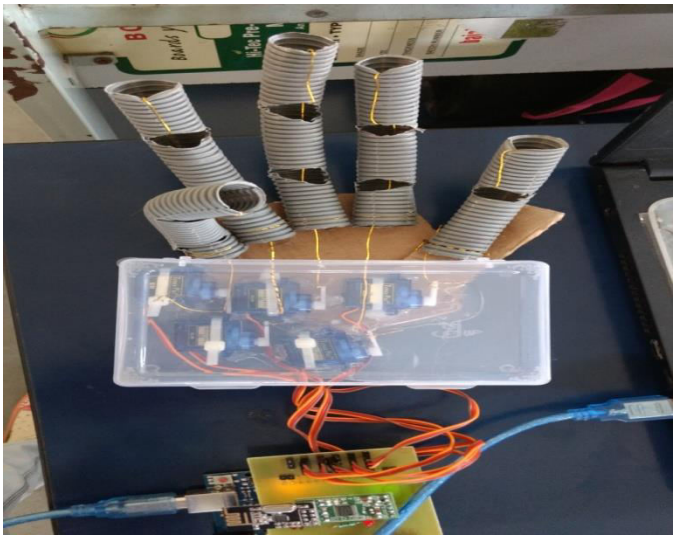

Fig.9. Actual Implemented system

6. CONCLUSION AND APPLICATIONS

As per proposed model, We have successfully completed the design and development animatronic hand using arduino. The UART transreceiver module is the perfect hardware module for wireless communication network between transmitter and the receiver model.

6.1 APPLICATIONS

1. For use in Chemical industries for safety point of view to human hand.
2. As a part of Humanoid robot to perform various tasks.
3. In medical field for physically challenged patients.
4. For Military use in bomb diffusing .
5. For use in Robots that help deaf and dumb in chatting with sign language.

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