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Arduino Based Wireless Robotic Hand Using Zigbee

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ABSTRACT: Wireless hand is basically a robotic hand which is implemented by using a latest wireless technology. Robotic hand is the use of mechatronics to create machines which can work like real hand. Robotic hand figures mostly powered by pneumatics (compressed air),& in special instances, hydraulics (pressurized oil), or by electrical means. The figures exactly dimensioned and proportioned as human fingers. Motion actuators are used to resemble muscle moves, such as limbs to generate motions. Also, the figure is covered with skins made of hard and soft plastic materials. Then, the figure can be completed by adding details like coloring and other components to provide real look for figure.

KEYWORDS: Robotic , Wireless , Pneumatics , Hydraulics , realistic , shells

Component required

- ARDUINO UNO (ATmega 328 microcontroller)
- Flex Sensor
- Micro Servo Motors SG90
- XBEE-S2 (wireless module)

I. INTRODUCTION

This project intends to implement an affordable electronic product known as wireless animatronic hand based on wireless technology based on XBee-S2 as well as Arduino- UNO board. Arduino-UNO is a microcontroller board which has on-board microcontroller ATmega-328. It has total 14 pins including analog and digital pins. There are 6 PWM(Pulse Width Modulation) output pins on this board. Also, it has 6 analog inputs, a USB connection, a power jack, a 16 MHz ceramic capacitor, an ICSP header and a reset button. The Arduino-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; so that this board is used to make this robotic hand. Basically there are two main parts of this project i.e. transmitter (Control glove) and receiver mechanical-electronic robotic hand). Control glove mainly consists of flex sensors. There are total five flex sensors placed separately on each finger on the glove. Human hand will control another robotic hand; so that it is called as a control glove. Future efforts would be to make this hand to fly as well as to move from one place to another.

II. WORKING OF SYSTEM

There are basically two parts of a wireless animatronic hand i.e. Transmitter side is a control glove and another is a Receiver which is a electronic hand. In the first block of transmitter side, there are Arduino-UNO and XBee-S2 and

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flex sensors . This part is known as a control glove. 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.

These flex sensor's change in resistance is converted into change in voltage with the help of voltage divider network.

These analog voltages are connected to the input ADC pins of the Arduino board. Arduino has 10-bit ADC which gives output between 0-1023 levels. The ADC converts the analog voltage in digital form and send to the serial port. The serial port is connected to th X-Bee S2 module which sends the data wirelessly to receiving side.

The Receiver has X-Bee, Arduino Uno and Micro servo motor. The X-Bee receives the data which is send through the transmitter. The receiver Arduino Uno process the receiver the data and controls the movement of servo motors. Servomotor is a rotary actuator that allows for a precise control of velocity, acceleration as well as an angular position. To handle the finger movements and rotations, micro servo motors are being used in this project. The servomotors are connected to the PWM pins of Arduino . The Arduino generates the PWM signals of different width in accordance with the data received and controls the servo motor rotation. The servo motors rotates between 0-180 degree and move the fingers of electronic hand and imitates the movement of users.The electronics hand acts as a shadow hand.

III. ALGORITHM

1. START.
2. INITIALIZE ADC AND UART OF ATMEGA 328.
3. GET THE ANALOG OUTPUT FROM FLEX SENSORS.
4. CONVERT THE ANALOG INPUT INTO DIGITAL FORM.
5. MAP THE ADC OUTPUT BETWEEN 0-180 DEGREE.
6. SEND THE DATA TO THE UART.
7. SEND DATA WIRELESSLY THROUGH ZIGBEE ON TRANSMITTER SIDE.
8. RECEIVE THE DATA WIRELESSLY THROUGH ZIGBEE ON RECEIVER END.
9. SEND THE RECEIVED DATA TO THE SERVOMOTORS ACCORDINGLY.
10. RESET THE TRANSMITTER AND RECEIVER SIDE SIMULTANEOUSLY FOR SYNCHRONIZATION.
11. STOP

IV. TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the hardware and/or software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement. Levels of tests are as follows:

- Unit Testing.
- Integration Testing.
- Functional Testing.
- Validation Testing.
- Regression Testing.
- Alpha Testing.
- Beta Testing.

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1. Component Test

a) Flex sensor:

- Flex sensors are variable resistor whose value keeps changing according to the bending of finger on which it is mounted.
- Connect Flex sensors in voltage divider network with the help of 10 kohm resistance.
- Take output of all the sensors and give to ADC of the Arduino UNO.

b) Arduino UNO:

- To check the normal functionality of the Arduino Uno , connecte it to PC via USB
- Open the Arduino IDE and select the COM port.
- When it is supplied with power, different LED blinks like power LED.
- To check the functionality and serial port, burn LED flashing and serial communication program into the board.
- Observed the output on the hyperterminal.

c) Zigbee: It used as wireless communication module.in this X-Bee S2 module is used which is not a plug and play device. First it needs to be configured using a standard software called X-CTU. Zigbee is connected to the PC via Arduino Uno and configuration is done

- Disable bootloader of Arduino by burning a blank code to bypass Arduino. It is done so that the configuration commands are directly send to the X-Bee.
- Open the X-CTU software and detect the X-bee module connected to it.
- Read the configuration file of X-bee and configure it setting the Baud rate, Destination address, PAN ID depending upon whether it is a transmitter or receiver .
- Open the terminal in X-CTU to check the connectivity and communication between the two Zigbee.
- To check the working of the X-bee with Arduino a simple communication program is burnt into Arduino and the received data is viewed on the hyperterminal.

d) Micro servomotor SG90:

- Servomotor motor is nothing but an angle actuator which works on PWM pulses.
- Servomotors angle movement between 0-180 degree.
- Interfaced servomotors with PWM, Vss and Vcc pins of Arduino.
- PWM code is burnt in the Arduino via USB.
- angular movement are observed for different PWM signals.

2. System Test

All the units of project such as servomotors, flex sensor, zigbee were assembled and mounted on the board. They were interfaced properly. The testing of the whole assembly took place in following steps:

- Initially, tie the sensors on the surface of the glove by thread. This is done to bend the flex sensor with the bending of the glove.
- Connect the terminals of the sensors with the voltage divider network. The network consist of 10kohm resistance with one point to 7.5 DC voltage and the other to ground.
- Give the output of the network to ADC pin of Arduino. The Arduino process the value from the sensors for transmission.
- Give the value from Arduino is to the Zigbee module. X-Bee (S- 2) send the data wirelessly from the transmitter to the receiver section.
- Receive the transmitted data on Receiver side which consists of the X-Bee and pass it to receiver Arduino.
- Interface the Servomotors (SG 90) with the receiver Arduino via 3 Terminals Vcc, ground and PWM .
- Process the received data and produce PWM signals accordingly on the respective pins of Arduino.
- Tie the shaft of the motor with the robotic hand fingers with the thread which bends depending upon the shaft movement.

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V. RESULT AND ANALYSIS

The Animatronic hand using wireless modulation works smoothly without any hindrance. When the fingers are bent, the flex sensors resistance changed accordingly and with the help of voltage divider network , this change in resistance is converted into change in voltage. The inbuilt ADC converted the analog voltage into digital form and finally sent to the serial port which is sent wirelessly through X-Bee.
The receiver electronic hand imitated the control glove which is mounted on the receiver's hand. The receiver side X-Bee received the transmitted data from the flex sensors. The Arduino UNO processed the received data and produced the precise PWM signals to control the movement of servomotors. As the user bent the fingers , the servomotors rotated to control the movement of electronic hand fingers and all the movements of hands are imitated. So the objectives mentioned in the previous sections of the project report are completely fulfilled.

Detailed alysis of the components:
Flex sensor: Flex sensors are connected in a voltage divider network in series with 10 kohm resistance. The network is supplied with 7.5 DC voltage. The reading observed are as under:

Bending angle	Resistance	Voltage
0	25.8 kohm	5.4 V
90	40 kohm	5.97 V
180	60 kohm	6.6 V

Table.1 Observation table of flex sensor

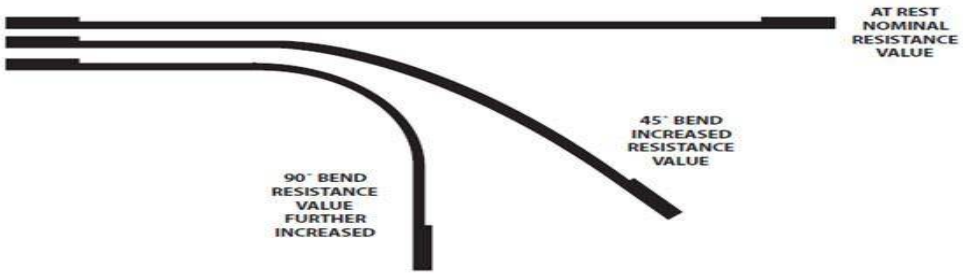

Fig:1 different bending positions of flex sensors

Fig:2 Flex sensors mounting

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1) **Arduino UNO:** Arduino UNO board consist of ATmega 328 micro contollerfor the operation. To check the functionality and serial port of board with PC, a simple LED flashing code and serial communication code is burned and results are as under:

Operation: 1) condition 'on' – LED blinks
2) condition 'off'- LED doesn't blinks

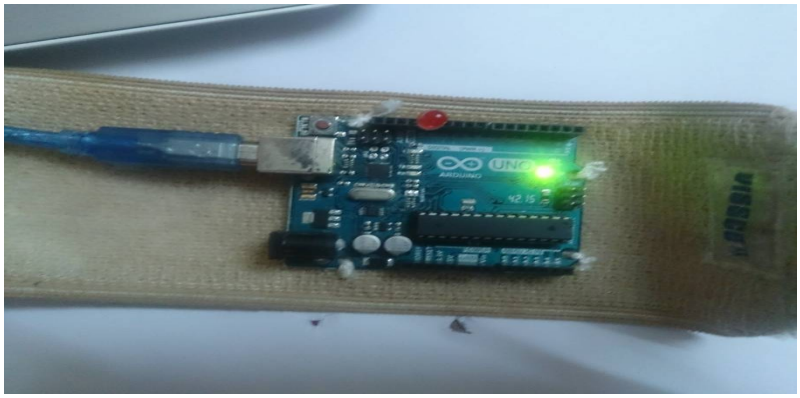

Fig.3 LED off

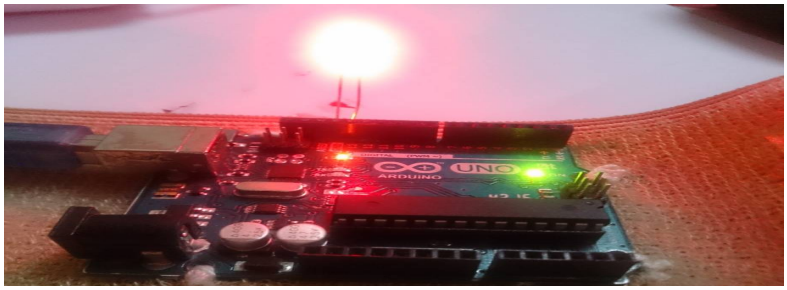

Fig.4 LED on

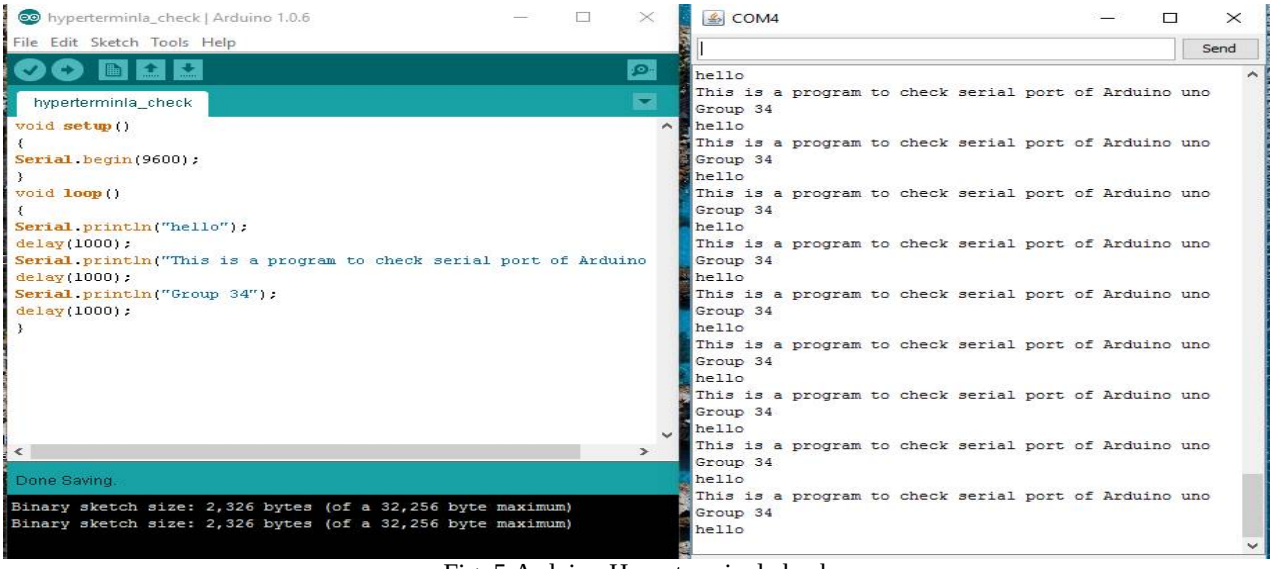

Fig:.5 Arduino Hyperterminal check

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3) Micro servo motor: The servomotors SG- 90 is interfaced on the PWM pins of Arduino UNO board. Motors provide very precise angular movement depending on the control signals.

Pulse duration	Angular movement
1 msec	0 degree
1.25 msec	45 degree
1.5 msec	90 degree
1.75 msec	135 degree
2 msec	180 degree

Table: 7.2 Angular movements of servomotors depending on pulse duration

motor at 0 deg. motor at 90 deg. motor at 180 deg.

Fig: 6 Motor at different angles

4) X-Bee : Both are transmitter(COM3) and receiver(COM4) Zigbee are connected to PC and the communication between them is established as below :

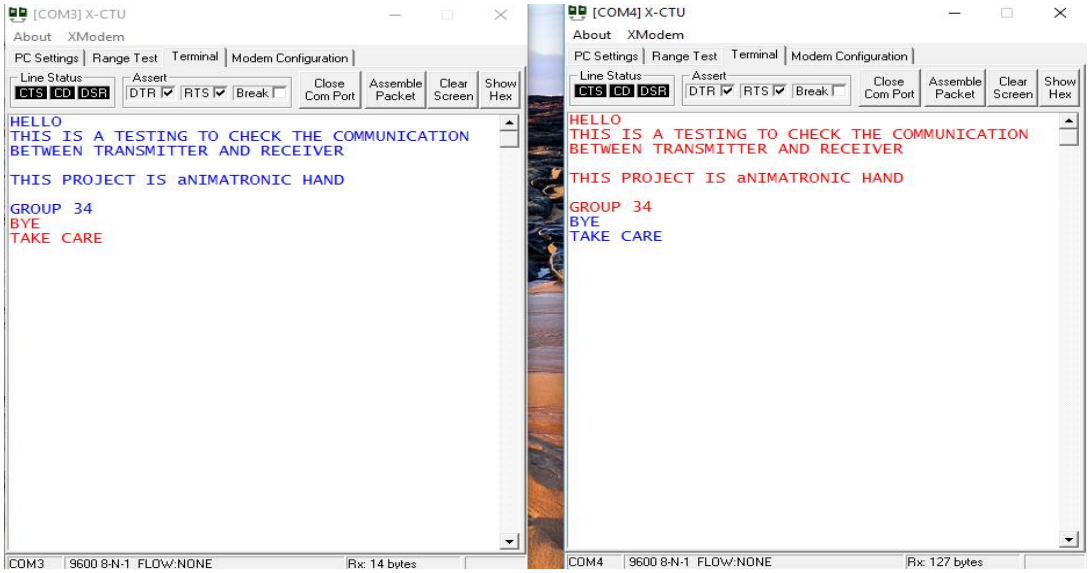

Fig.7 Communication between TX and RX X-Bee

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5) System:

The control glove (Transmitter side) and electronic hand (Receiver side) are connected to power supply. Both are parts are synchronized with each other for wireless serial communication. There can be different conditions of control glove and electronic hand like one finger bending, no finger bending, thumb bending. The few such conditions are as follows:

Condition 1: No bending that is initial condition

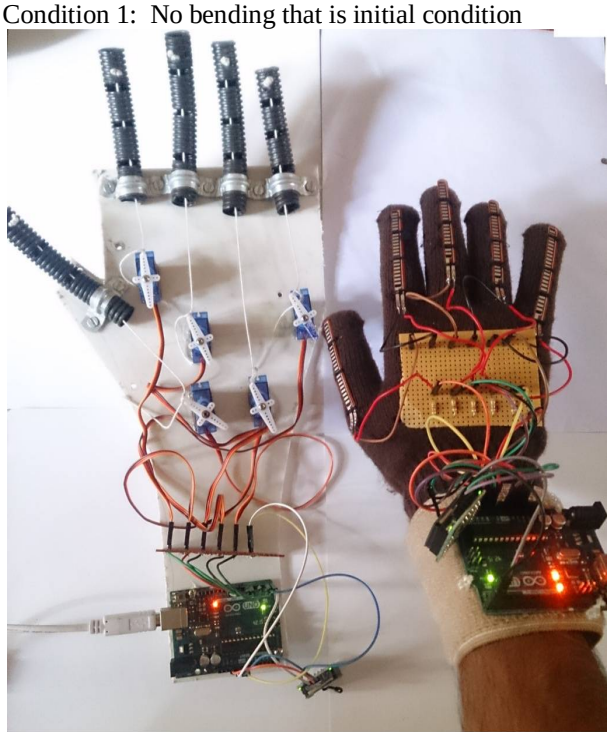

Fig.8 Initial Condition (No Bending)

Condition 2 :Thumb bending

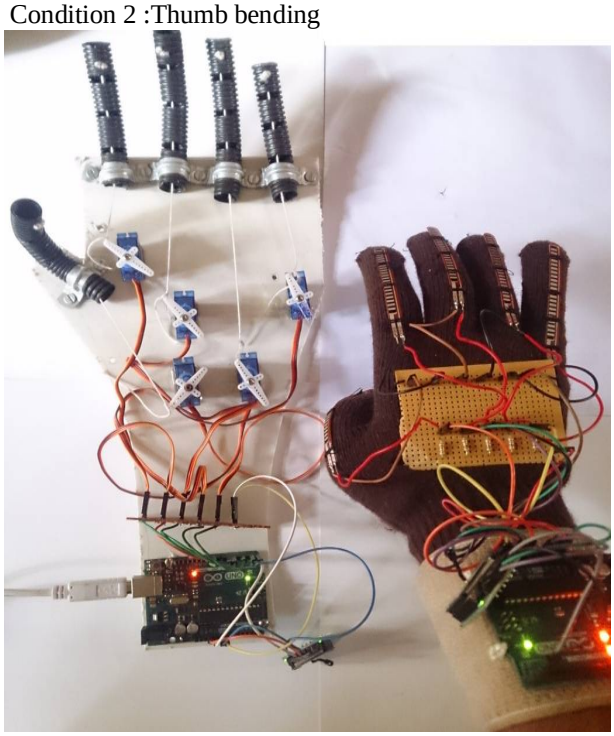

Fig..9 Thumb bending

Condition 3 : All fingers and thumb bending

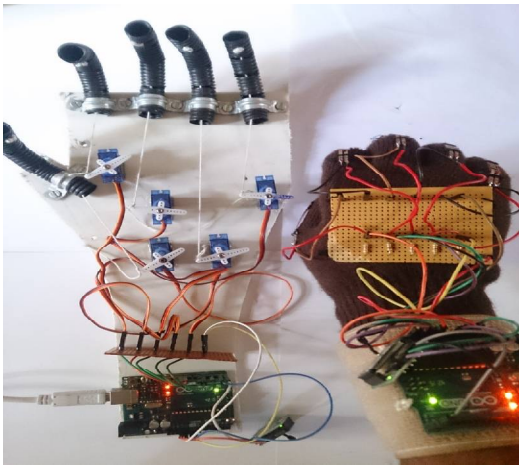

Fig10. All fingers and thumb bending

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VI. CONCLUSION AND FUTURE WORK

A robotic hand will work smoothly when there is no any obstacle in between two XBee antennas. It can be widely used where there are restrictions or a hazard to a human hand. The price of this wireless Robotic hand can be reduced by using optional kits for a wireless communication purpose like Bluetooth module. For physically challenge this can on be done via wired communication which can effectively reduce the cost of this project. Future efforts will be made to make this hand movable (from one place to another), carry some loads and more precise movement of the fingers.

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

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