Accelerometer Based Wireless Gesture controlled Robot for Medical assistance using ArduinoLilypad

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ABSTRACT *This paper represents a medical assistance system ,which can be controlled wirelessly via gesture, for specially abled people. 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 in desired direction.*

There are two parts of the whole process, a transmitting circuit and the receiving circuit. The most important part for any medical assistant 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 ArduinoLilypad as the main governing microcontroller which makes the transmitting circuit wearable. So the patient only needs 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

ArduinoLilypad, 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 incorporate then it becomes more smart , 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 various types of 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 patient need to carry 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 ArduinoLilypad [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 ArduinoLilypad. 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 alongwith of accelerometer, arduinolilypad, encoder, decoder, motor-driver, four DC motor is proposed and to make the system wireless a RF module is also used. Accelerometer helps to detect the gesture through generating X, Y and Z co-ordinate which is fed to the microcontroller, ArduinoLilypad. According to the programme, 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 it controls the motor movement.

2.   BLOCK DIAGRAM OF THE OVERALL WORK

The overall working principle of the work is presented with the following block diagram in figure 3. The complete work has mainly two parts one transmitter section and another receiver section. In the transmitter section an accelometer is connected to the Arduinolilypad. According to the gestures the value of accelometer output connected to the Arduinochanges . Those values are then encoded using encoder and transmitted through the RF transmission module connected to it. The receiver section comprises 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 proper movement of the wheels are controlled through the motor driver IC and connected DC motors. The details of the transmitter and receiver section is elaborated in the next section.
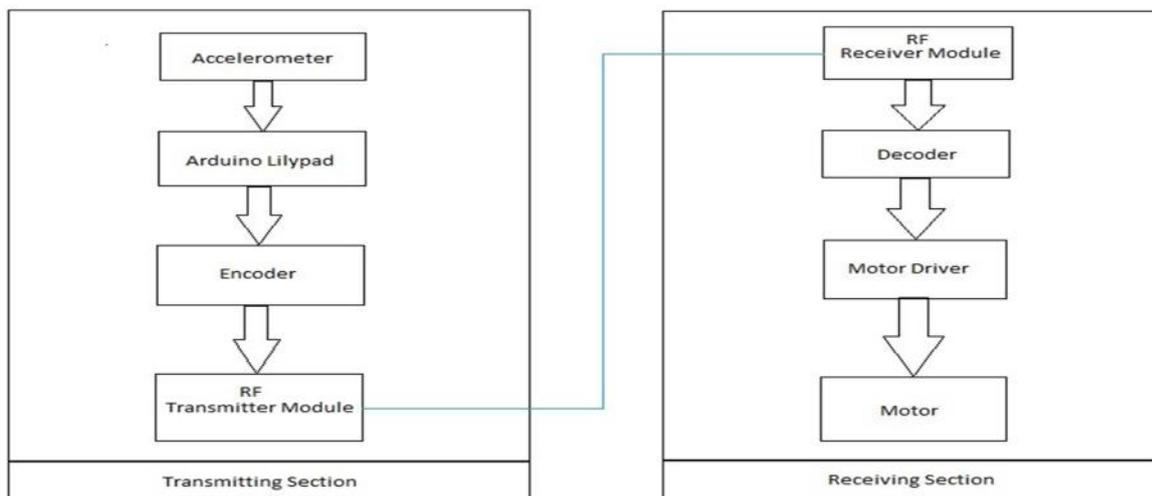

Fig.1 Block diagram of the complete work

3.   TRANSMITTER SECTION

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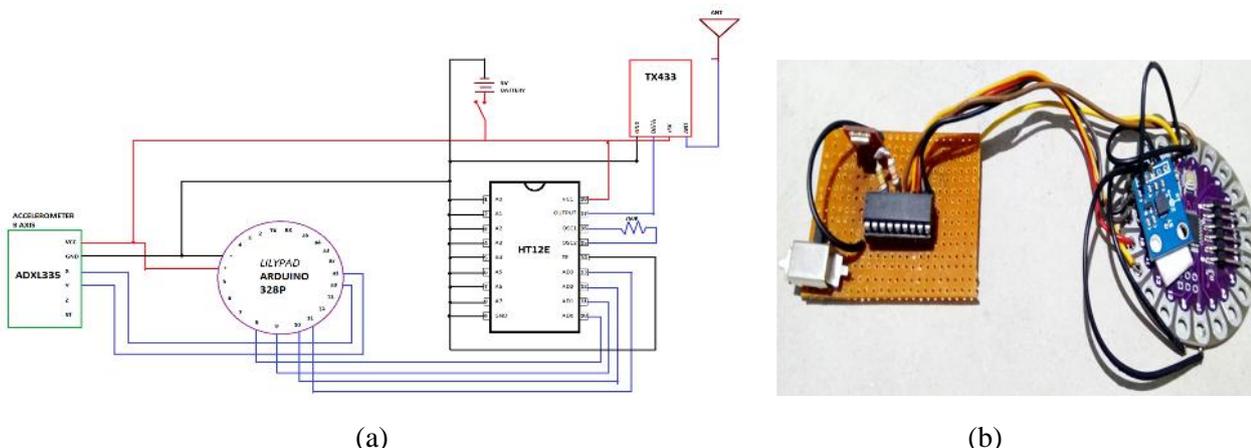

(a)   (b)

Fig 2 (a) Transmitter section circuit diagram (b) Trasmitter section implementation with ArduinoLilypad

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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 are 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).The Accelerometer's X-pin and Y-pin are connected to VCC or the power supply.The pin number a0,a1 as well as the '+' and '-' pin of lilypad are connected to 0Volt. We have used ArduinoLilypadwhere Atmega 328P has been used as the microcontroller. The gesture controlling algorithm, written using Arduino IDE. Afterwards it is 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 2^{12} 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 andDC 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 get 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 9volt source to the receiver section input and getting stable 5volt at its output by using 7805 voltage regulator IC. Here total four DC motors are used and for driving the motors two L293D, motor driver IC s are used. The implemented receiver circuit is shown in figure 3 (b).

Table 1.Motor Movement according to input logic

Input Logic	Movement
00	STOP
01	Clockwise
10	Anti- Clockwise
11	STOP

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(a)   (b)
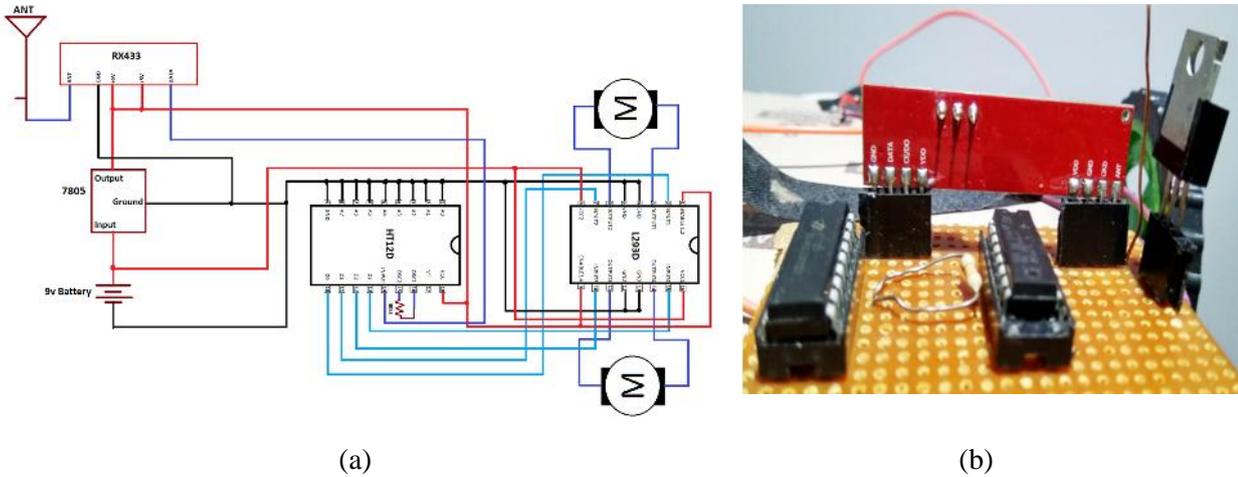
Fig 3 (a) Receiver section circuit diagram (b) Receiver section implementation with ArduinoLilypad

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 medical assistance system can be moved forward, backward, right, left or stopped.

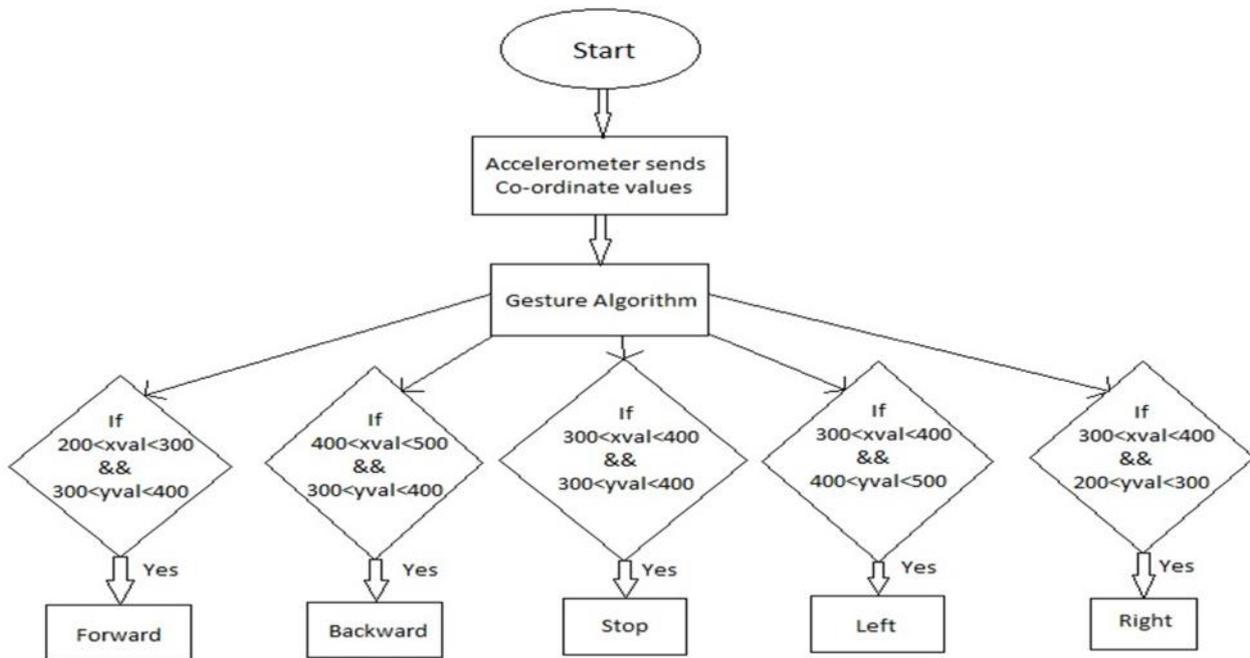**Fig.4**. Flow chart

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 IDEis shown in Figure 5(a) and (b) respectively.

<div align="center">(a)   (b)</div>

Fig5. (a) Gesture (b) Co-ordinate value for Forward Motion

If the accelerometer is tilted 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.

<div align="center">(a)   (b)</div>

Fig 6. (a) Gesture (b) Co-ordinate value forBackward Motion

If the accelerometer is kept in parallel to the ground, both X and Y co-ordinate value ranges between 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.

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(a)   (b)

Fig 7. (a) Gesture (b) Co-ordinate value for Stop

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.

(a)   (b)

Fig 8. (a) Gesture (b) Co-ordinate value forLeft Motion

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

(a)   (b)

Fig 9. (a) Gesture (b) Co-ordinate value for Right Motion

CONCLUSION

This work presents a hand gesture based wireless medical assistance system for specially able people with ArduinoLilypad.ArduinoLilypad mainly designed for e-textile purpose 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.

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