GESTURE CONTROLLED WHEELCHAIR FOR THE ELDERLY AND DISABLED

A Project Report
Submitted for the course
EEE3999 Technical Answers for Real World Problems

By

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Under the Guidance of

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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

April 2019

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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

CERTIFICATE

This is to certify that the project entitled "Gesture Controlled Wheelchair" submitted by Sarthak Dilawari(16BEE0342) and Vidit Pant(16BEI0071) to Vellore Institute of Technology, Vellore, in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology is a record of bonafide work carried out by them under my guidance.

Supervisor

OBJECTIVE:

To make a gesture-controlled wheelchair using an accelerometer for controlling, for the elderly and physically disabled along with obstacle avoidance.

ABSTRACT:

Due to many unforeseeable circumstances and old age people lose their ability to walk. These people have to use the conventional wheelchair in which a person has to be present with the patient so that they can move around using the wheelchair. This is an ineffective exercise. Not everyone can have someone present to move their wheelchair. Another option in such cases is the electric wheelchair which are readily available in the market. These are perfect as they provide a freedom of movement without an assistant present for the patient. However these wheelchairs are expensive and a lot of people can't afford them.

Many soldiers lose their legs in warfare protecting the nation. A lot of kids have disabilities and cannot walk. Due to old age people lose the strength of their muscles and bones and cannot walk because of this.

We have designed an electrical wheelchair using an accelerometer as gesture control for the movement of this wheelchair. This is affordable and can be manufactured on a larger scale and be used by such people in need.

The inspiration of the project came to us while working on our robotics project. We made a gesture-controlled robot, then we realized that this very project when applied on a larger scale can help a lot of people in need. Both of us grew up with grandparents in our home and we realize how difficult it is to move after a certain age. This made us choose this project idea and implementing it on a larger scale. Although we couldn't exactly implement it on a larger scale, we did finish the groundwork. The motors were chosen after calculating how much would an average person be needing to move forward. We were able to finish the prototype of the entire wheelchair which showed the basic idea and implementation of the project.

DESIGN OF THE WHEELCHAIR:

The basic design of the wheelchair was-

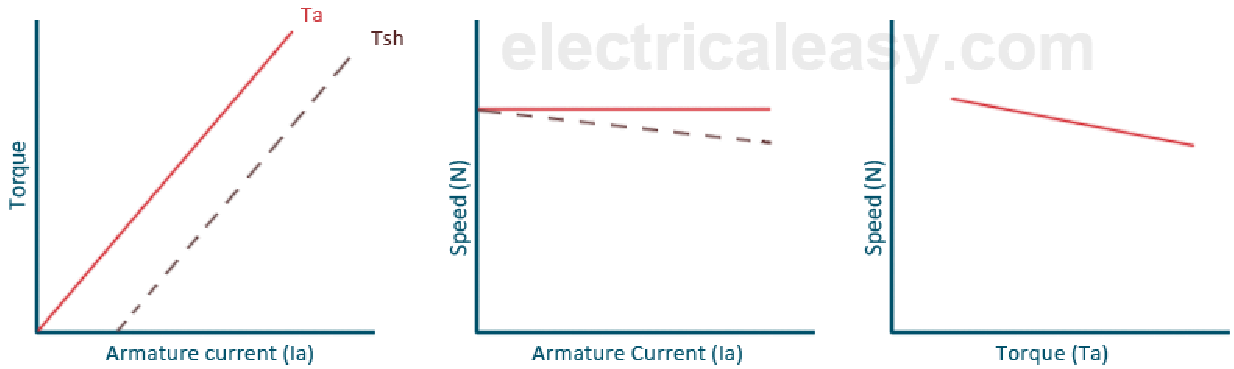
1.) DC Motors attached to the rear wheels of the wheelchair. These motors will drive the wheelchair forward.
2.) The battery assembly right under the seat. This was done because the weight of the batteries will be large. This assembly will create a balance and the entire weight of the wheelchair and the patient combined will fall on both the wheels equally.
3.) The Arduino and the motor driver will be attached on the side so that they can be easily maintained and the accelerometer can be easily used by the patient.
4.) The accelerometer will be on the left handle or the right handle of the wheelchair according to the needs of the patient.
5.) The Ultrasonic Sensor will be attached in the front to monitor obstacle avoidance.

1.) CHOOSING THE PROPER DC MOTORS-

One of the major challenging tasks for us was choosing the proper DC-Motors. There are various different kinds of motors present in the market. We needed to use the proper DC-Motors that will provide an ample amount of torque for moving the wheelchair forward.

An average person weighs about 70 kgs. Suppose the wheelchair provides less torque then the person won’t be able to travel at his desired speed. However, if the torque is too high then there are chances of accidents.

We decided to choose 2 different types of motors. One was 24 VDC, 600W BLDC Motor. The other was 24VDC, 350 W BLDC motor. After all the analysis and experimentation with various loads we figured that the latter would be the better choice as it provides an ideal torque.

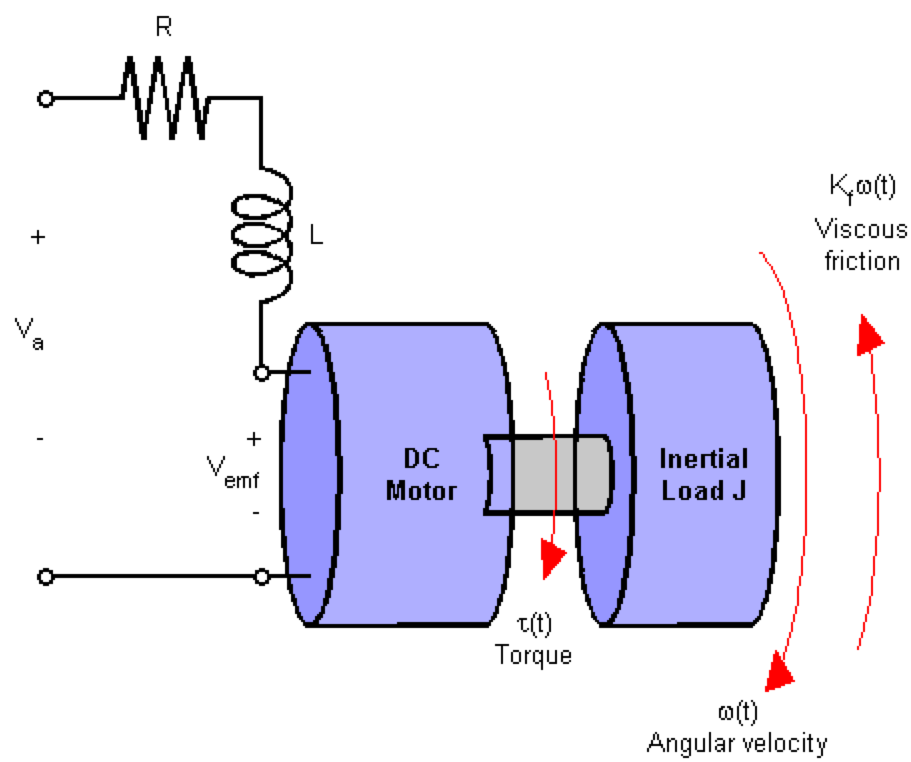


We chose PMDC motors because they provide the following advantages-

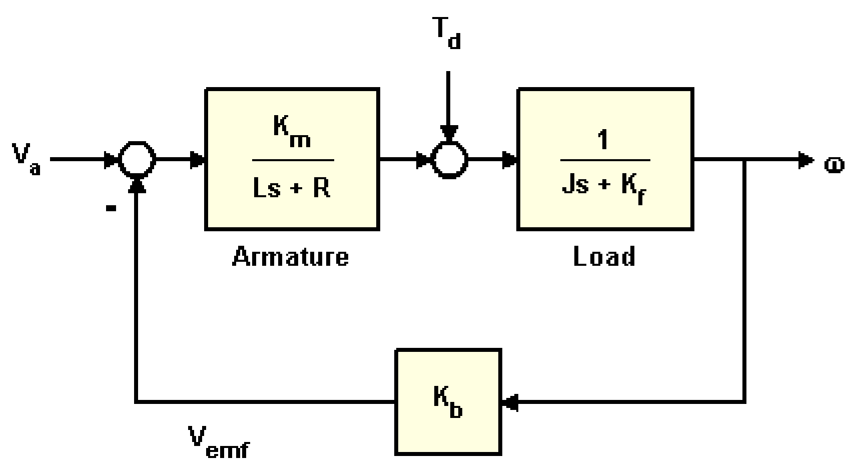
1. For smaller ratings, use of permanent magnets reduces manufacturing cost.
2. No need of field excitation winding, hence construction is simpler.
3. No need of electrical supply for field excitation, hence PMDC motor is relatively more efficient.
4. Relatively smaller in size
5. Cheap in cost

2.)DESIGNING THE PROPER MOTOR DRIVER-

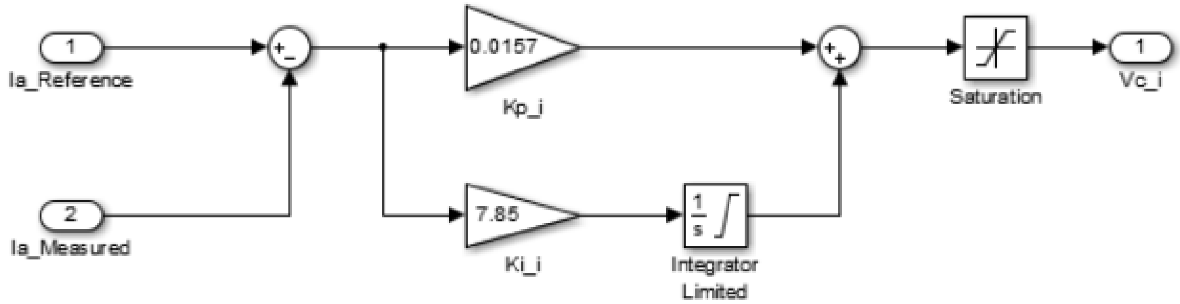
One of the major challenges we faced was finding the motor driver for the motors we chose. This task was tedious because we wanted perfect connection between the microcontroller and the motors. There shouldn't be any latency in the movement of the wheelchair. This task is solely dependent on the type of motor driver we chose.



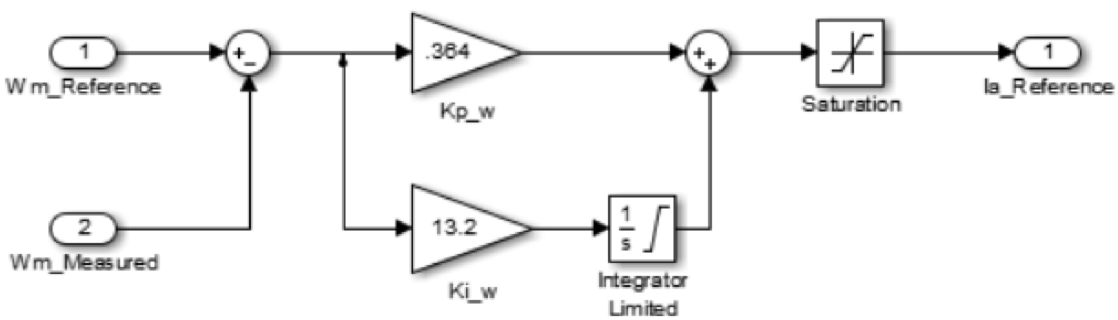
R
L
+
Va
-
+
Vemf
-
DC Motor
Inertial Load J
Kfω(t)
Viscous friction
τ(t)
Torque
ω(t)
Angular velocity



Td
Va
-
Km
Ls + R
Armature
1
Js + Kf
Load
ω
Kb
Vemf



The figure above is the MATLAB Simulink of a PM-DC Motor current Controller.



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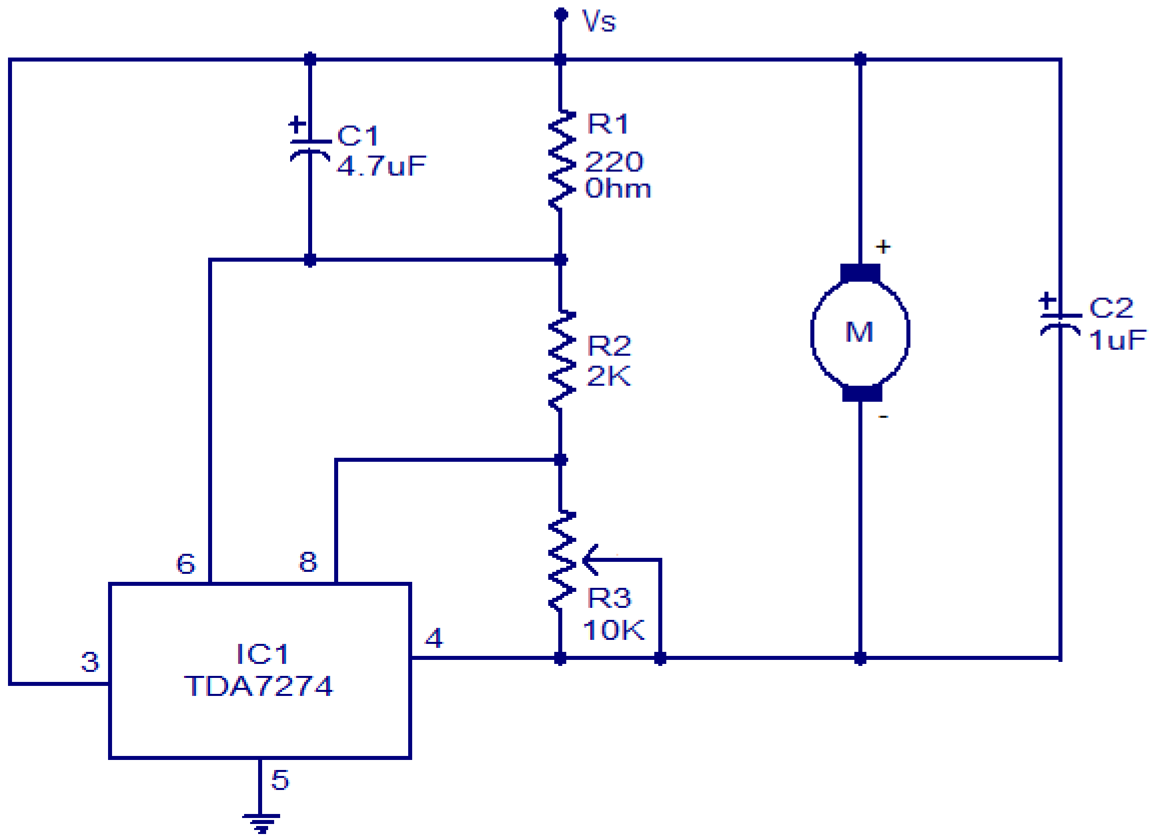

Low voltage DC motor speed control www.circuitstoday.com

WORKING-

The main reason of using an accelerometer is to give direction command to the motor driver as in to which direction should the motor move in. It’s like a joystick and the motion of the wheelchair will be through the accelerometer.

The four directions the wheelchair can move is-

1.)Forward
2.)Backwards
3.)Right
4.)Left

Each of the movements will be controlled in the following ways-

The accelerometer will be calibrated in straight position so that a base value is noted for all the axes. We are planning to use the x-axis as the forward motion, y-axis for the left and right motion and we won’t be needing the z-axis.

1.)**Forward and Backward Movement -** While calibrating the accelerometer we’ll tilt it in the forward direction then get the readings from the accelerometer. These readings will be put in the code. Now whenever the accelerometer is tilted forward the wheelchair will move forward and when we tilt it backwards the wheelchair will move back.
2.)**Left and Right** – This sideways movement will be achieved when we tilt the accelerometer in the y-axis. We’ll write the code in such a way that suppose the wheelchair has to turn left, then only the right motor will work and the left motor will stop. This way the wheelchair will move left. When we have to turn it right, the right motor will stop and vice-versa.

Movement of hand	Input for Arduino from gesture				
Side	**D3**	**D2**	**D1**	**D0**	**Direction**
Stable	0	0	0	0	Stop
Tilt right	0	0	0	1	Turn Right
Tilt left	0	0	1	0	Turn Left
Tilt back	1	0	0	0	Backward
Tilt front	0	1	0	0	Forward

PROCEDURE-

The connections from the motor driver are made to the battery and the Arduino board.

Prototype-

We were able to create a prototype of the desired wheelchair using the same code as mentioned above.

It used-

1.)Arduino Uno
2.)12V DC Motors x2
3.)L293D Motor Driver
4.)ADXL335 Accelerometer
5.)Ultrasonic Sensor

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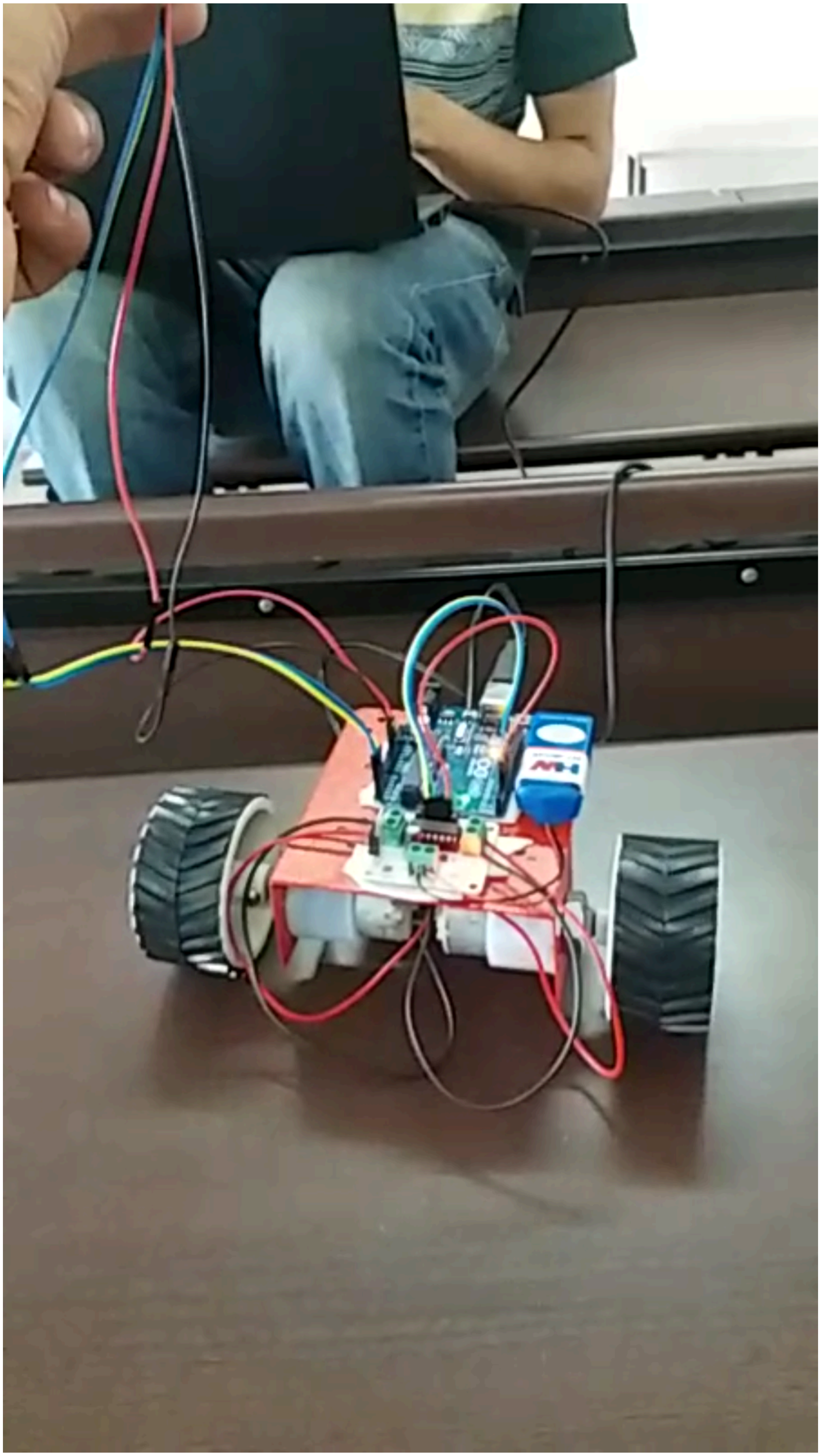
Tilt left	0	0	1	0	Turn Left
Tilt back	1	0	0	0	Backward
Tilt front	0	1	0	0	Forward



Full Scale Model-

The Full-scale model has 2 PM-DC Motors attached to the rear wheels and the motor drivers as attached in the pictures above. We were unable to interface the entire setup with the wheelchair as a microcontroller is already wired into the wheelchair. However, we shall continue our research on the project. We successfully managed to run our experiments on a smaller prototype model that we created of the wheelchair. We were able to take readings and calibrate the accelerometer accordingly. We were able to realize that the same model can be successfully converted into a larger scale model as we desire.

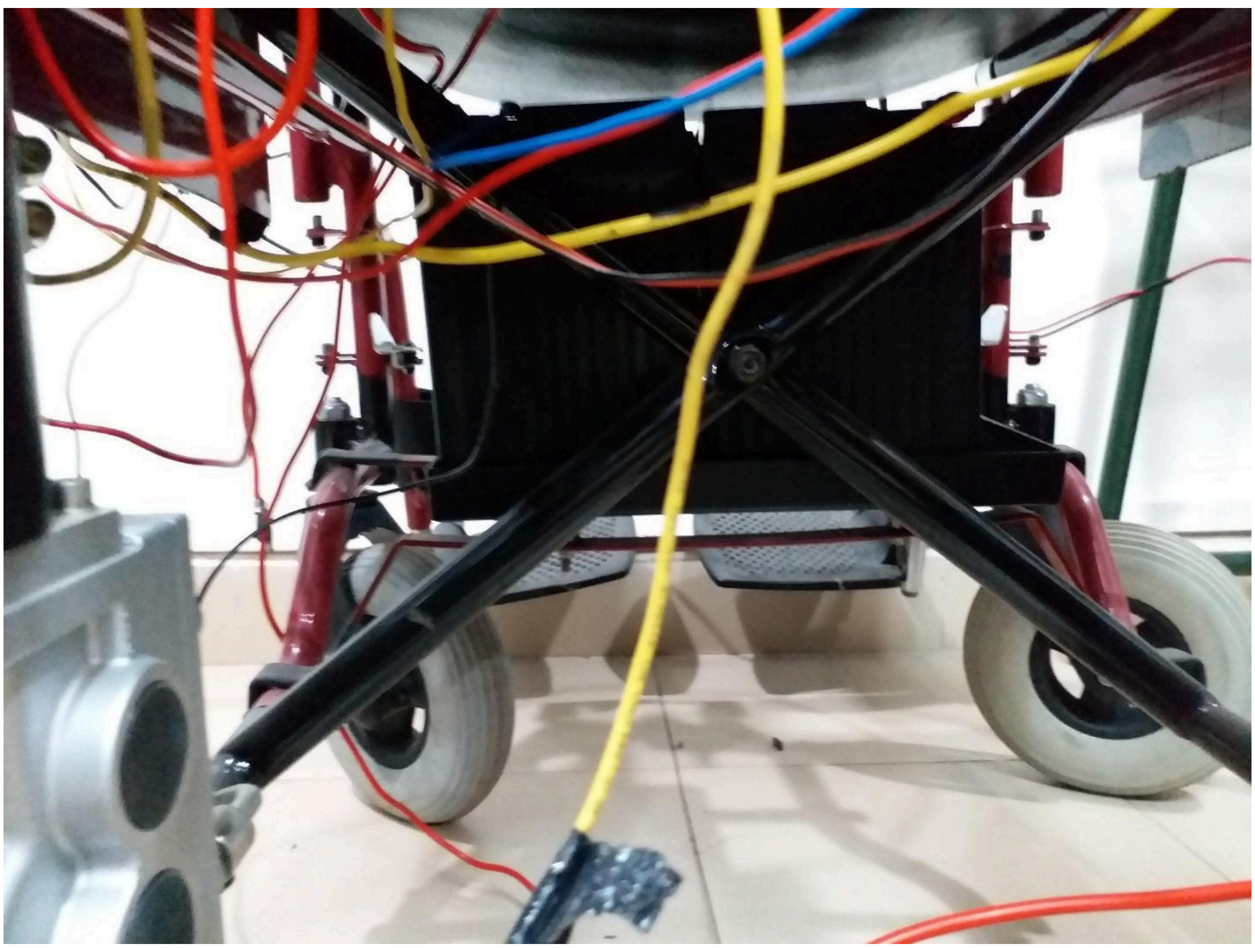


Figure 1

Figure 2

Figure 1 represents how the battery assembly is rested between the two wheels to balance the weight of the chair and the person using it.

Figure 2 shows hoe the motors are connected to the rear wheels of the wheelchair.

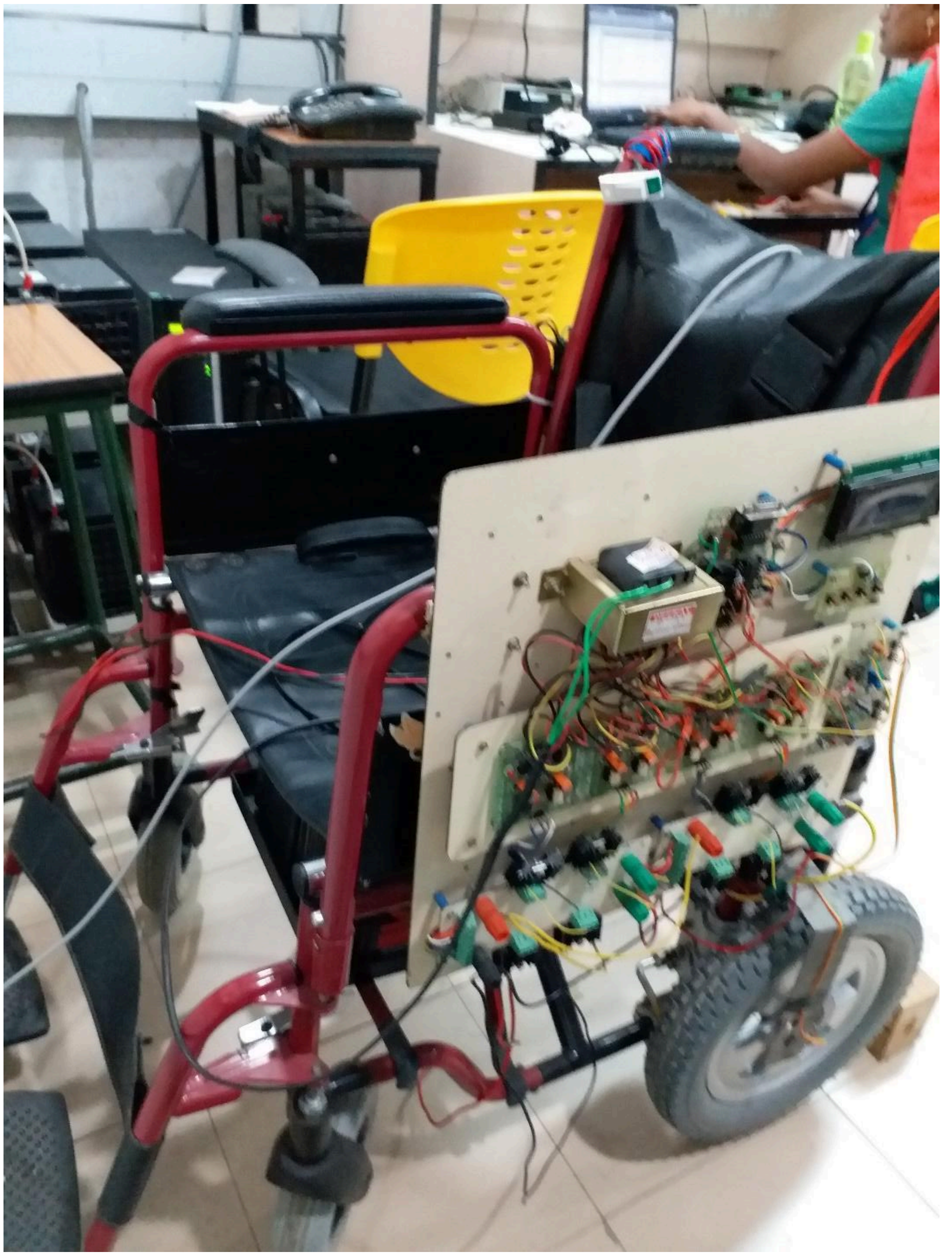


Figure 3

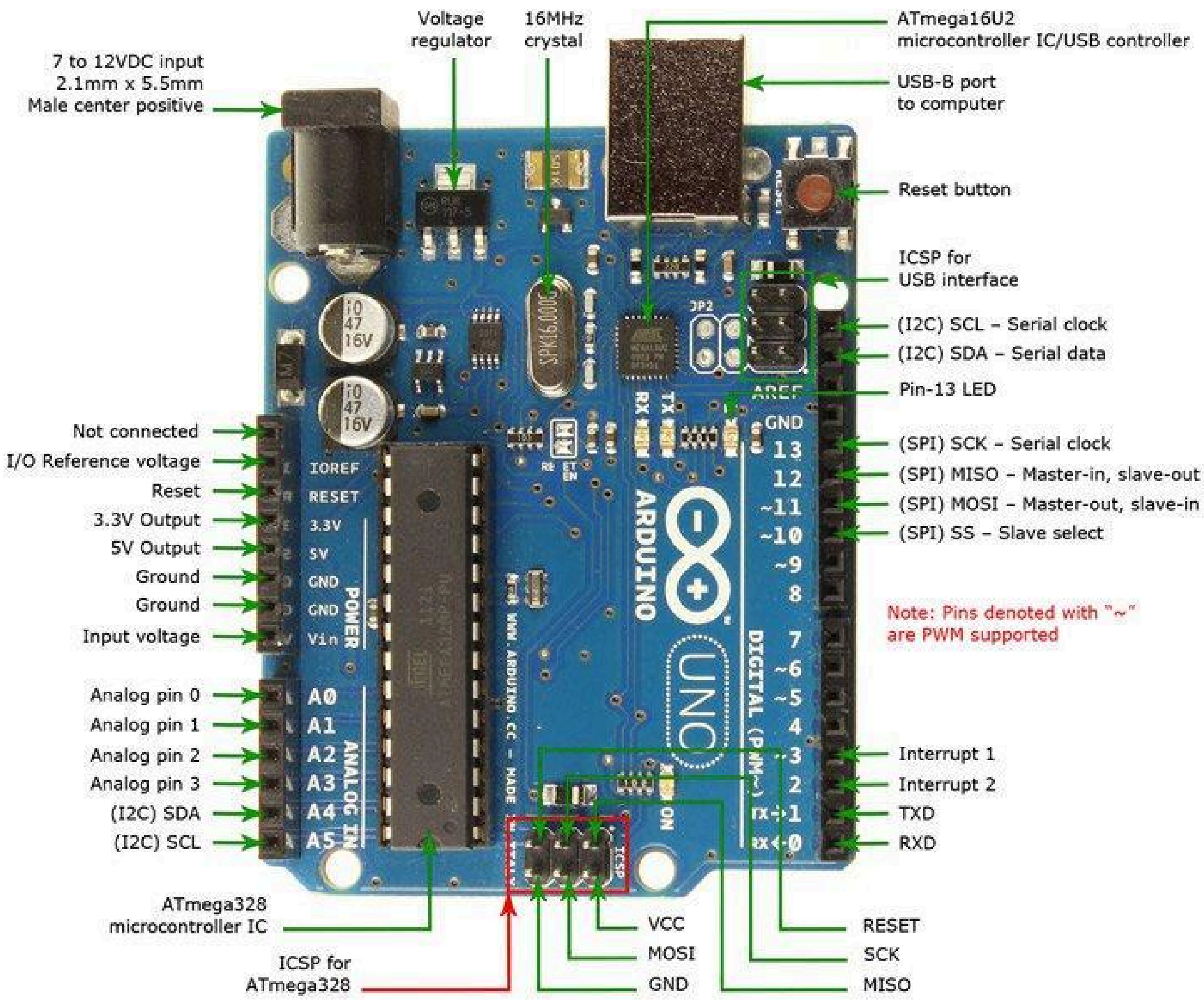
Figure 3 shows the position of the motor controller circuit.

CONCLUSIONS AND RESULTS-

We successfully managed to run our experiments on a smaller prototype model that we created of the wheelchair. We were able to take readings and calibrate the accelerometer accordingly. We were able to realize that the same model can be successfully converted into a larger scale model as we desire.

APPENDIX

1.)Arduino Uno R3-

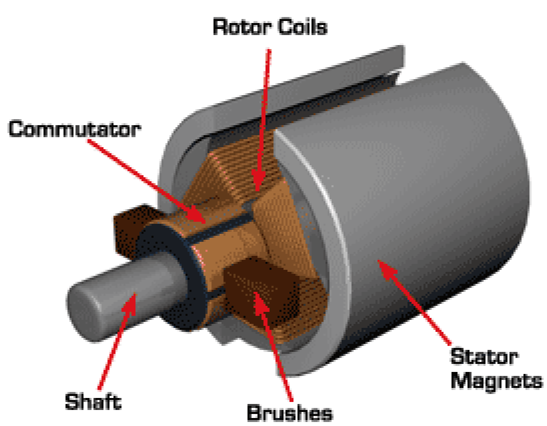


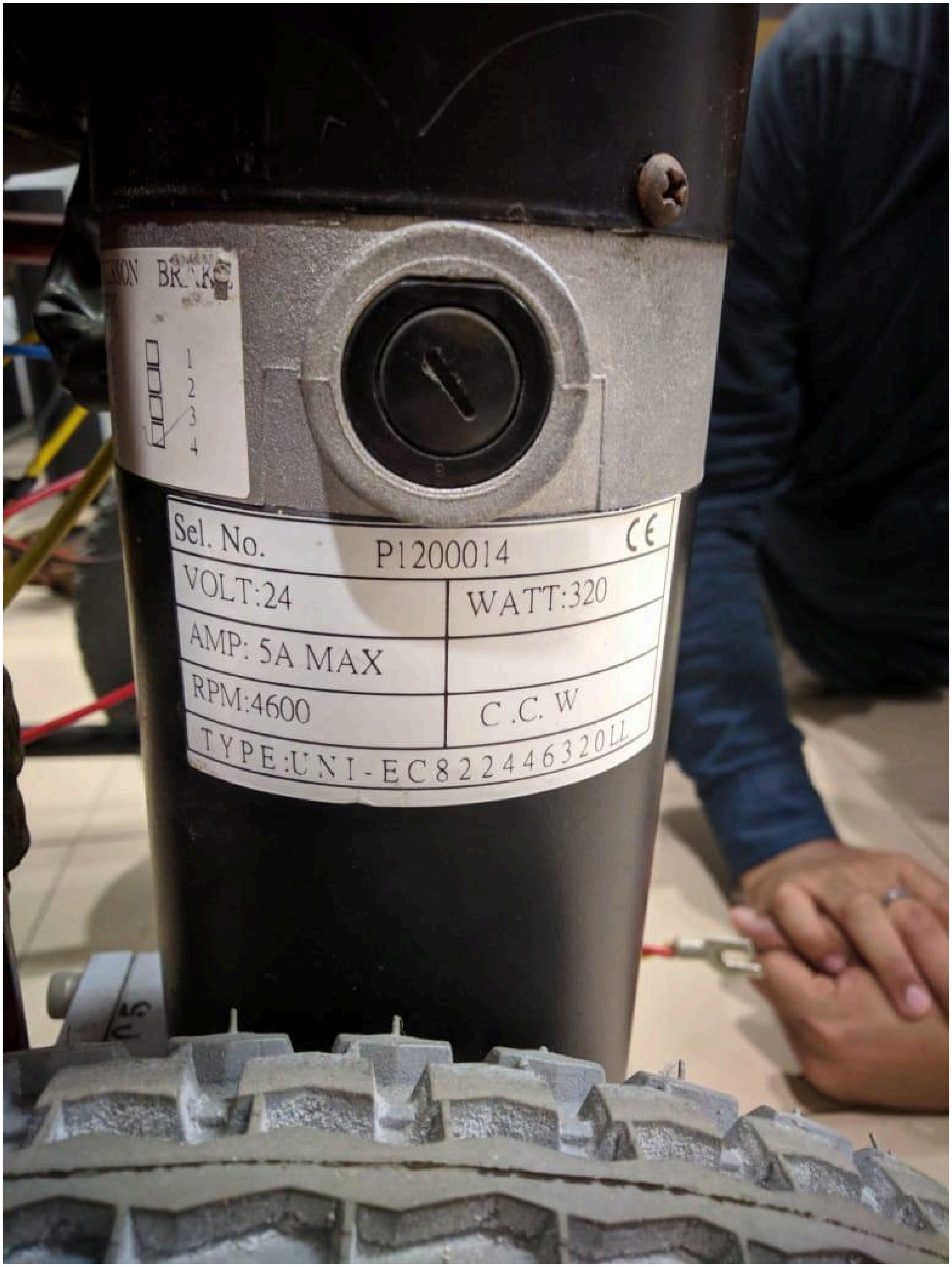
The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The board has 14 Digital pins, 6

Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.It communicates using the original STK500 protocol.The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

2.)2 350W PM-DC Motors-

A brushed DC motor is an internally commutated electric motor designed to be run from a direct current power source. Brushed motors were the first commercially important application of electric power to driving mechanical energy, and DC distribution systems were used for more than 100 years to operate motors in commercial and industrial buildings. Brushed DC motors can be varied in speed by changing the operating voltage or the strength of the magnetic field. Depending on the connections of the field to the power supply, the speed and torque characteristics of a brushed motor can be altered to provide steady speed or speed inversely proportional to the mechanical load. Brushed motors continue to be used for electrical propulsion, cranes, paper machines and steel rolling mills. Since the brushes wear down and require replacement, brushless DC motors using power electronic devices have displaced brushed motors from many applications.




Sel. No.
P1200014
CE
VOLT:24
WATT:320
AMP: 5A MAX
RPM:4600
C.C.W
TYPE:UNI-EC822446320LL
1
2
3
4

3.)Accelerometer-

The ADXL335 is a 3-axis analog-output accelerometer with ±3 g measurement range. The small size (1" x 1") of the breakout board makes it easy to mount the accelerometer to an existing system without the need for additional hardware and with minimal effect on performance of the system and of the accelerometer.
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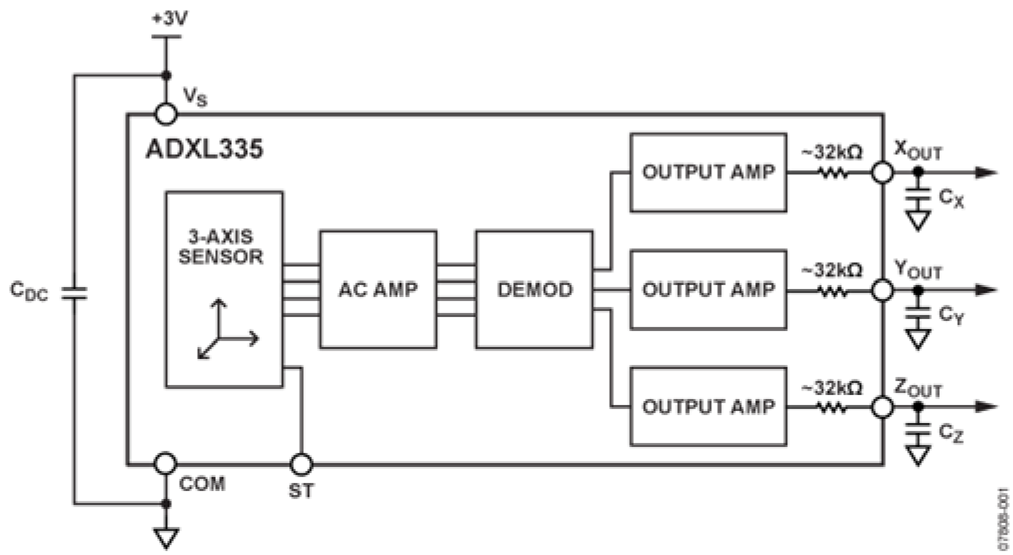


The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 g minimum. It contains a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration. The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

MECHANICAL SENSOR

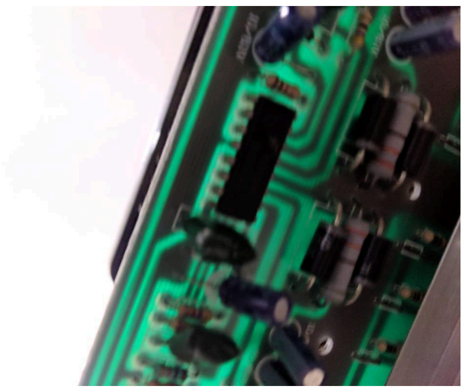
The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes' sense directions are highly orthogonal and have little cross-axis sensitivity. Mechanical misalignment of the sensor die to the package is the chief source of cross-axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level.

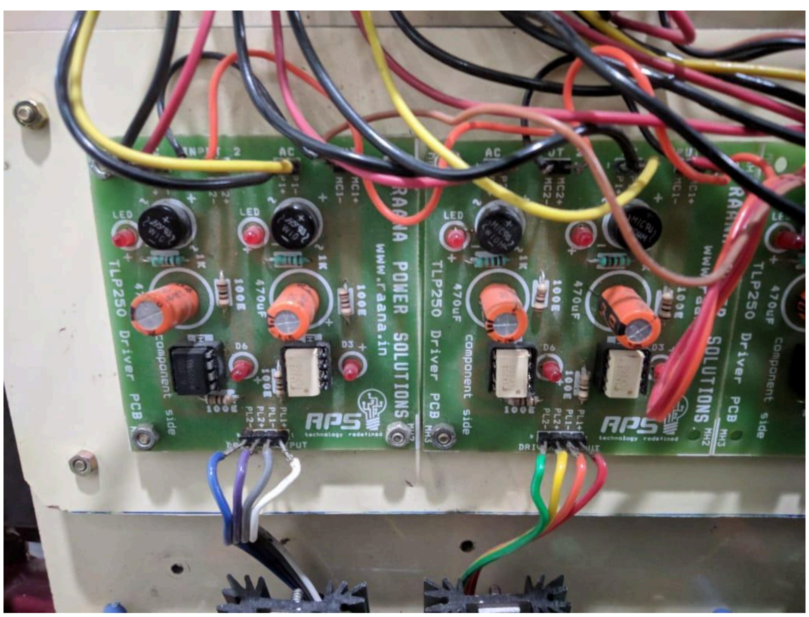
PERFORMANCE

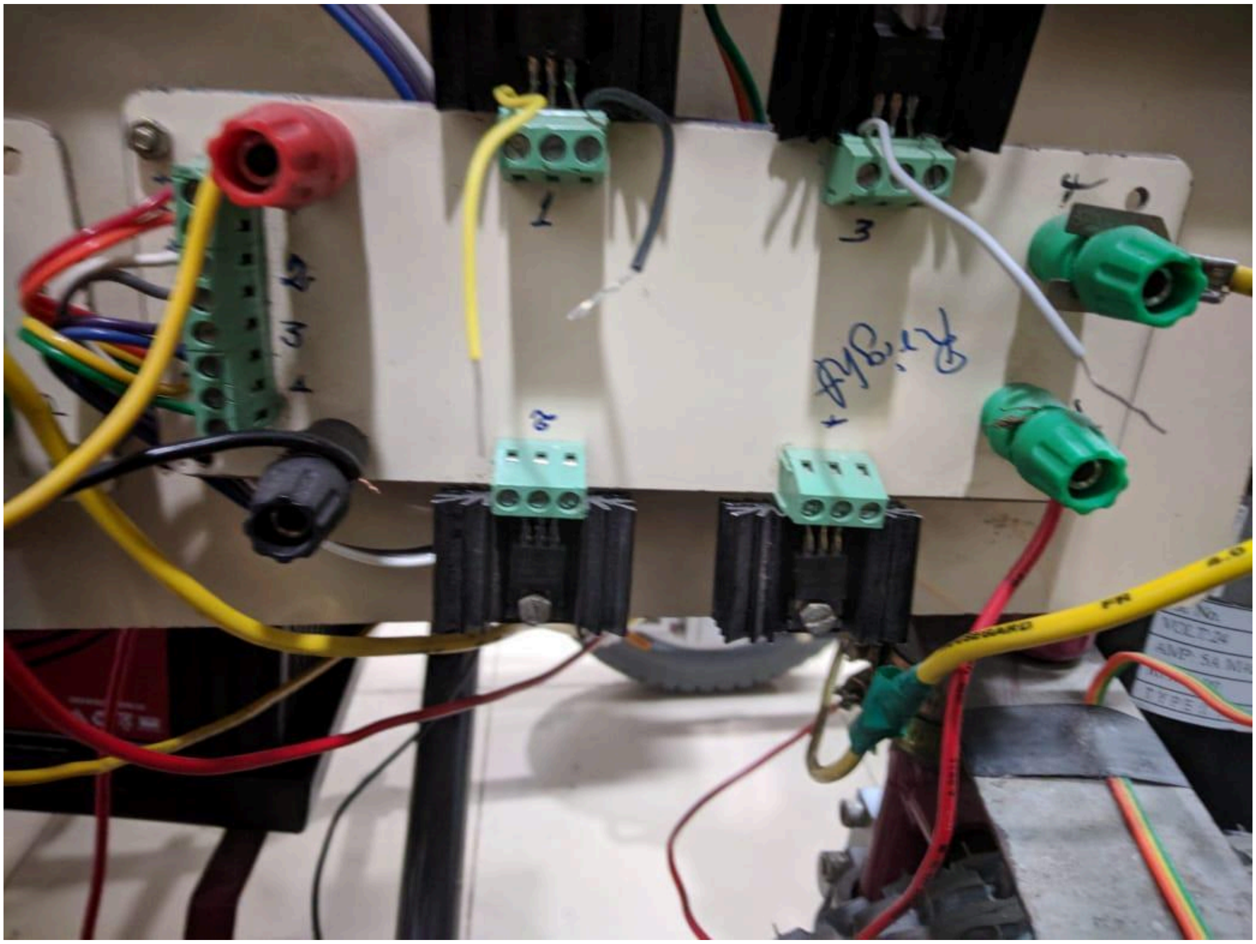
Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or nonmonotonic behavior, and temperature hysteresis is very low (typically less than 3 mg over the −25°C to +70°C temperature range).

4.)Motor Driver-

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

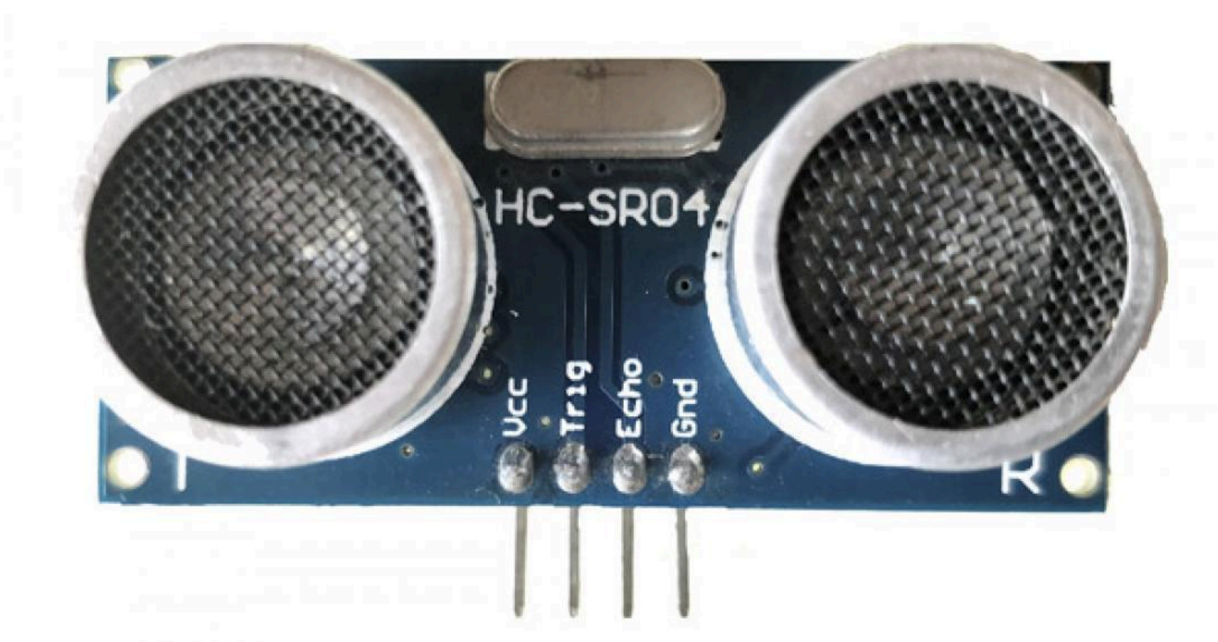





1
3

5.) Ultrasonic Sensor SR04

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver and control circuit. The basic principle of work: (1) Using IO trigger for at least 10us high level signal, (2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. (3) IF the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340M/S)/2.



Code-

```
#define FD 16
#define BD 17
#define LD 18
#define RD 19
#define m11 3
#define m12 4
#define m21 5
#define m22 6
void forward()
{
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, HIGH);
  digitalWrite(m22, LOW);
}
void backward()
{
```

```
  digitalWrite(m11, LOW);
  digitalWrite(m12, HIGH);
  digitalWrite(m21, LOW);
  digitalWrite(m22, HIGH);
}
void left()
{
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, LOW);
}
void right()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, LOW);
  digitalWrite(m21, HIGH);
  digitalWrite(m22, LOW);
}
void Stop()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, LOW);
}
void setup()
{
 pinMode(FD, INPUT);
 pinMode(BD, INPUT);
 pinMode(LD, INPUT);
 pinMode(RD, INPUT);
 pinMode(m11, OUTPUT);
 pinMode(m12, OUTPUT);
 pinMode(m21, OUTPUT);
 pinMode(m22, OUTPUT);
}
void loop()
{
 int temp1=digitalRead(FD);
 int temp2=digitalRead(BD);
 int temp3=digitalRead(LD);
 int temp4=digitalRead(RD);
```

```
if(temp1==1 && temp2==0 && temp3==0 && temp4==0)
backward();
else if(temp1==0 && temp2==1 && temp3==0 && temp4==0)
forward();
else if(temp1==0 && temp2==0 && temp3==1 && temp4==0)
left();
else if(temp1==0 && temp2==0 && temp3==0 && temp4==1)
right();
else
Stop();
}
```

References

[1] Yang Y.P., Lin H.C., Tsai F.C., Lu C.T., Tu K.H. Design and integration of dual power wheels with rim motors for a powered wheelchair. IET Electr. Power Appl. 2012; 6 (7):419–428. [2] Nguyen T.N., Su S.W., Nguyen H.T. Robust neuro-sliding mode multivariable control strategy for powered wheelchairs. IEEE Trans. Neural Syst. Rehab. Eng. 2011; 19(1):105-111. [3] Lord W., Hwang J.H. DC servomotors-modelling and parameter determination. IEEE Trans. Ind. Appl. 1977; IA-13(3): 234-243. [4] Schulz R.A. A frequency response method for determining the parameters of high-performance DC motors. IEEE Trans. Ind. Electron. 1983; IE-30 (1):39-42. [5] Zhou H. Model-based regulator in PMDC Motor. IEEE Int. Conf. on Systems, Man, and Cybernetics. 2004; 508-512. [6] Hadef M, Mekideche M.R. Parameter identification of a separately excited dc motor via inverse problem methodology. Turk J Elec Eng & Comp Sci. 2009; 17(2):99-106. [7] Hadef M., Bourouina A, Mekideche M.R. Parameter identification of a DC motor via moments method. International Journal of Electrical and Power Engineering. 2008; 1(2): 210–214. [8] Obeidat M.A., Le Yi Wang, Feng Lin. Real-time parameter estimation of PMDC motors using quantized sensors. IEEE Transactions on Vehicular Technology. 2013; 62(7): 2977–2986. [9] Udomsuk S., Areerak K-L., Areerak K-N., Srikaew A. Parameters identification of separately excited dc motor using adaptive tabu search technique. IEEE International conference on Advances in Energy Engineering. 2010; 48-51. [10] Dupuis A., Ghribi M., Kaddouri A. Multi-objective genetic estimation of DC motor parameters and load torque. IEEE International Conference on Industrial Technology. 2004; 3:1511-1514. [11] Huynh D.C., Dunnigan M.W. Parameter estimation of an induction machine using advanced particle swarm optimization algorithms. IET Electr. Power Appl. 2010; 4(9):748–760. [12] Shanmugasundram R. Zakariah K.M., Yadaiah N. Implementation and performance analysis of digital controllers for brushless dc motor drives. IEEE/ASME Transactions on Mechatronics, 2014; 19 (1): 213-224. [13] Ogata K. Modern Control

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