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AUTOMATIC HEAD-MOVEMENT CONTROLLED WHEELCHAIR

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ABSTRACT

This project is regarding the Motion controlled wheelchair for disabled. We are going to control motorized wheelchair using a head band having motion sensor and Arduino as controller. Problem: "often disabled who cannot walk find themselves being burden for their families or caretakers just for moving around the house. Disabled who are paralysed below head, who may not have functioning arms cannot control joystick controlled electric wheelchair."

This project is to solve their problem using a motion sensor to control their wheelchair.We are aiming towards building a more affordable, unique, low maintenance and available for all kind of head-controlled wheel chair.

1. INTRODUCTION

Hands free control is increasing nowadays. This project is for building a Motion controlled wheelchair for disabled. Our first proposed solution was to use eye tracking sensors but there were many drawbacks in that system. The tracker is required to be placed in front of users face, which makes it hard to perform other tasks and also it is not pleasant. Then we thought of using a concentration wave sensor but again it was hard to maintain control on system just like eye tracking system.

Thus, we finally reached to conclusion that the gyroscopic accelerometer is what fits our requirement perfectly. It is easy to use and its sensitivity is high and easily adjustable. We have used a gyroscopic-accelerometer to detect motion and Arduino as main controller. We have used accelerometer which works on the principle of acceleration and has also an integrated gyroscopic sensor which will help in measurement of angular velocity and tilt.It is very accurate in terms of recognizing the motion and turning instructions into data that has to be transmitted and to be analysed further. So, the wheelchair will receive instructions from accelerometer and analyse them and do its motion accordingly.

Block diagram

Transmitter section

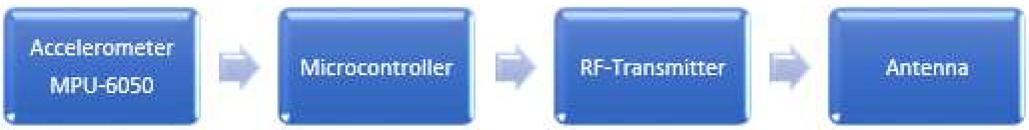

FIG. 1.1 Transmitter section Block Diagram

Accelerometer MPU-6050 will detect the motion and transfer the readings to the microcontroller. After this the microcontroller will send the calculated data to the RF transmitter. Which will send the data to the receiver section.

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Receiver section

FIG. 1.2 Receiver section block diagram

This data will be received by antenna at the receiver. Receiver will further pass the data to the microcontroller. The calculated data will be sent to the motor driving IC. Which will further drive the motors i.e. our main driving mechanism.

Component description

MPU6050

MPU-6050, it is a six-axis motion tracking device that combines a 3-axis accelerometer and gyroscope. Digital-output temperature sensor,400kHz Fast Mode I²C or up to 20MHz SPI (MPU-6000 only) serial host interfaces.

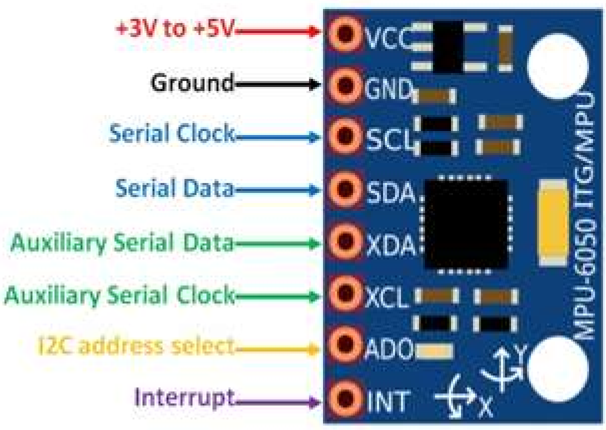

FIG. 1.3 MPU6050 Pin diagram

TABLE 1.1 MPU6050 Pin configuration

Pin No.	Function	Description
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used
2	Ground	Connected to Ground of system
3	Serial clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary serial data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional

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6	Auxiliary serial clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional
7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used to vary the address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

ARDUINO UNO

The **Arduino Uno** is an open source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc

Its technical specifications are:

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- UART: 1
- I2C: 1
- SPPI: 1
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB

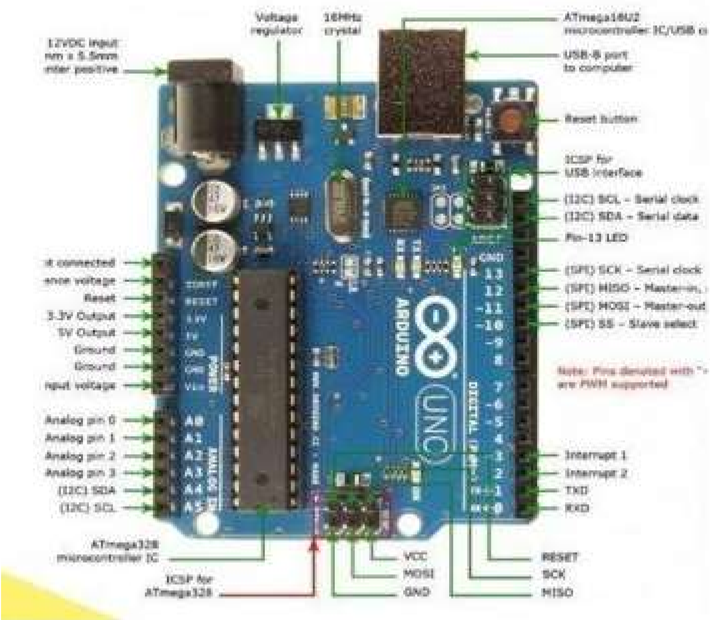

FIG. 1.4 Arduino UNO Pin diagram

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TABLE 1.2 Arduino pin configuration

Pin Number	Pin Name	Function
1	PC6	RESET
2	PD0	Digital Pin(RX)
3	PD1	Digital Pin(TX)
4	PD2	Digital Pin
5	PD3	Digital Pin(PWM)
6	PD4	Digital Pin
7	VCC	Positive Voltage
8	GND	Ground
9	XTAL1	Crystal Oscillator
10	XTAL2	Crystal Oscillator
11	PD5	Digital Pin(PWM)
12	PD6	Digital Pin(PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin(PWM)
16	PB2	Digital Pin(PWM)
17	PB3	Digital Pin(PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin
20	AVCC	Positive Voltage for ADC(power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

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RF *transmiter and receiver*

The transmitter/receiver (Tx/Rx) pair operates at a frequency of **434 MHz.** The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

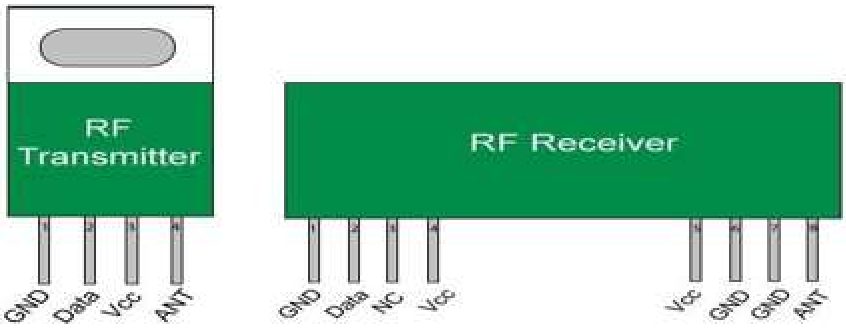

FIG. 1.5 RF Transmitter Receiver pin diagram

TABLE 1.3, 1.4 RF transmitter and receiver pin description:

RF Transmitter

Pin number	Function	Name
1	Ground (0V)	Ground
2	Serial data input pin	Data
3	Supply voltage; 5V	Vcc
4	Antenna output pin	ANT

RF Receiver

Pin number	Function	Name
1	Ground (0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

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Motor IC L293D

A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors and the motors in the wheelchair. The **L293D** is a **16** pin IC, with eight pins, on each side, dedicated to the controlling of a motor. Thereare 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor.

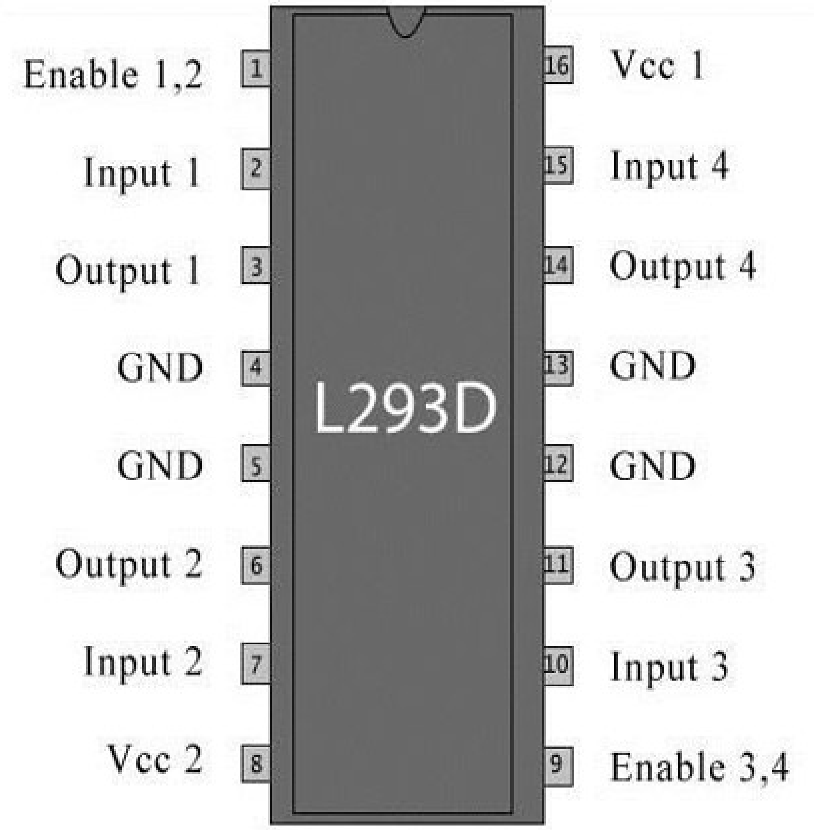

FIG. 1.6 L293D IC Pin diagram

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TABLE 1.5 L293D Pin Description

Pin Number	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground(0V)	Ground
5	Ground(0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply Voltage for Motors; 9-12V(upto 36)	Vcc2
9	Enable pin for Motor 2; active high	Enable 3,
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground(0V)	Ground
13	Ground(0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input 2 for Motor 1	Input 4
16	Supply voltage; 5V(upto 36V)	Vcc1

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Motor DC

Electrical DC motors are continuous actuators that convert electrical energy into mechanical energy. Bi-directional motor, Operating voltage = 5V,Speed = 2000 RPM

Capacitor

1nF capacitor used.

Crystal

16HZ crystal to provide clock to the microcontroller

HT-12E

It is an encoder IC that converts the 4-bit parallel data into serial data in order to transmit over RF link

HT-12D

It is a decoder IC that converts the serial data received by the RF Receiver into 4-bit parallel data. This parallel data can be used to drive the motors.

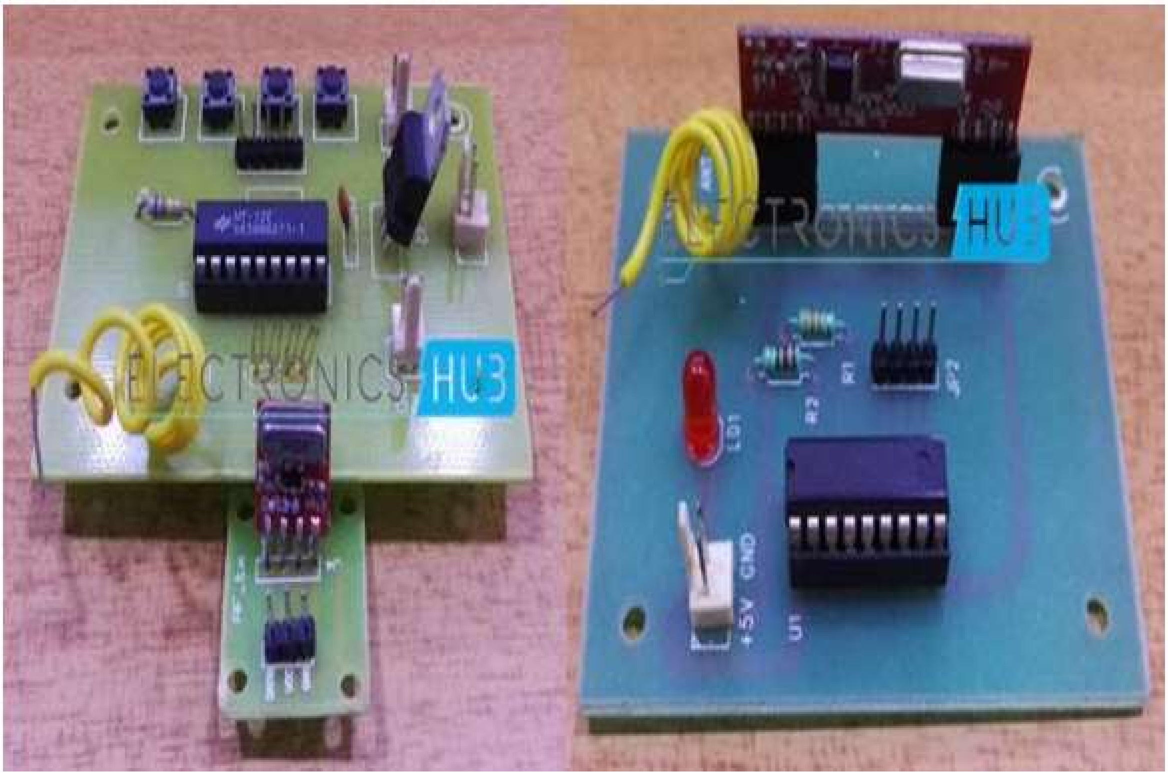

FIG. 1.7 Transmitter and Receiver section pin diagram PCB

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PCB LAYOUT (RECEIVER SECTION)

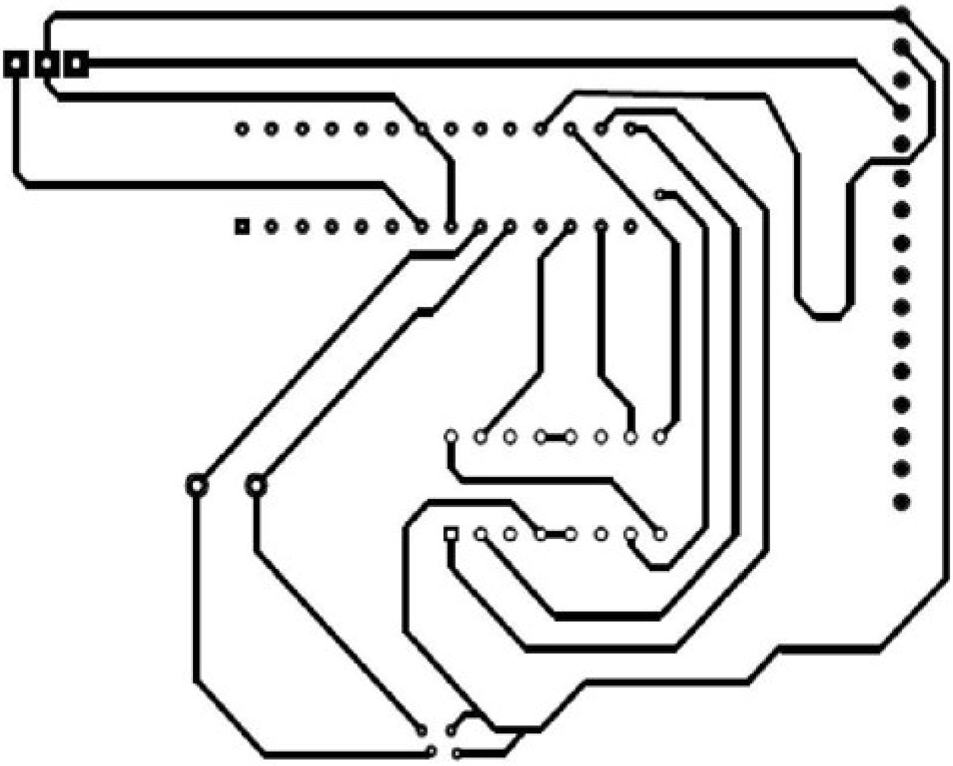

FIG. 1.8 PCB Layout

2. WORKING AND SETUP

Working and circuit diagram

We wanted to find a solution for people who are disabled from neck below, people who do not have functioning limbs, needs a different way to control wheelchair. All parts and components of HMCW (Head Motion Controlled Wheelchair) are decided on the functionality required. Functions are as follows- Control mechanism (steering), Input data analysis and synthesis (Microcontrollers), Signal transmission from user to the HMCW, Basic hardware mechanism of HMCW, Breaking mechanism

Control mechanism

We decided to go with a micro-controller-based accelerometer and gyroscopic sensor MPU6050 as our primary controlling sensor which would calculate values of accelerometer and gyroscopic sensors of the three axis to help with the movements of HMCW desired by the user.

Basic movements by the HMCW are: -

2 Forward acceleration
3 Backward i.e.(reverse)
4 Right turn
5 Left turn
6 Break

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These instructions will be processed by the microcontroller and will be sent to the HMCW for desired movements.

Analysis and synthesis

Data or directional instructions will be taken from the MPU6050 in the digital form and will be given to microcontroller for logical synthesis of the data so that it can be further transmitted to the actual hardware of HMCW. We have used a compact microcontroller, Arduino Uno which can be integrated with the MPU6050 and take input data. Movement Sensitivity and speed are the other 2 clauses which are taken care by the microcontroller. Binary codes will be sent serially from the microcontroller to the actual hardware to be controlled.

Signal transmission

Data from MPU6050 sensor is sensed by microcontroller Arduino Uno and according to the program preinstalled in it, data goes through HT-12E to RF transmitter. This transmitter sends the signal to RF receiver on the receiving end of the wheel chair. The RF receiver sends the received data to HT12-D to decode it. Then from there the signal goes to L293D motor driver. Thus, we get final output on motors.

Breaking and safety mechanism of HMCW

Breaking will be done basically by the head movement of reverse which in turn will reduce HMCW's speed. Currently for the prototype breaking intensity will be dependent upon the user.

Basic hardware mechanism of HMCW

HMCW consists mainly of these parts are wheelchair, Motor driving IC (L293D), Bi-directional DC motors and Wheels.

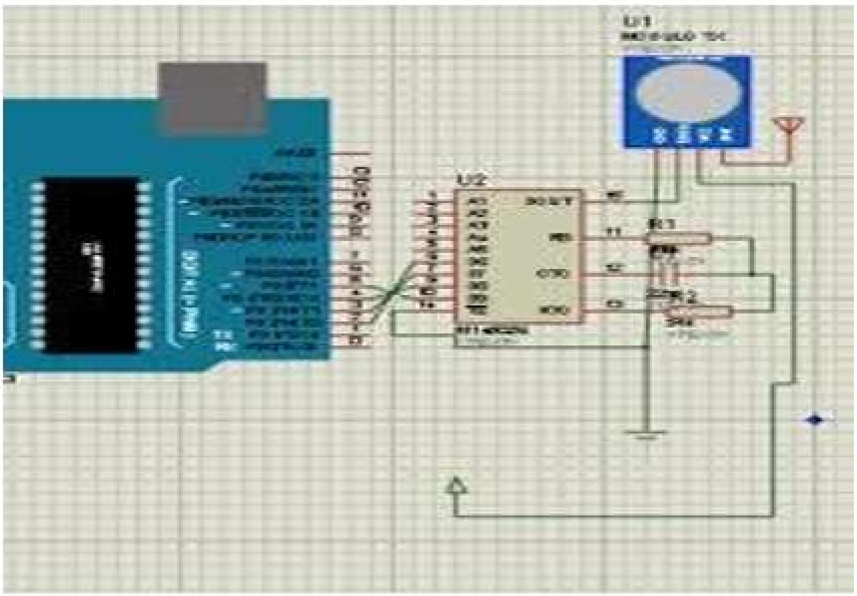

FIG. 2.1 Transmitter circuit diagram

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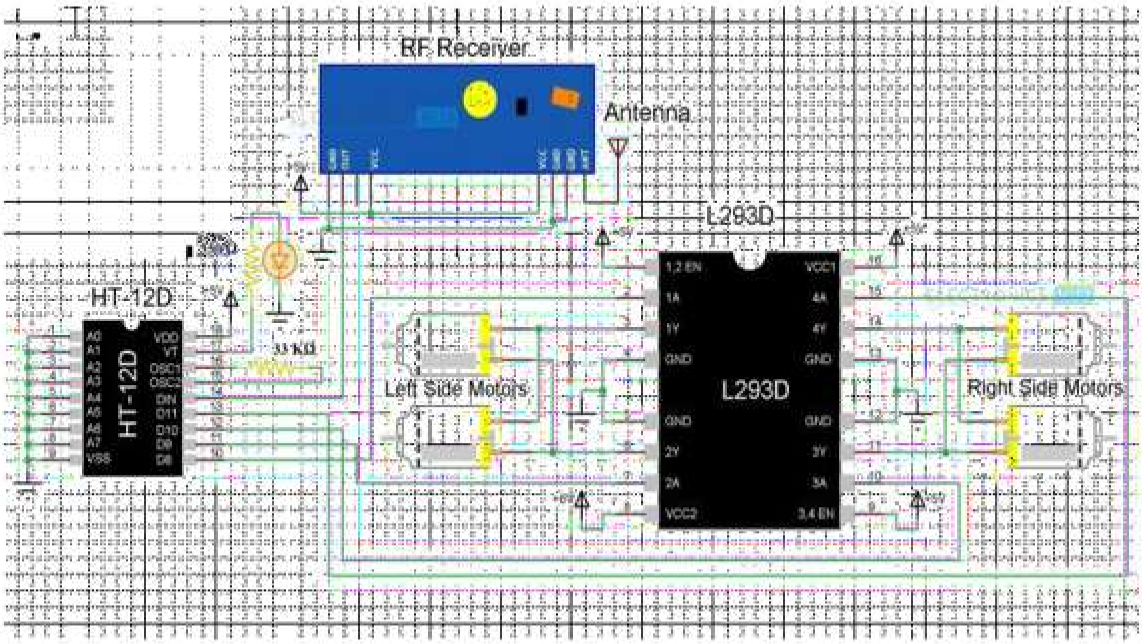

FIG. 2.2 Receiver circuit diagram

Practical setup and troubleshooting

Our main objective was to first verify the output of accelerometer, for that we integrated the MPU6050 with the Arduino and calculated its output for our four basic directions forward, backward, right and left. We also connected four different LEDs to observe the actual outputs. During this process we met with a problem of calibration with the changing time of direction and reception time of data by the microcontroller.

So, we matched the time or we can say delay of the complete loop and data reception time by the microcontroller. After that we also calibrated the amount 'PITCH' i.e. accelerometer output for front and back movement and 'ROLL' output for the left and right movements.

After we were able to get the proper communication and data transfer which we verified on the serial monitor. But the motor driving IC was still unable to drive the motor, after debugging and checking the voltages and currents of the driver IC we got to know that there was insufficiency of required current to drive the motor so we provided a separate power supply to the driving IC.Then our circuit worked well without any errors.

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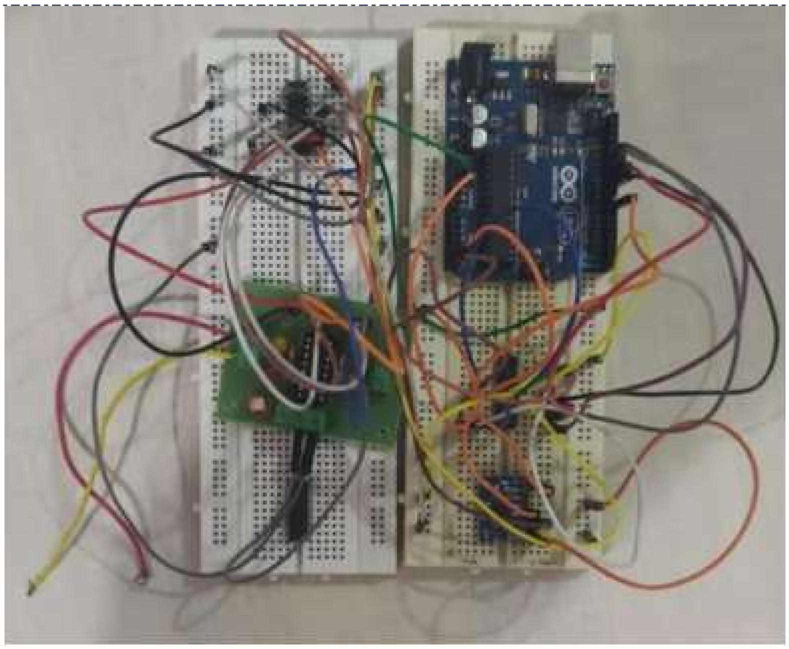

FIG. 2.3 practical circuit

Project code

```
//connection for mpu6050+UNO

//VCC = 3.3/5v

//GND = GND

//SCL = AD5

//SDA = AD4

//INT = 7


//connection for transmitter+UNO

//DATA=12

//VCC=5V

//GND=GND


#include
<VirtualWire.h
> char
*controller;
#include
<Wire.h>
#include
```

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```
<MPU6050.h
>

MPU6050 mpu;

void setup()

{

pinMode(9,OUTPUT); pinMode(10,OUTPUT);

  pinMode(11,OUTP
  UT);
  pinMode(12,OUTP
  UT);
  vw_set_ptt_inverte
  d(true); //
  vw_set_tx_pin(12);
  vw_setup(4000);// speed of data transfer Kbps

  Serial.begin(9600);
  Serial.println("Initialize
  MPU6050");

  while(!mpu.begin(MPU6050_SCALE_2000DPS, MPU6050_RANGE_2G))

  {

    Serial.println("Could not find a valid MPU6050 sensor, check
    wiring!"); delay(500);
  }


}


void loop() {

  // Read normalized values

  Vector normAccel = mpu.readNormalizeAccel();

  // Calculate Pitch & Roll

int pitch = -(atan2(normAccel.XAxis, sqrt(normAccel.YAxis*normAccel.YAxis +
normAccel.ZAxis*normAccel.ZAxis))*180.0)/M_PI;

  int roll = (atan2(normAccel.YAxis, normAccel.ZAxis)*180.0)/M_PI;

  Serial.print("
  \nPitch = ");
  Serial.print(pitc
  h);
  Serial.print("
  Roll = ");
```

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```
Serial.print(roll
);

if( pitch > 30)
{

 controller="b" ;

 vw_send((uint8_t *)controller,
 strlen(controller)); vw_wait_tx(); // Wait until
 the whole message is gone digitalWrite(9,
 HIGH);
 digitalWrite(1
 0,      LOW);
 digitalWrite(1
 1,      LOW);
 digitalWrite(1
 2,      HIGH);
 delay(200);
 }

        else if( pitch < -30)

 {

   controller="f" ;

vw_send((uint8_t *)controller, strlen(controller)); vw_wait_tx(); // Wait until the whole message is gone
digitalWrite(9, LOW);
   digitalWrite(1
   0,      HIGH);
   digitalWrite(1
   1,      HIGH);
   digitalWrite(1
   2,      LOW);
   delay(200);
  }

 else if(roll > 30)

  {

   controller="r" ;

   vw_send((uint8_t *)controller,
   strlen(controller)); vw_wait_tx(); // Wait until
   the whole message is gone digitalWrite(9,
   HIGH);
   digitalWrite(1
   0,      LOW);
   digitalWrite(1
   1,      HIGH);
   digitalWrite(1
   2,      LOW);
   delay(200);
```

```
}

else if(roll < -30)

{

    controller="l" ;

    vw_send((uint8_t *)controller,
    strlen(controller)); vw_wait_tx(); // Wait until
    the whole message is gone digitalWrite(12,
    LOW);
digitalWrite(10, HIGH); digitalWrite(11, LOW); digitalWrite(12, HIGH);

    delay(200);

}

  else

{

    controller="s" ;

    vw_send((uint8_t *)controller,
    strlen(controller)); vw_wait_tx(); // Wait until
    the whole message is gone delay(200);
    digitalWrite(
    9, LOW);
    digitalWrite(
    10, LOW);
    digitalWrite(
    11, LOW);
    digitalWrite(
    12, LOW);
}

delay(10);

}
```

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3. ADVANTAGES AND LIMITATIONS

Advantages

- The controls are user defined that means they can be customized as per user's choice.
- Our system can be installed on any ordinary wheel chair with some modifications.
- And above all our system is affordable so any one can buy it.

Limitations

Since we are planning to make this wheel chair as economical as possible the obtained speed and battery life are of moderate or below moderate level and they can vary with weight of the user.

Currently we have kept a switch for turning ON and OFF, and an emergency KILL switch, which definitely requires some assistance if the user is completely paralyzed from neck down.

4. APPLICATION AND FUTURE WORK

Applications

This wheelchair will help people without arms and legs to move without help of others and thus would help them be independent and generate confidence and would help eliminating disability to be an obstacle in their life. It will help people without legs to move without engaging their hands as it will totally be controlled by head movement

Future work

In our next iteration we have decided to make it completely hands free keeping the required switches and also creating alternate head movement control switch. We have decided to make our breaks more efficient by also using a mechanical break for actual wheelchair with relay. Modifications on design of wheel chair can be done in order to bring aesthetic look and modular and robust structure. Though these modifications are of industrial level but for small scale our designed wheelchair is feasible.

5. CONCLUSION

Nowadays automation playing an important role in making lives easy in every way, so we have made a head movement-controlled wheel chair that can be used by people who are handicapped from below their heads. This way they can have freedom of movement with minimum help from their assistance of family members. This is one of the Technology to go hands-free in the current era of automation and thus making things easier and time saving .This project gave us insights on making a circuit, using of microcontrollers such as Arduino, programming of controllers, using different IC's.

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