Accelerometer Based Wireless Gesture Controlled Robot for Medical Assistance using Arduino Lilypad

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ABSTRACT This paper represents a medical assistance system for specially abled people, which can be controlled wirelessly via gesture. A sensor (accelerometer) detects the gesture or change in the gesture through which the patient will control the robot for assistance and a microcontroller will command wirelessly, depending upon sensor’s value to move it in desired direction.

There are two parts of the whole process, a transmitting circuit and a receiving circuit. The most important part for any medical assistance system is the part which will be associated with the patient and in this case it is the transmitting circuit. So it has to be easy to use and most importantly easy to carry. In our project we have used Arduino Lilypad as the main governing microcontroller board which makes the transmitting circuit wearable. So the patient only need to wear the transmitting circuit to the body part through which he/she intend to make the gesture. A RF module has been used to make the data transmission wireless and the programming has been done in Arduino IDE.

Keywords  
Arduino Lilypad, Accelerometer, RF Module, Gesture, Motor Driver.

1. INTRODUCTION

In modern era, a robot is getting controlled in various ways. Controlling it through gesture is one of them and if the wearable technology is incorporated, then it becomes smarter, efficient and easy to use. The motivation of this work is to provide easy to use medical assistance for those who are specially abled, with a gesture controlled medical assistance system. Although the scope of this work is not limited to only medical field, it can be used in military field and heavy industry. As discussed before, any artificial medical assistance should be easy to use and if it is associated with the patient i.e. if a patient needs to carry it in order to get the service, it should be easy to carry. Our work fulfils both the criterion.

Previously several works [1-5] are reported on automated wheelchair with gesture control but so far no work has been done using Arduino Lilypad [6]. The previously proposed systems use bulky and weighty transmitter part, which is not at all easy to carry, thus makes it difficult to use. In our work we have used Arduino Lilypad. It is specially designed for e-textile. Thus, it gets suitable for wearable technologies, which in turn makes the total transmitter part very light weight. Another reason is its size, having approximately the size of a silver dollar. Anyone can just sew the lilypad to a piece of cloth and wear it to make the gesture and the total board costs very low. Altogether it makes the transmitter part easy to carry, easy to use, thinner and cheaper than the systems previously proposed.

Here in this paper a gesture controlled system consisted of accelerometer, arduino lilypad, encoder, decoder, motor-driver, four DC motor is proposed and to make the system wireless a RF module has been used. Accelerometer helps to detect the gesture through generating X, Y and Z co-ordinate which is fed to the microcontroller. According to the program, the encoder sends the command to the transmitter module. The receiver module in the receiving circuit, receives the signal and sends it to the decoder. After decoding the
analog signal it sends the digital data to the motor driver, according to which the motor movement gets controlled.

2. BLOCK DIAGRAM OF THE OVERALL WORK

The overall working principle of the work is presented with the following block diagram in figure 1. The complete work has mainly two parts one transmitter section and another receiver section. In the transmitter section an accelerometer is connected to the Arduino lilypad. According to the gestures the output of the accelerometer changes. Those values are then encoded using encoder and transmitted through the RF transmission module connected to it. The receiver section is comprised of the RF receiver module, decoder, motor driver and motors. The received values are then decoded using the decoder at the receiver end. According to that, the movement of the wheels are controlled through the motor driver IC which is connected DC motors. The details of the transmitter and receiver section is elaborated in the next section.

![Block diagram of the complete work](image1)

**Fig.1** Block diagram of the complete work

3. TRANSMITTER SECTION

The transmitting section is comprised of four parts such as Accelerometer, Microcontroller, Encoder and Transmitter Module.

![Transmitter section circuit diagram](image2a) ![Transmitter section implementation with Arduino Lilypad](image2b)

**Fig 2** (a) Transmitter section circuit diagram (b) Transmitter section implementation with Arduino Lilypad
The Accelerometer is an electromechanical device that measures the acceleration of an object across 3-axis or multiple axis. It detects position, velocity, vibration and orientation of an object. Here we have used ADXL335, which provides X, Y, Z co-ordinate of the associated object. The X and Y co-ordinate has been used in this work to detect the gesture which is fed to the microcontroller. The circuit diagram of the same is shown in Figure 2 (a). Accelerometer’s X-pin, Y-pin, ‘VCC’ and ‘GND’ is connected with lilypad’s a0, a1, ‘+’ and ‘-’ pin respectively. We have used Arduino Lilypad where Atmega 328P has been used as the microcontroller. The gesture controlling algorithm has been written using Arduino IDE. Afterwards it has been uploaded to the microcontroller. After getting X and Y co-ordinate from the accelerometer, according to the algorithm microcontroller sends the decision in digital format to the encoder. The encoder HT12E, used in this work, is integrated circuit of 212 series of encoder. Its 12 bits are divided into 8 address bits and 4 data bits. We can use the address bits (Pin no 1- Pin on 8) for secure data transmission. According to the algorithm ‘HIGH’ and ‘LOW’ are send to the data pins which are AD0(Pin No: 10), AD1(Pin No: 11), AD2(Pin No: 12), AD3(Pin No: 13). The Output (Pin no: 17) of the encoder is sent to the ‘Data’ pin of the receiver module. As it has a transmission enable pin (TE, Pin: 14) which is active low, the pin is always connected to ground to keep the data transmission cycle repeating. We have used a 433 MHz transmitter-receiver module to make the data transmission process wireless. The implemented circuit of the transmitter section is shown in Figure 2 (b).

4. RECEIVER SECTION
The receiving section is comprised of 5 parts such as Receiver Module, Decoder, Motor Driver IC, Voltage Regulator and DC Motor, shown in figure 3 (a). The receiver module receives the analog signal from the transmitter and sends it to the decoder through ‘DATA’ pin. We have used HT12D in our project. As we have kept the address bits of the encoder to low state, we have connected the address pins (Pin no 1- Pin no 8) of the decoder to ground. The serial data received from the receiver module is first compared with the local address bits and if it gets matched, then only the received data gets decoded. It converts the analog signal to digital signal and sends it to the motor driver IC. Pin VT produces a high signal on valid data transmission. The motor driver IC L293D has two H-bridge driver circuit in it which helps to drive two motors in two different direction i.e. clockwise and anti-clockwise simultaneously. Movement of motor according to the log inputs are shown in table 1. We have connected a 9 voltage source to the input of the voltage regulator 7805A, in order to get stable 5V output. Here total four DC motors has been used and for driving the motors, a motor driver IC L293D has been used. The implemented receiver circuit is shown in figure 3 (b).

Table 1. Motor Movement according to input logic

<table>
<thead>
<tr>
<th>Input Logic</th>
<th>Movement</th>
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<tbody>
<tr>
<td>00</td>
<td>STOP</td>
</tr>
<tr>
<td>01</td>
<td>Clockwise</td>
</tr>
<tr>
<td>10</td>
<td>Anti-Clockwise</td>
</tr>
<tr>
<td>11</td>
<td>STOP</td>
</tr>
</tbody>
</table>

![Fig 3 (a) Receiver section circuit diagram](image)
![Hardware implementation of receiver section](image)
5. SOFTWARE IMPLEMENTATION AND RESULTS

The software part is implemented in the Arduino IDE. The flow chart of the complete software implementation is given in Figure 4. After all the initializations, accelerometer sends the co-ordinate values according to the hand gestures. A gesture algorithm is then executed where the particular values of x and y co-ordinates are checked and accordingly the decision is made, whether the medical assistance system should be moved forward, backward, right, left or stopped.

![Flow chart](image)

**Fig.4. Flow chart**

On tilting the accelerometer, when it generates X co-ordinate value between 200 to 300 and Y co-ordinate value between 300 to 400 it sends ‘HIGH’ to AD0 and AD2 and sends ‘LOW’ to AD1 and AD3 of encoder HT12E, which moves the car in forward direction. The gesture and corresponding X and Y coordinate value in serial monitor of ARDUINO IDEs shown in Figure 5(a) and (b) respectively.

![Serial Monitor](image)

**(a)** Gesture value for Forward Motion

![Serial Monitor](image)

**(b)** Co-ordinate value for Forward Motion

On tilting the accelerometer in the opposite direction, when it generates X co-ordinate value between 400 to 500 and Y co-ordinate value between 300 to 400 it sends ‘LOW’ to AD0 and AD2 and sends ‘HIGH’ to AD1 and AD3 of encoder HT12E, which moves the car in backward direction. Figure 6 (a) and (b) respectively shows the gesture and corresponding X, Y coordinate value in serial monitor of ARDUINO IDE respectively.
If the accelerometer is kept in parallel to the ground, both X and Y co-ordinate value ranges from 300 to 400 and it sends ‘HIGH’ to all the data bit pins of encoder HT12E which in turn stops the car. The gesture and corresponding X and Y coordinate value in serial monitor is shown in Figure 7 (a) and (b) respectively.

Figure 8 (a) depicts the gesture and (b) shows the co-ordinate values for Left movement if the accelerometer is tilted perpendicularly to the ground. When the associated X co-ordinate value is between 300 to 400 and Y co-ordinate value is between 400 to 500, it sends ‘HIGH’ to AD0 and AD3 and sends ‘LOW’ to AD1 and AD2 of encoder HT12E, which helps to move the car to the left without changing its axis.
Similarly the right movement with gesture is shown in figure 9 (a) and (b) along with the co-ordinates. If accelerometer is tilted perpendicularly on the opposite direction to the ground (X co-ordinate value between 300 to 400 and Y co-ordinate value between 200 to 300) it sends ‘LOW’ to AD0 and AD3 and sends ‘HIGH’ to AD1 and AD2 of encoder HT12E, which helps to move the car to the right without changing its axis.

CONCLUSION
This work presents a hand gesture based wireless medical assistance system for specially able people, with Arduino Lilypad. Arduino Lilypad is mainly designed for e-textile purpose, which reduces the size and weight of the easily wearable transmitter part. Results of the system designed, are also discussed in details. According to the hand gesture the motors of the medical assistance system can be controlled in different directions.

REFERENCES