Faculty of Information Technology

IN 1900/ ICT Project

Multifunctional Massaging Chair

Final Report

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Group no:34

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1. Introduction

People who work in offices spend most of their time sitting in a chair. Due to the covid-19 pandemic situation office, workers use computers extensively to do their jobs as well as students to do their studies. Spending a lot of time in the same posture can cause physical discomfort and pain. Also because of various reasons such as busy and boring lifestyles people may suffer from mental health issues.

So, in this project, we planned to make a chair that will help to minimize those physical and mental health issues.

2. Literature Survey

There are several multifunctional massaging chairs available in the market.

1. HOMCOM's High Back Heated Massage Chair [2]

Features:6 heating and vibrating points
a remote controller,
solid five-leg base with 360° swivel wheels
a padded seat, armrests
backrest

The heating and vibrating points massage the upper back, lower back, and legs of the user. Users can choose the time duration for the massage (between 15,30 and 60mins) by using the remote controller. Also, this chair supports up to 120Kg.*(figure 1.1)*

Figure 1. 1:HOMCOM's High Back Heated Massage Chair

There are some office chairs with massaging functions available in the market. Most of them have the same features as the “HOMCOM” massaging chair.[4]

2. X COMFORT AIR professional gaming chair [31]*(figure 1.2)*

Figure 1. 2:X COMFORT AIR professional gaming chair

There is a high-quality aerodynamic design.

Also, they have used *(figure 1.3)*

- Five fan blade design for optimal cooling
- State-of-the-art wind blocker frame
- High-performance fan

Figure 1. 3:Functions of X COMFORT AIR professional gaming chair

Also, there are water-cooled gaming chairs.*(figure 1.4)*

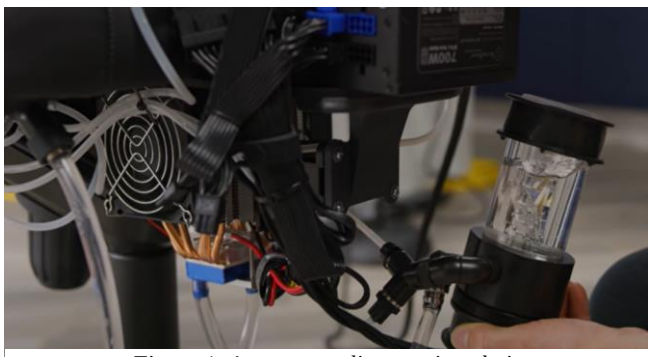


Figure 1. 4: water cooling gaming chair

3. Dowinx Gaming Chair Office [22] *(figure 1.5)*

Remarkable features:

- The Winged back provides multi-point body contact to share the pressure, save spine and lumbar with ergonomic back and massage support.
- retractable footrest for relaxing.

Figure 1. 5:Dowinx Gaming chair

Like this, there are various kinds of multifunctional chairs in the market.

But ,

- They are expensive.
- There are limited no of stocks.
- Also, **cannot find chairs with all functions with one chair.**

3. Aim and Objectives

3.1. Aim:

The aim of this project is to build a Multifunctional Massaging Chair that functions automatically.

3.2. Objectives:

The goal of this project is to build a multifunctional massaging chair by fulfilling the below objectives to create a comfortable environment for the user to work and also relax.

- Cool or heat the chair according to the user's necessity.
- Massage the user according to his preferences.
- Give Lumbar support to the user when the user isn't comfortable with the chair.
- Make an automated footrest for the user

4. Analysis and Design

4.1. System Block Diagram

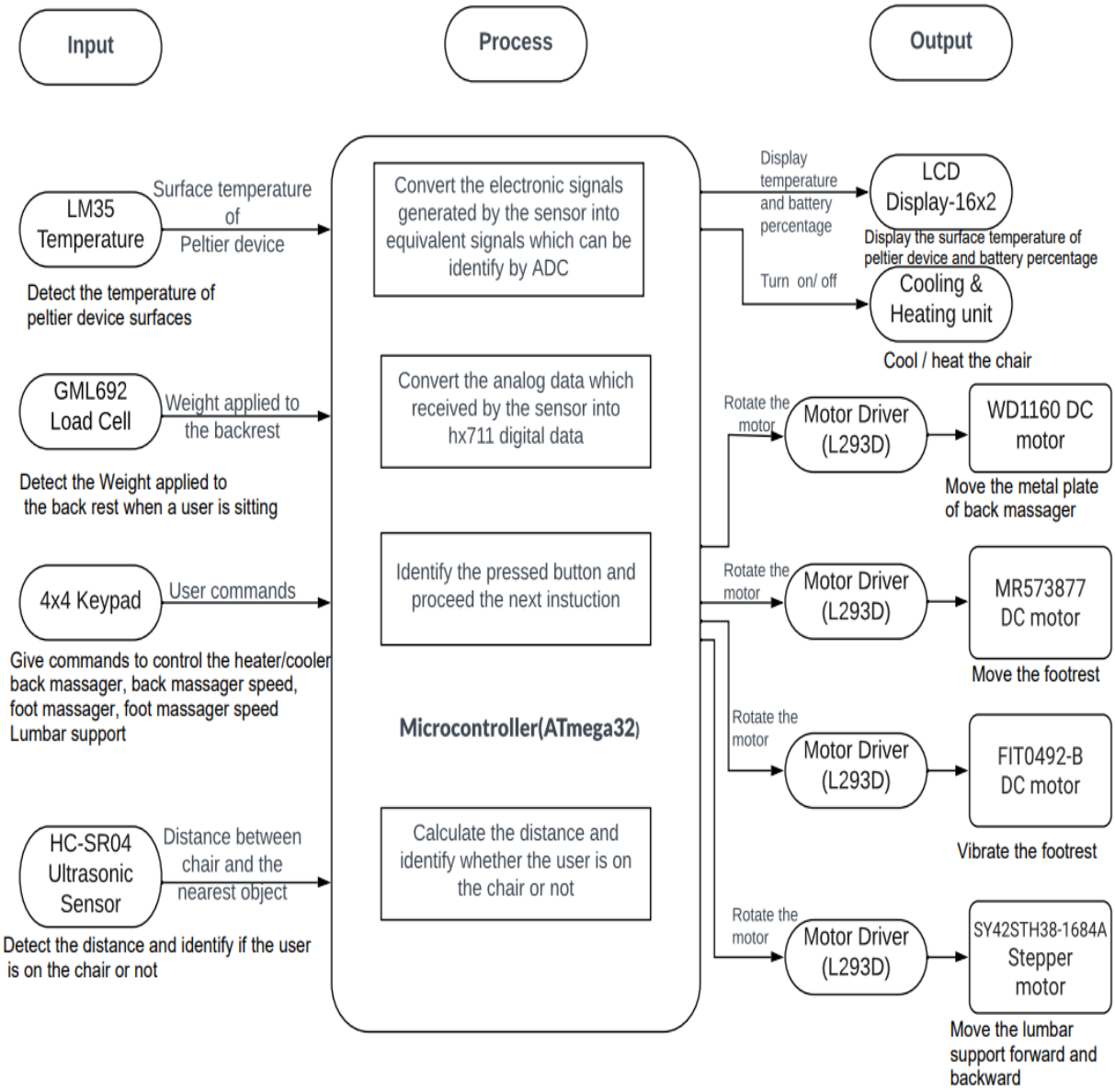


Figure 2. 1:System block diagram

4.2 Schematic of the product

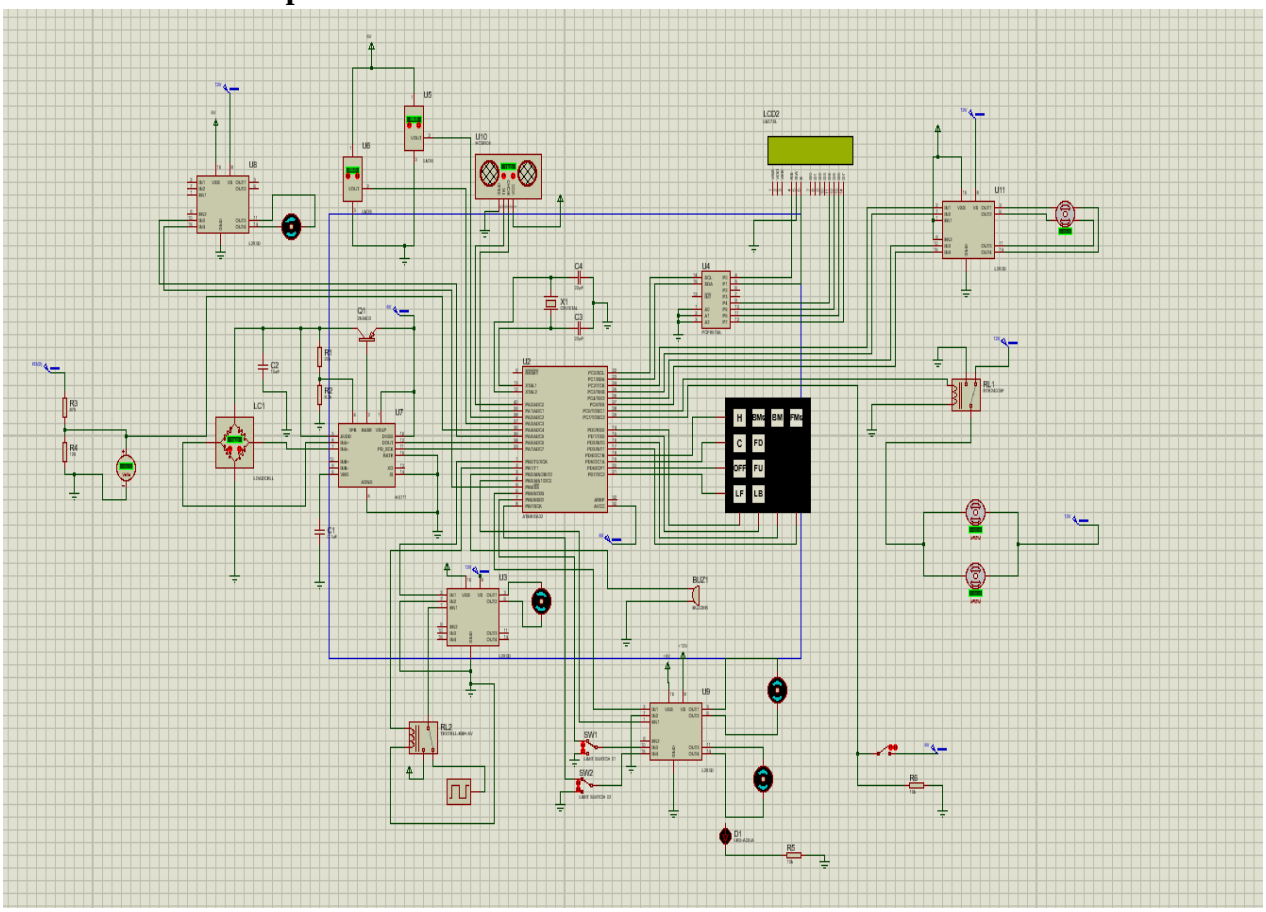


Figure 2. 2: Schematic of the product

4.3. 3D Design of the System

Figure 2. 3:3D view of the chair

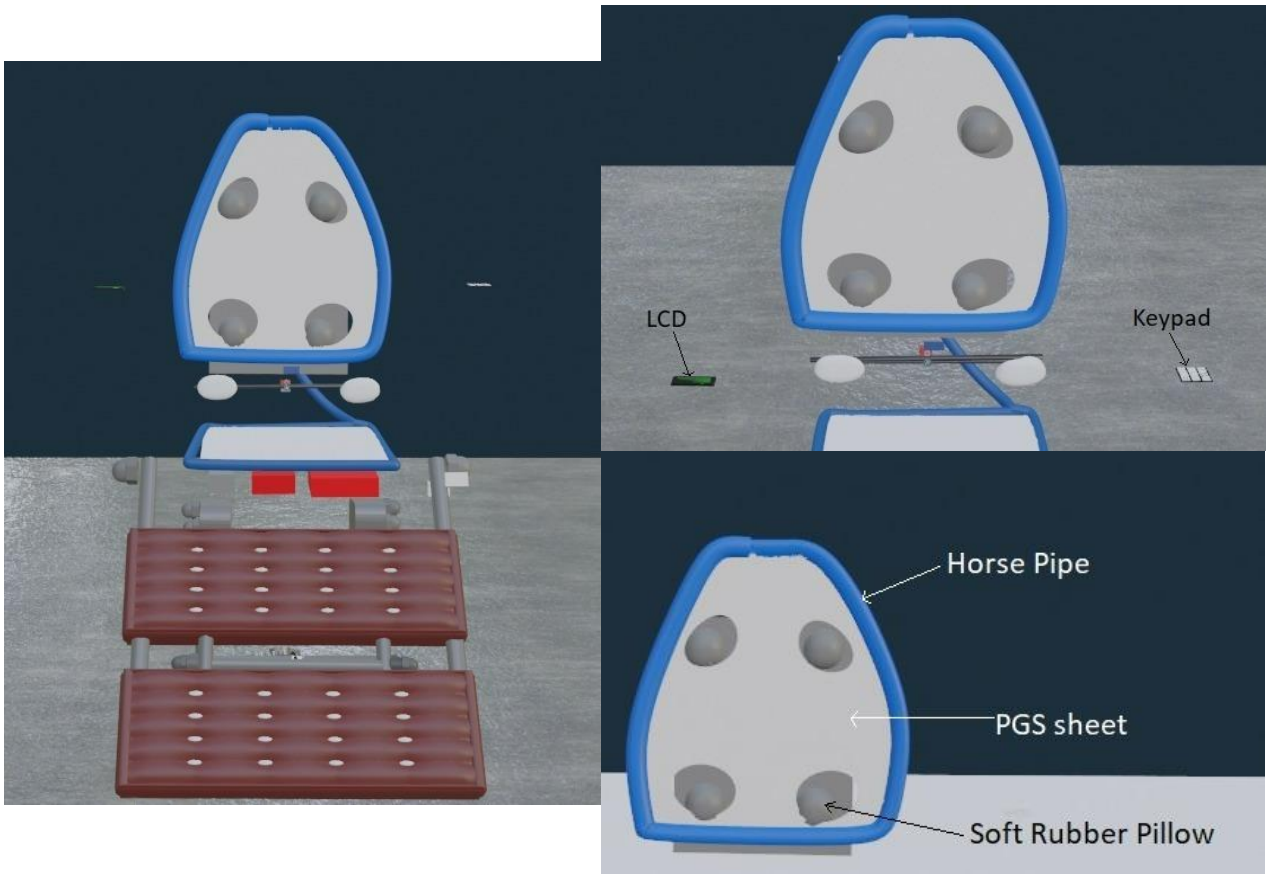


Figure 2. 4: internal view of chair 1

Figure 2. 5:internal view of chair 2

1

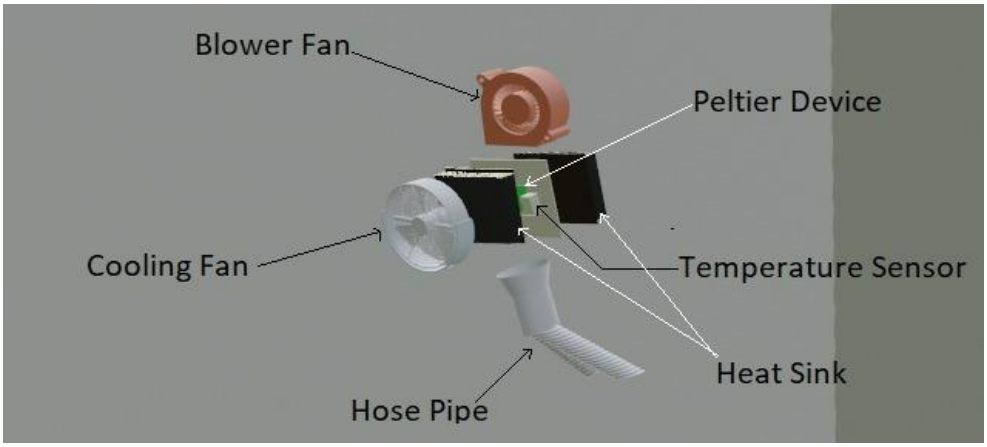


Figure 2. 6:internal view of chair 3

2

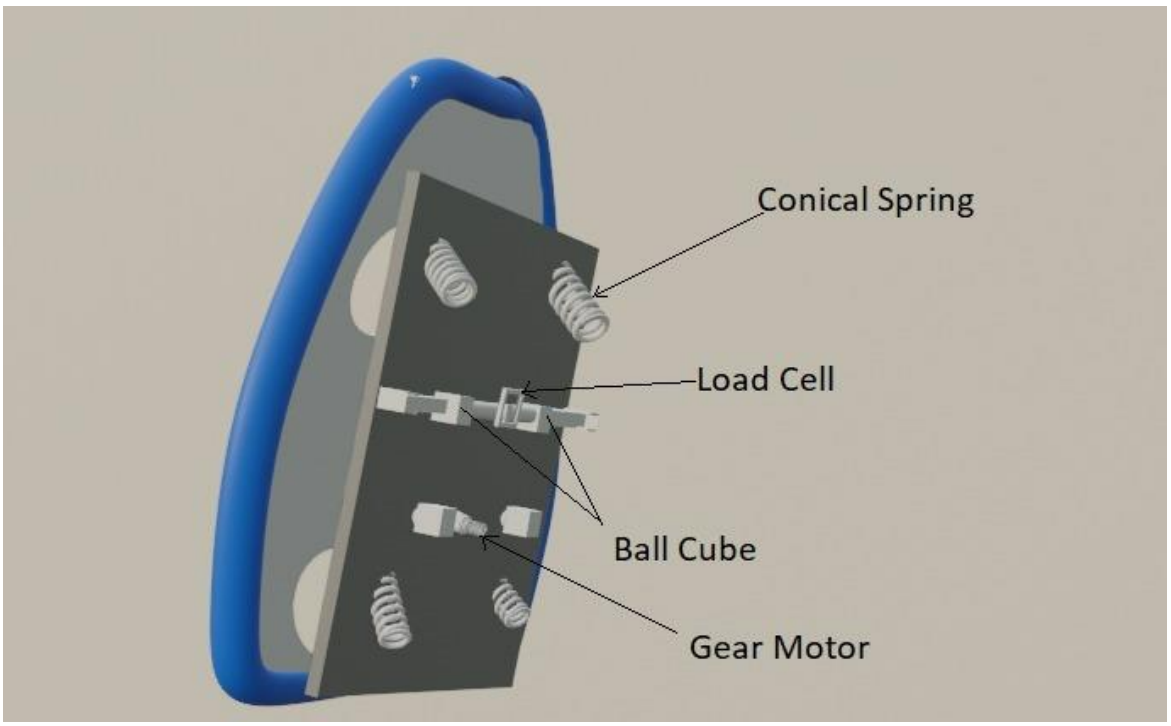
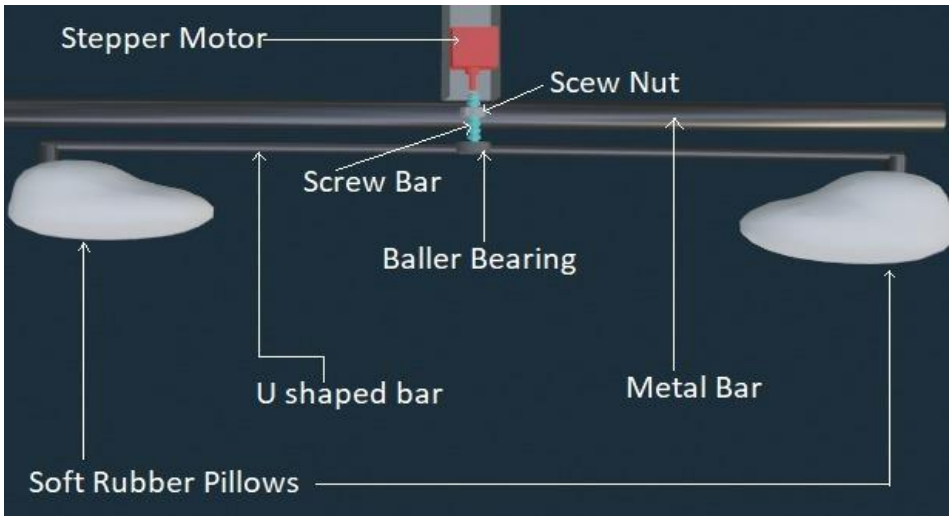


Figure 2. 7:internal view of chair 4

3



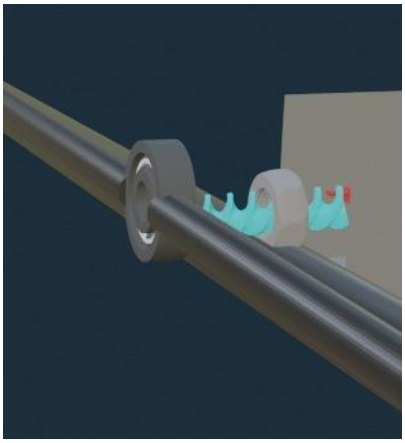


Figure 2. 8:internal view of chair 5

4

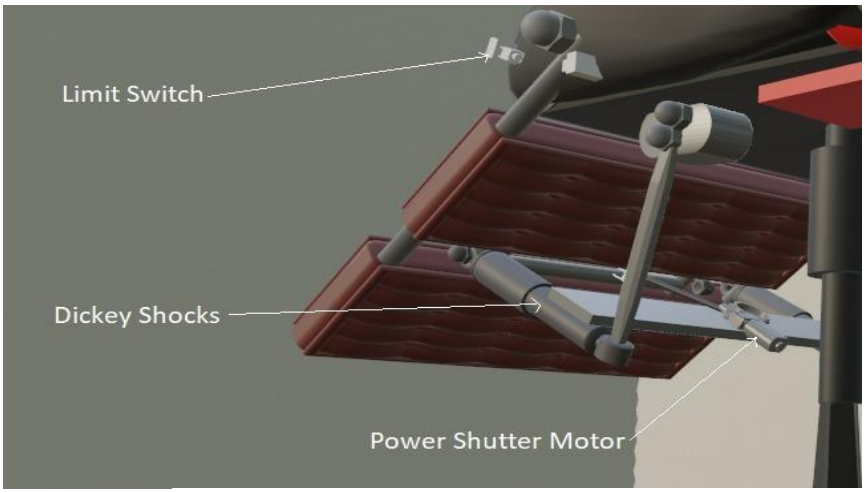


Figure 2. 9:internal view of chair 6

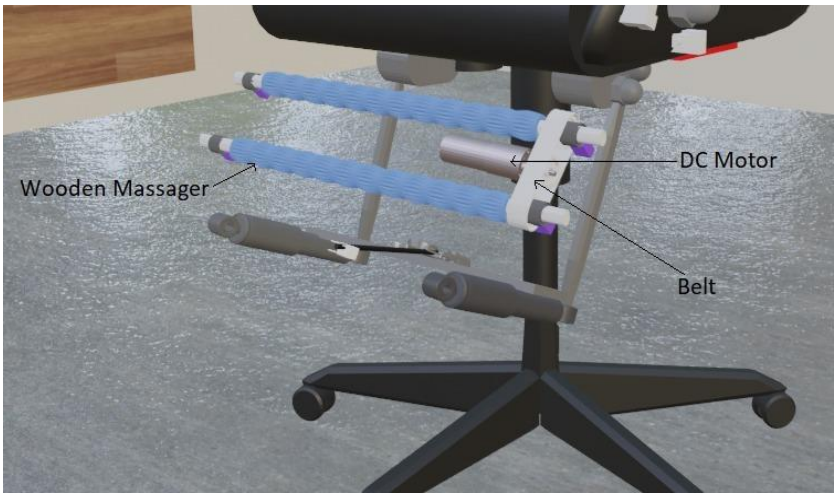


Figure 2. 10:internal view of chair 7

5. Testing and Implementation.

In our system, there are four main units. they are

1. Cooling and heating system
2. Automated lumbar support system
3. Massaging function
4. Automated footrest and foot massaging Function

To construct these units, we assigned all of the components to each member.

Then we did individual research on our components by reading datasheets and articles on the internet.[24]
The following step is to learn how to code the components using Microchip Studio and to simulate them using Proteus 8 Professional.
So after that, we tested our components individually, and once all of them worked properly, we began combining the codes.

5.1. Testing components individually

Footrest unit

Examine the DC motors that are used to move and vibrate the footrest.

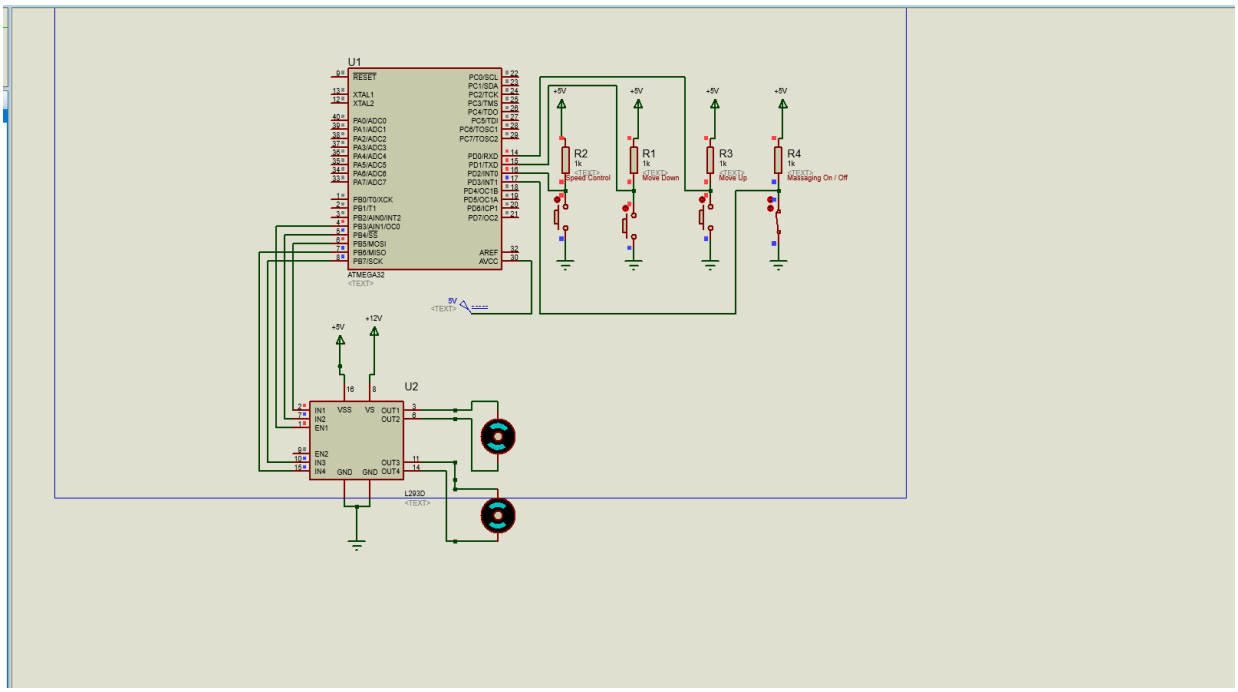


Figure 3. 1: Testing the footrest (individual)

LCD

Test whether the required strings are displayed on the LCD(16x2) by using the i2c protocol (PCF8574A).

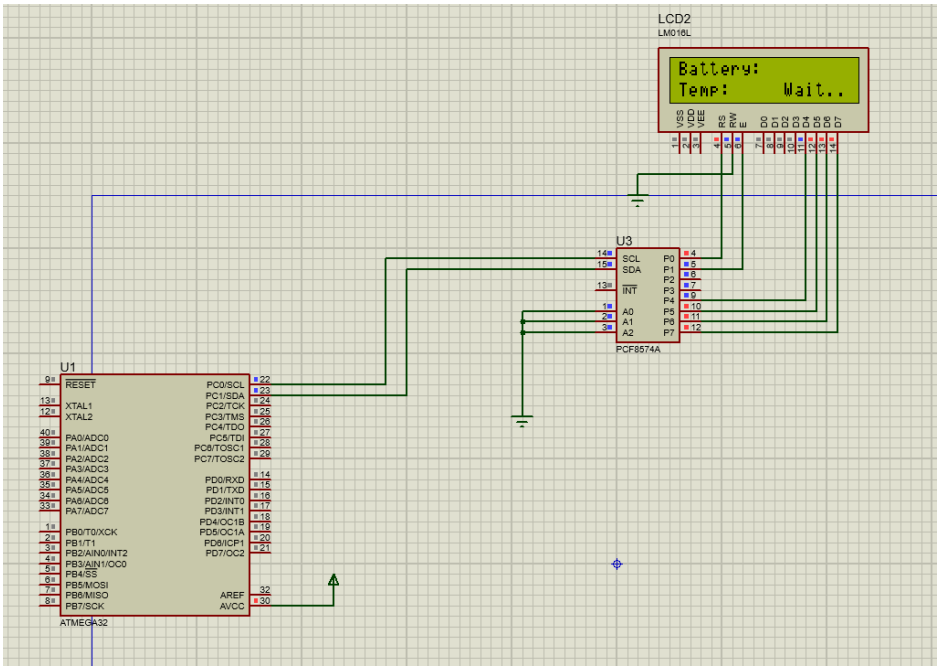


Figure 3. 2: Testing the LCD (individual)

Moving Lumbar Support(using Stepper Motor)

Test whether the stepper motor is rotating 45 degrees by 45 degrees according to the user preference. Examine whether the stepper motor rotates by 45 degrees.(clockwise) (to move lumbar support forward)

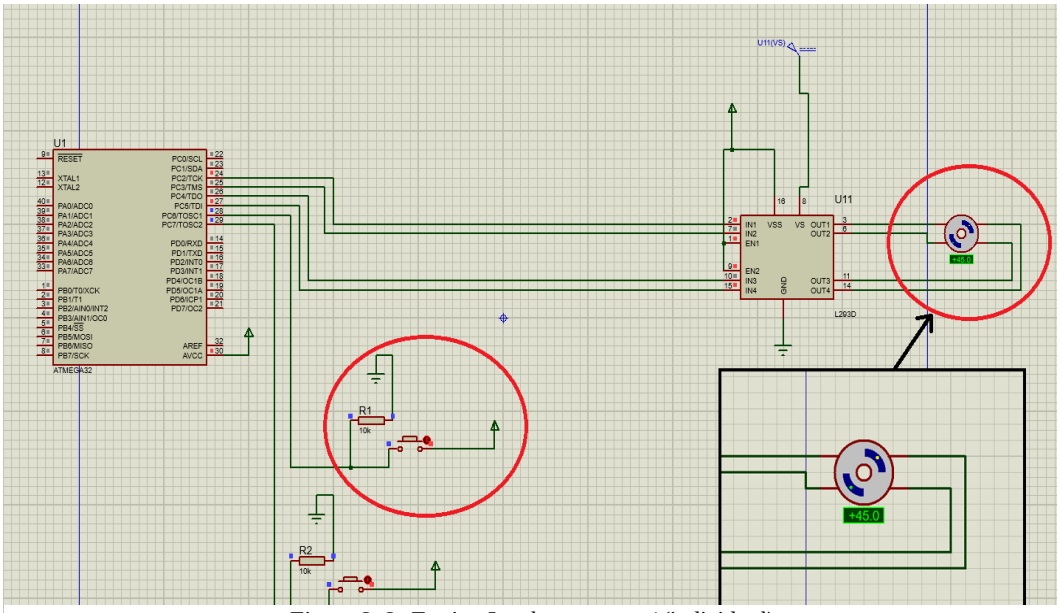


Figure 3. 3: Testing Lumbar support 1(individual)

Suppose that the stepper motor has rotated 270 degrees.

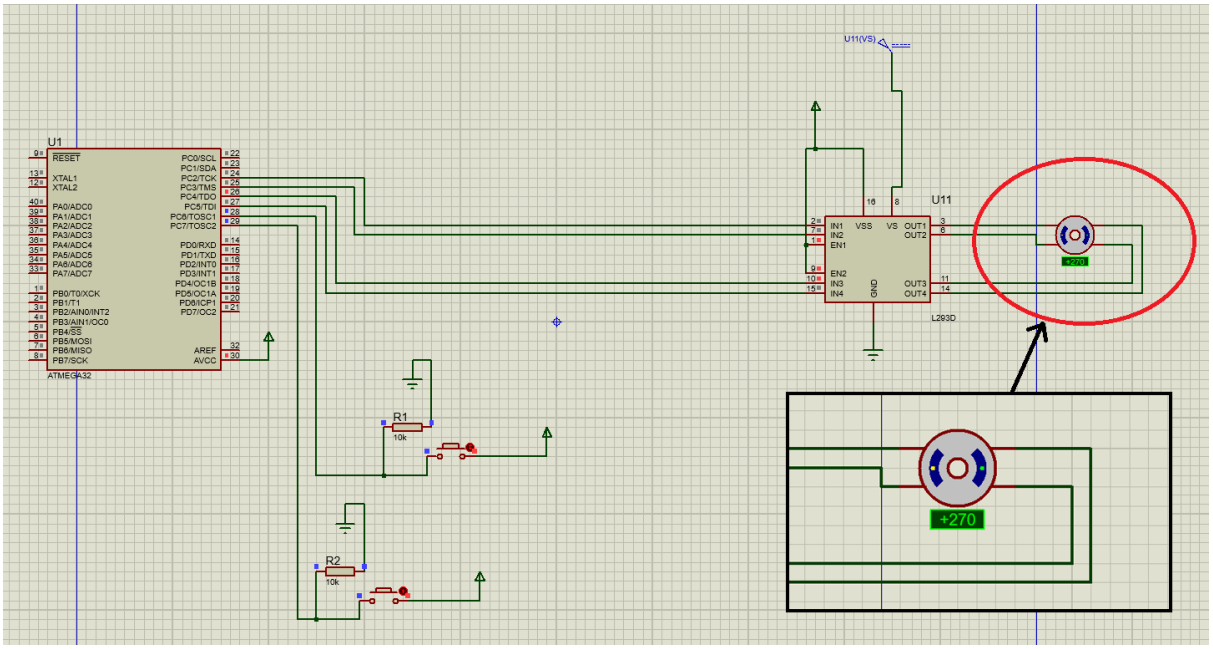


Figure 3. 4: Testing the Lumbar support 2(individual)

Then test whether the stepper motor rotates backward by 45 degrees.(eg:from 270 degrees to 225 degrees)
(anticlockwise)(to move lumbar support backward)

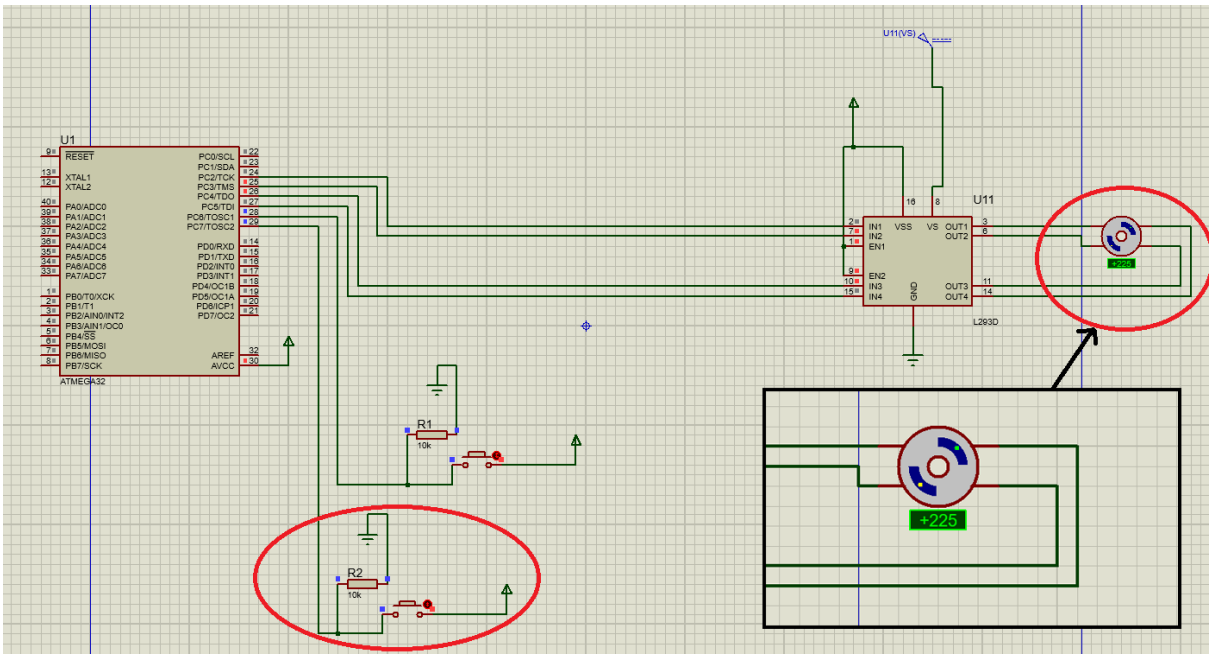


Figure 3. 5:Testing the Lumbar support 3(individual)

Cooling and heating Function

When either of the temperature sensors exceeds 70 degrees Celsius, the Peltier module will automatically turn off while fans are working.

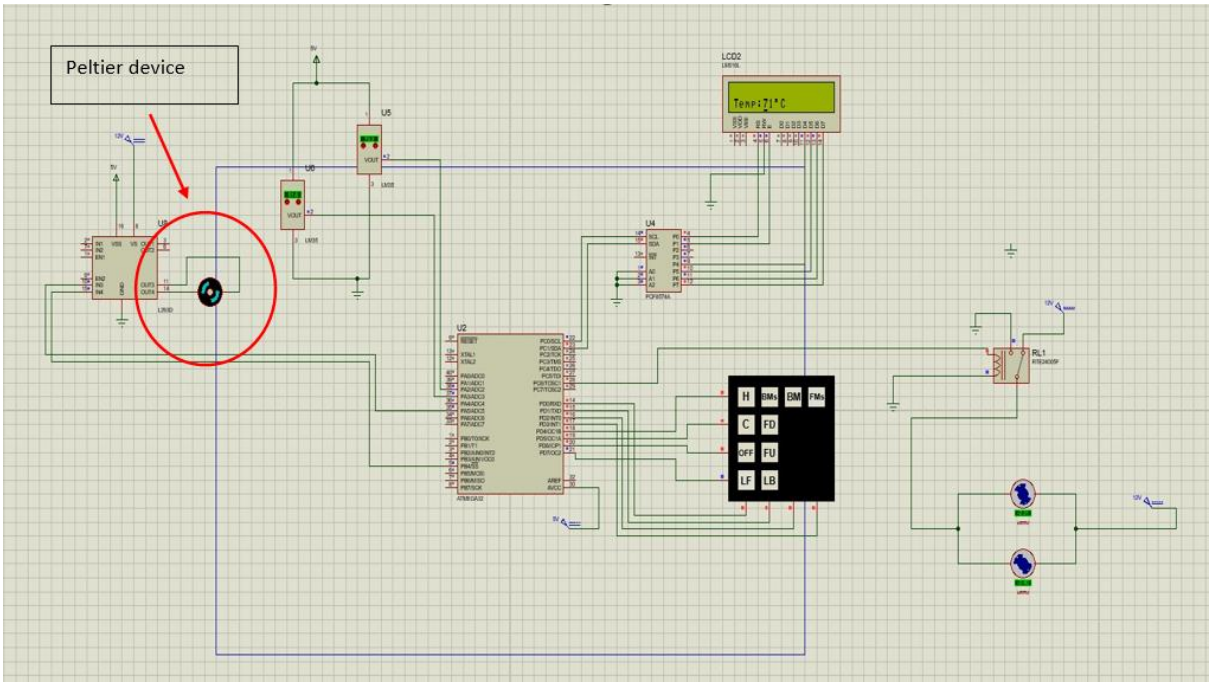


Figure 3. 6:Testing cooling and heating system 1(individual)

When the temperature exceeds 15 degrees Celsius, we test that pressing the 'H' button activates the heating function. If the temperature detects less than 38 degrees Celsius by pressing the ‘C’ button we can activate the cooling function (current direction through the Peltier Module changed)

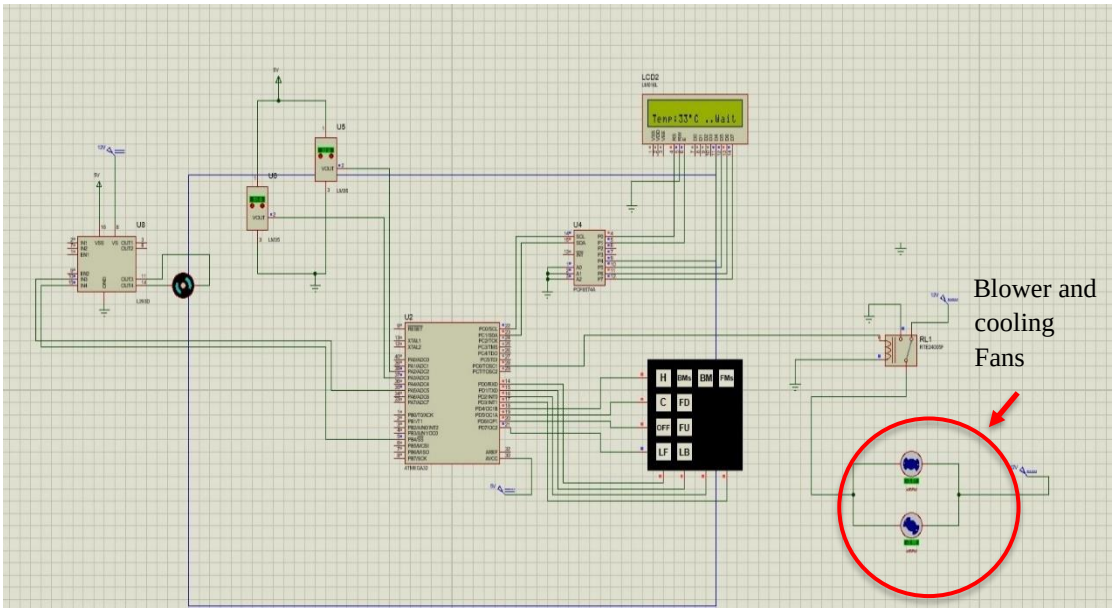


Figure 3. 7:Testing the cooling and heating system 2(individual)

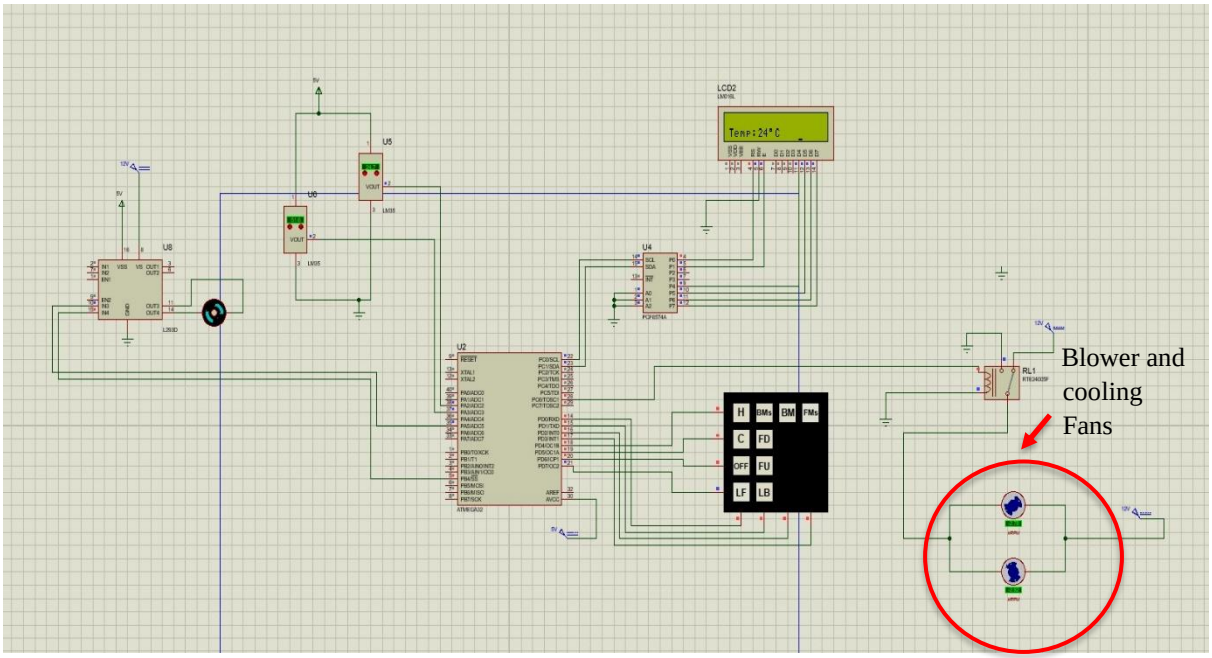


Figure 3. 8:Testing the cooling and heating system 3(individual)

Testing whether the Peltier module and two fans turn off when we press the off button.

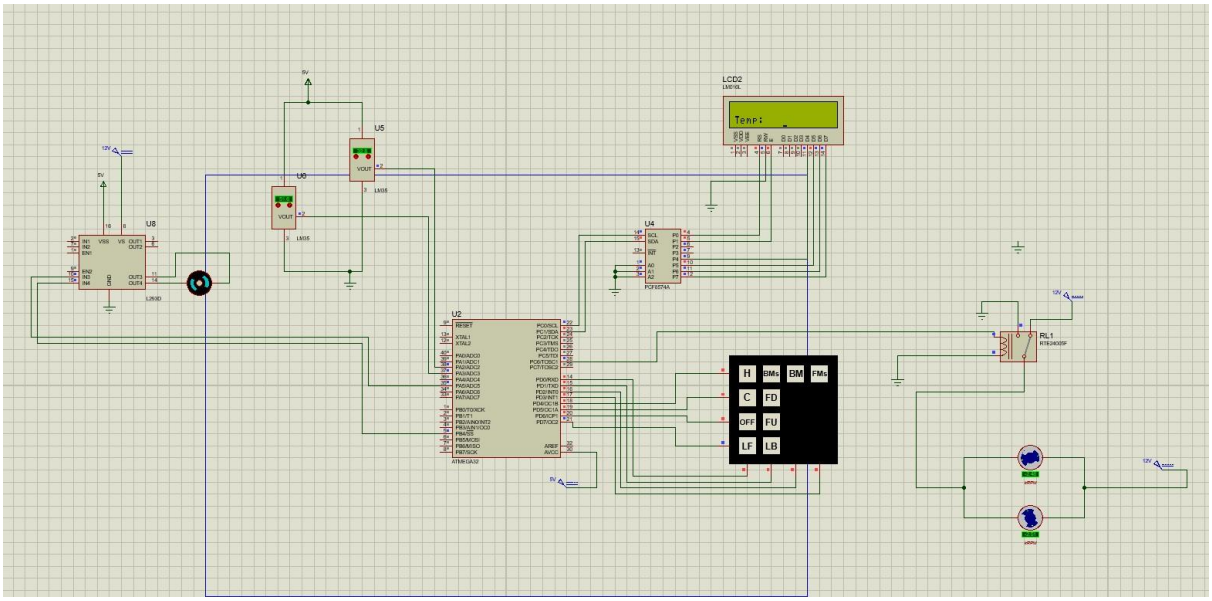


Figure 3. 9:Testing the cooling and heating system 3(individual)

Back massaging function

The massager will activate when the weight is less than or equal to 15 and the activating button is pressed.

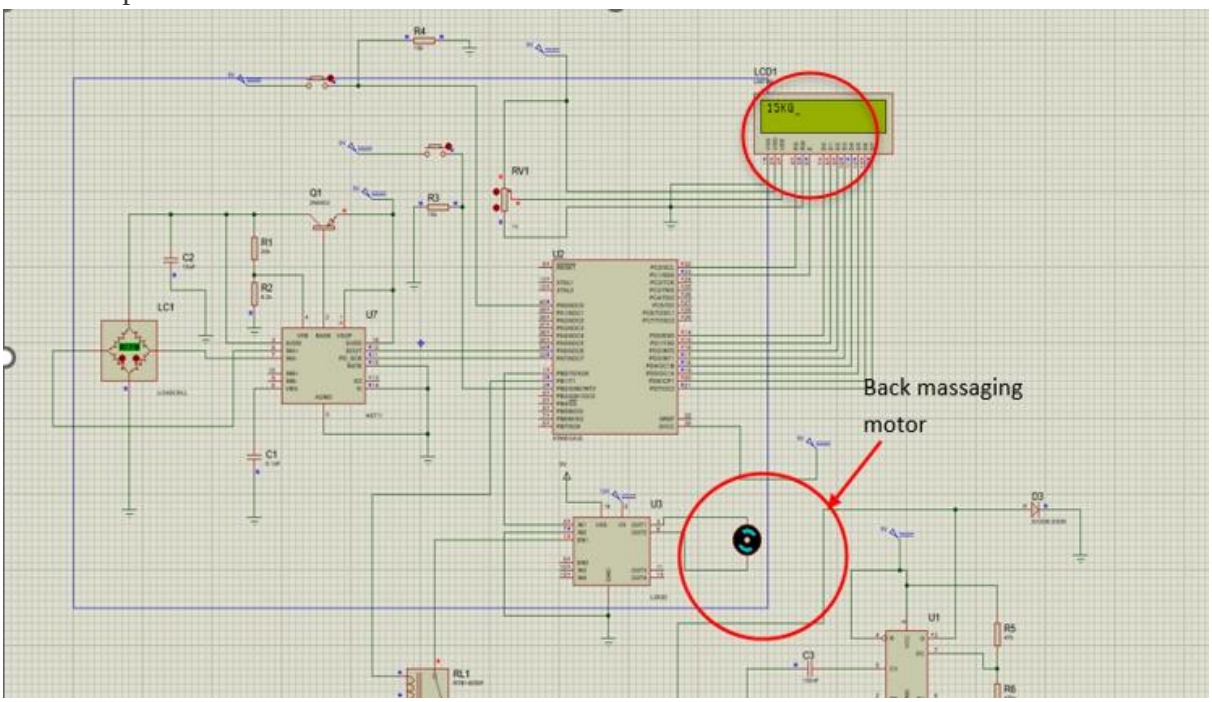


Figure 3. 10:Testing the back massage function 1(individual)

When the weight exceeds 15, the function will automatically stop.

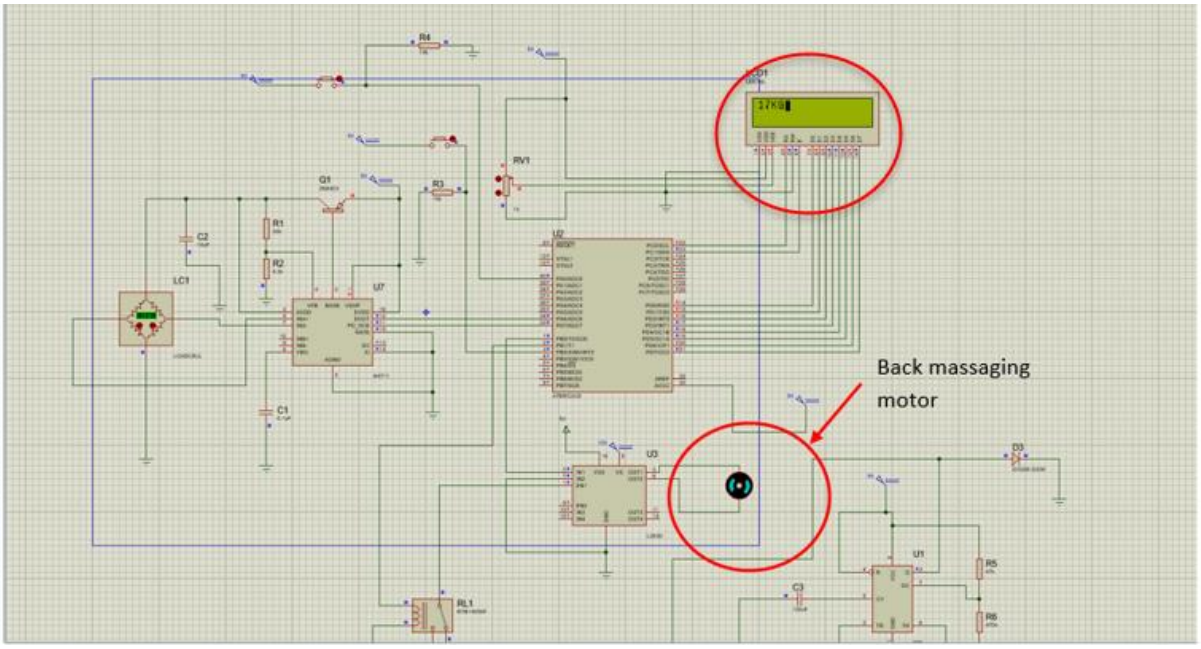


Figure 3. 11:Testing the back massage function 2(individual)

This function cannot be performed if the button is not pressed.

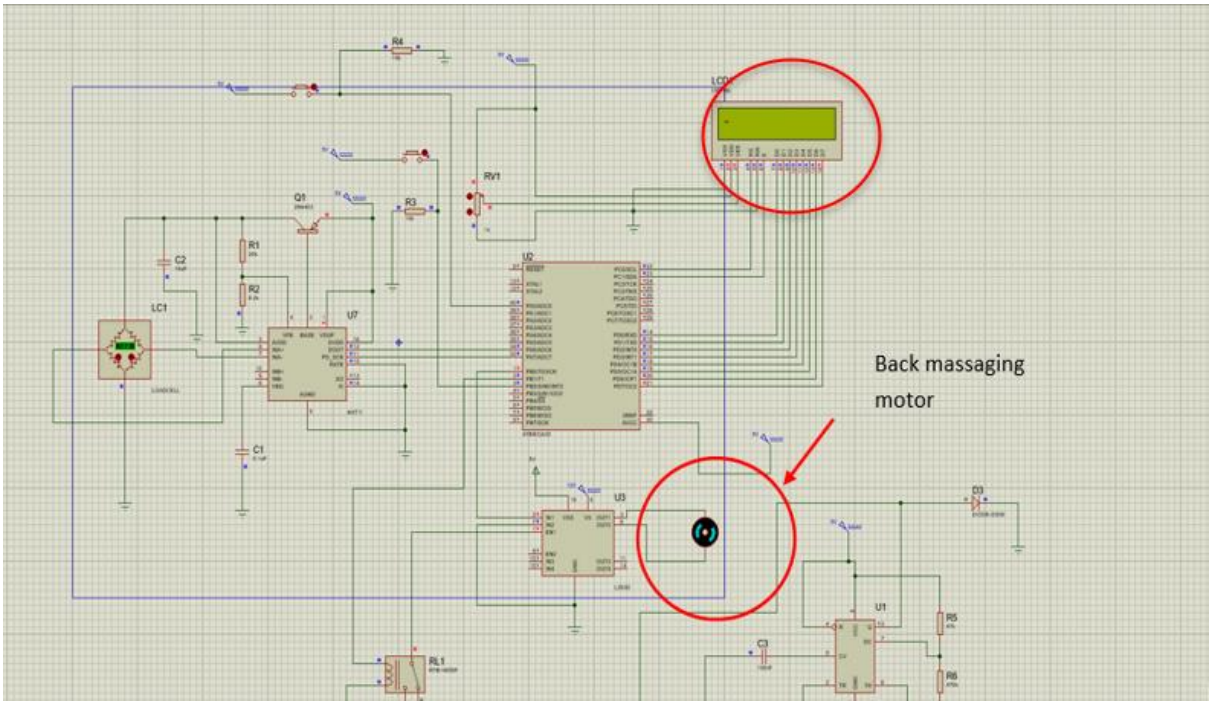


Figure 3. 12:Testing the back massage function 3(individual)

Ultrasonic sensor

If the distance detected by the Ultrasonic sensor exceeds 15 cm, the back massager should be turned off. So we tested it by replacing the motor with an LED.

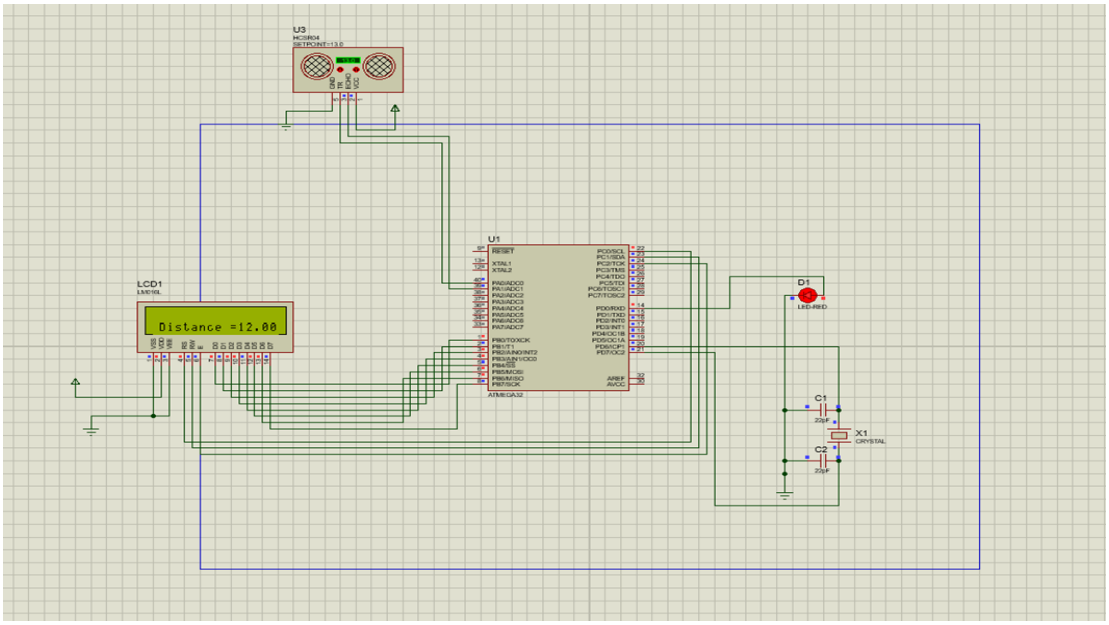


Figure 3. 13:Testing the ultrasonic sensor 1 (individual)

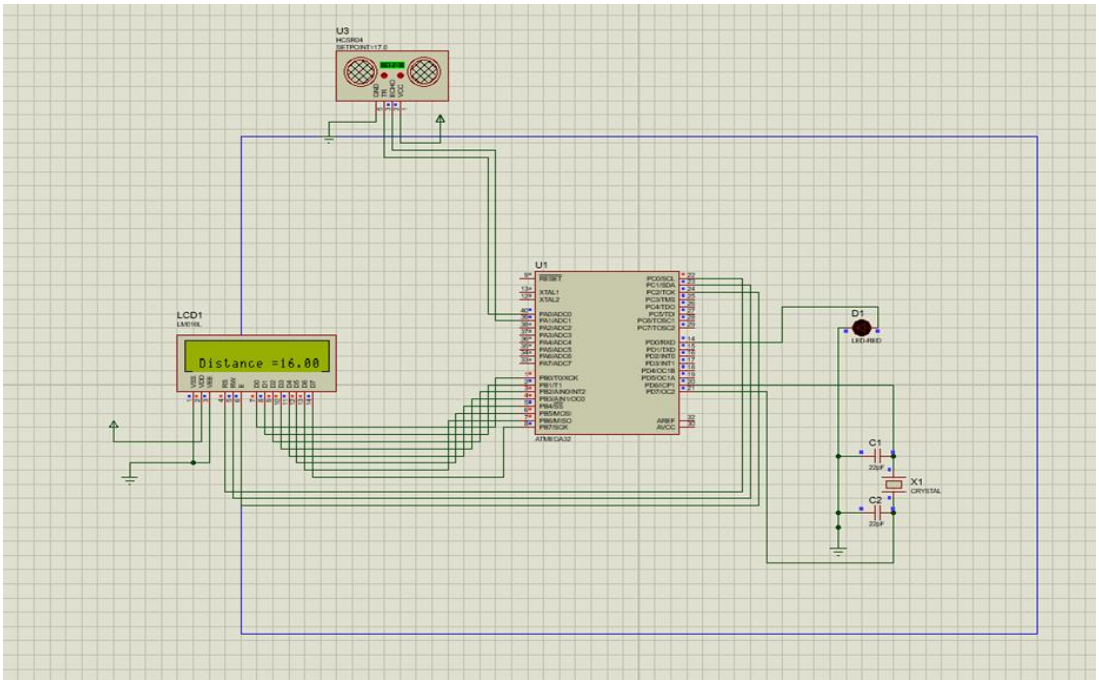


Figure 3. 14:Testing the ultrasonic sensor 2 (individual)

After we have assembled all of the components, we test each one to ensure that it is operational

5.2.Testing the components in full proteus simulation

When the load cell detects less than 15, press the 'BM' button and test that the DC Motor is working. Also, check whether the Motor speed can control by pressing the ‘BMs’ button.

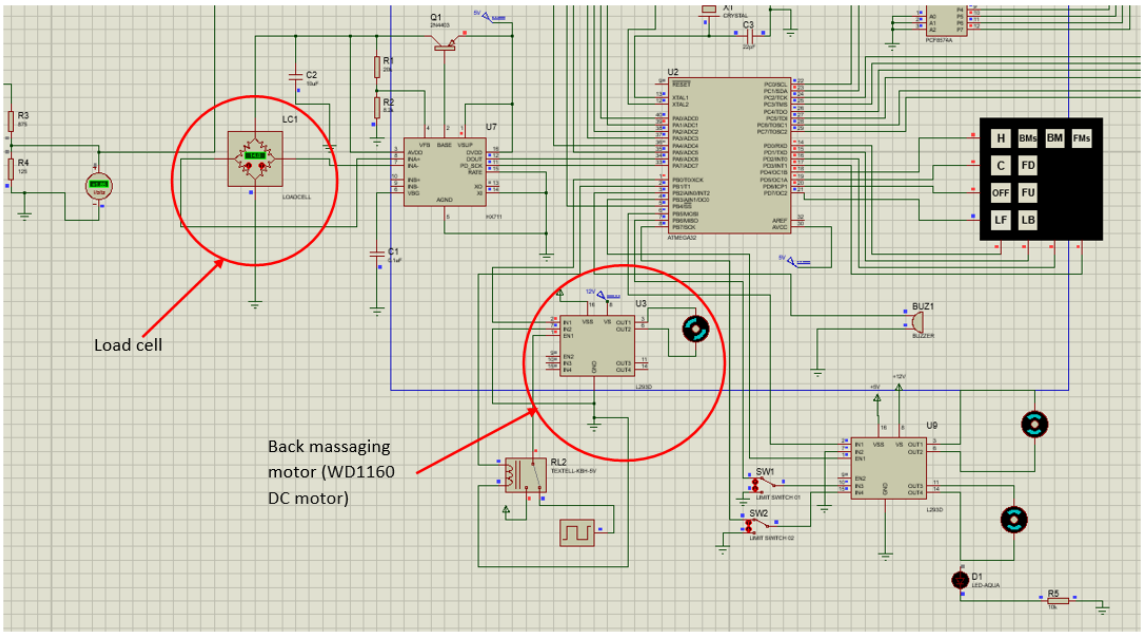


Figure 3. 15:Testing the back massage function 1

Check whether when the load cell detects more than 15, the DC motor will be stop.

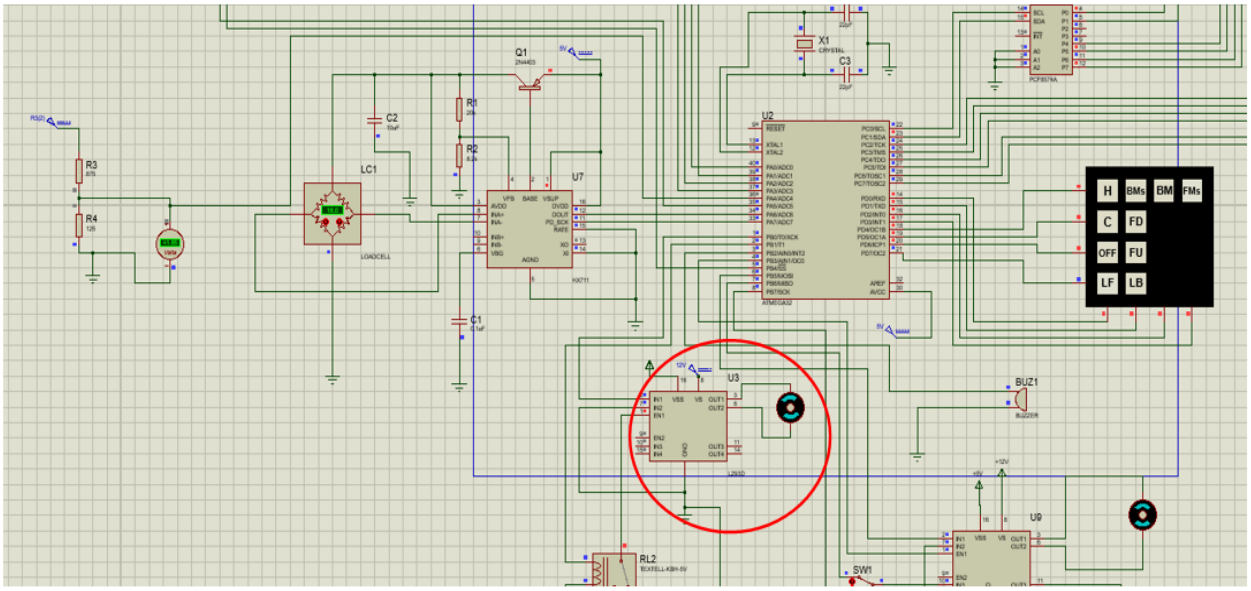


Figure 3. 16:Testing the back massage function 2

Test whether the stepper motor rotates by 45 degrees when we press the “LF” (lumbar support forward) button.
(clockwise)(to move lumbar support forward)

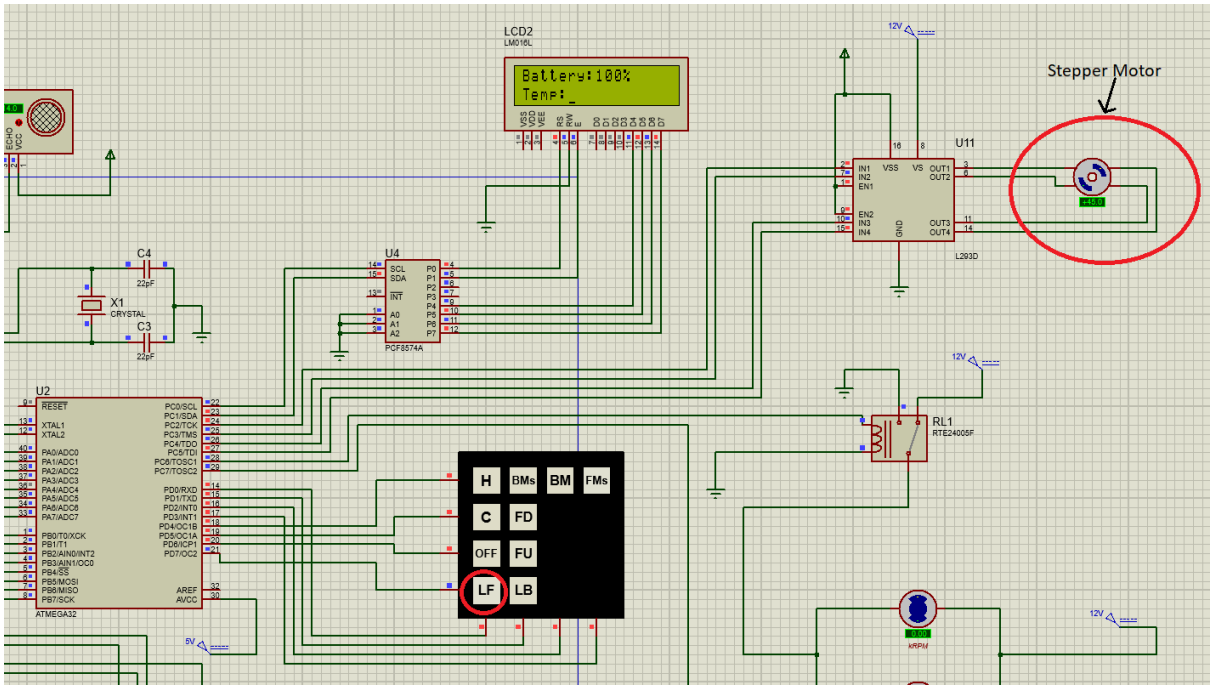


Figure 3. 17: Testing the Lumbar support 1

Suppose that the stepper motor has rotated 270 degrees.

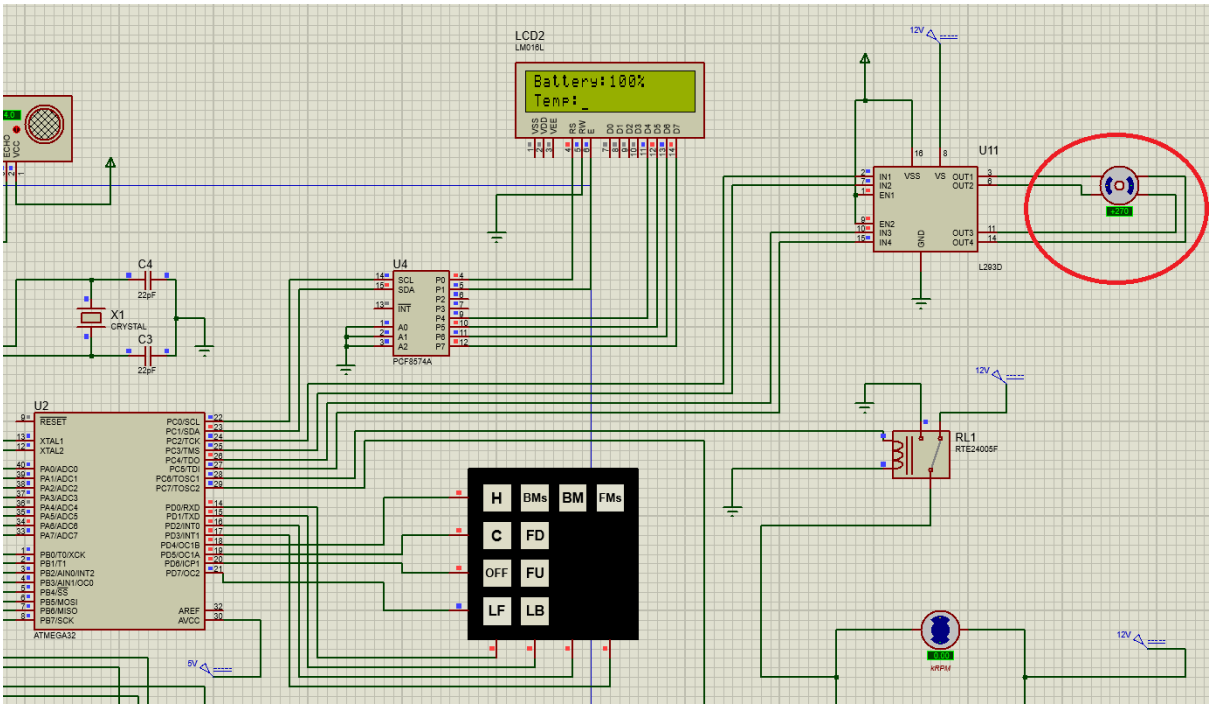


Figure 3. 18:Testing the lumbar support2

Then test whether the stepper motor rotates backward by 45 degrees(eg:from 270 degrees to 225 degrees) when we press the “LB” (lumbar support backward) button. (anticlockwise)(to move lumbar support backward)

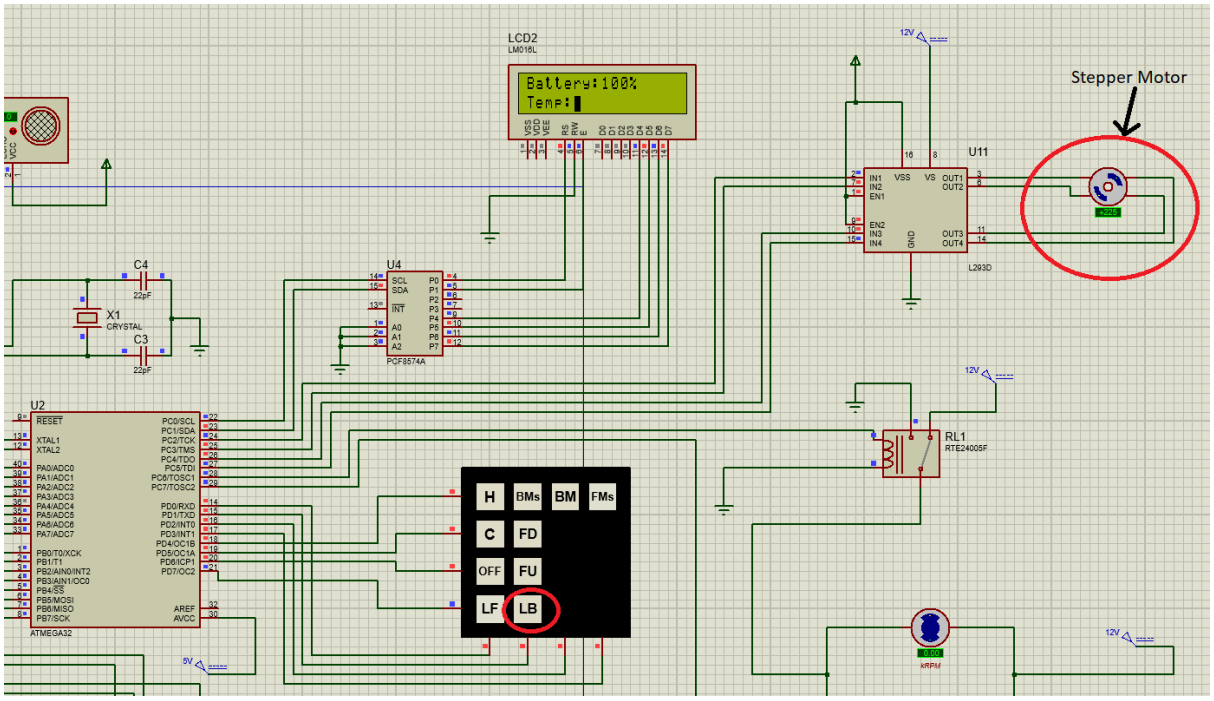


Figure 3. 19:Testing the lumbar support 3

When the temperature exceeds 15 degrees Celsius, we test that pressing the 'H' button activates the heating function. If the temperature detect less than 38 degrees Celsius by pressing the ‘C’ button we can activate the cooling function (current direction through the Peltier Module will be changed)

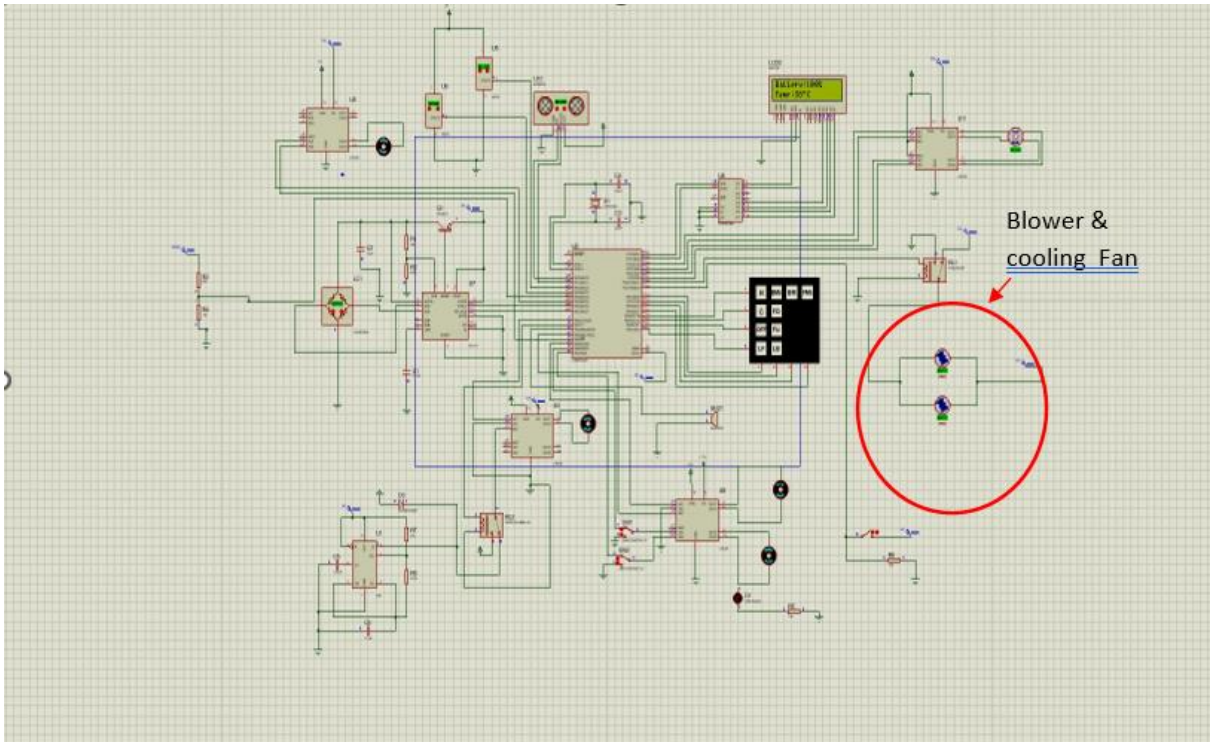


Figure 3. 20: Testing the Cooling and heating function 1

Testing that the Peltier module will stop if any of the sensors detects a temperature greater than 70 degrees Celsius.

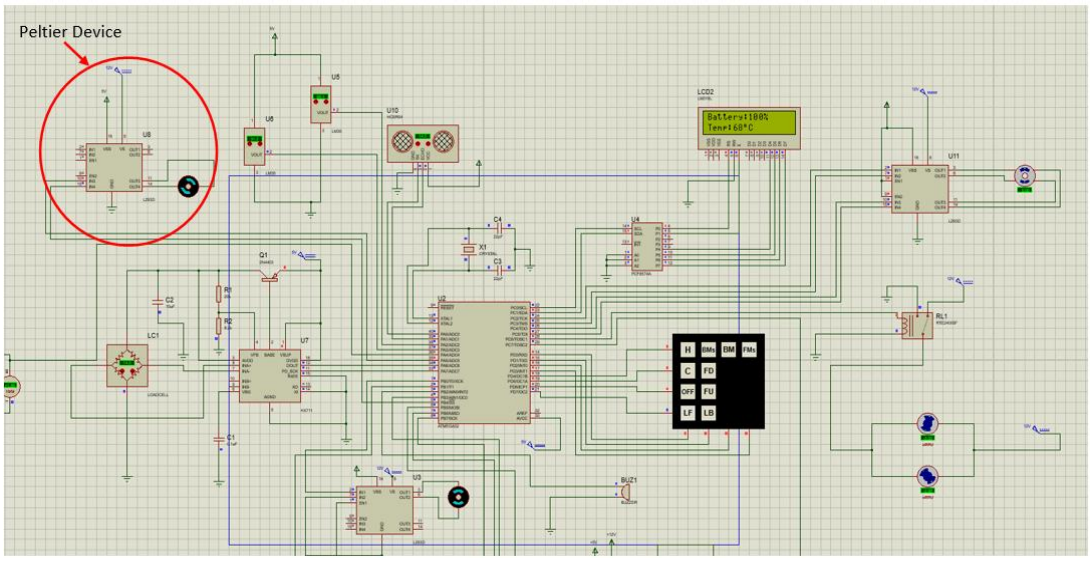


Figure 3. 21:Testing the Pelitier device 1

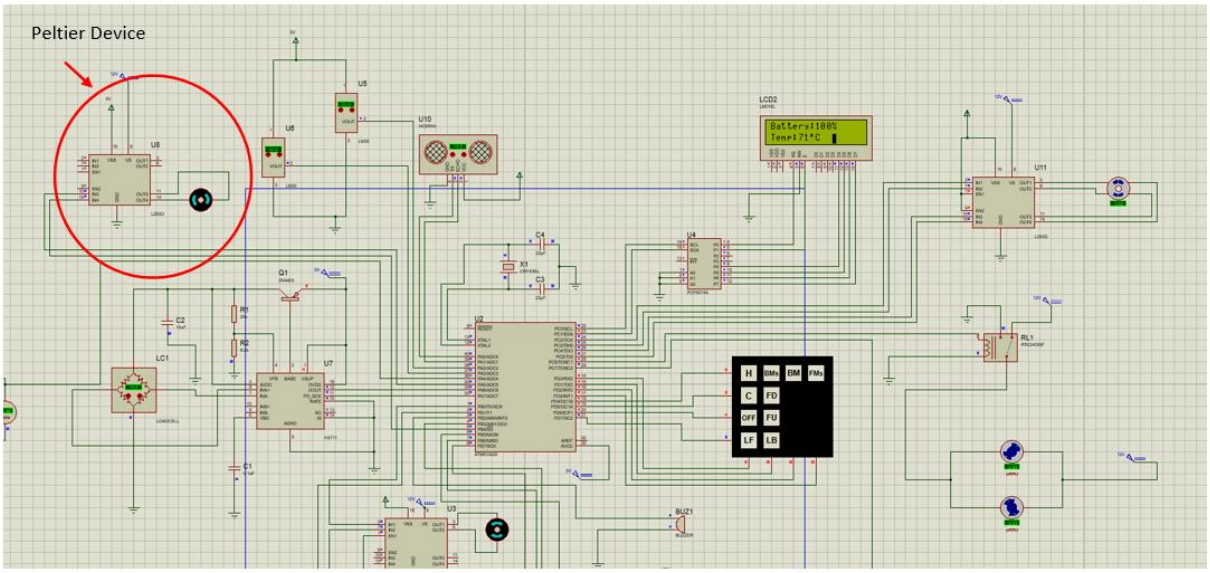


Figure 3. 22: Testing the Peltier device 2

Check that the DC motor used to move the footrest rotates in the correct direction according to the command (up/down).

If the user press the FU(footrest up) the Dc motor rotates clockwise

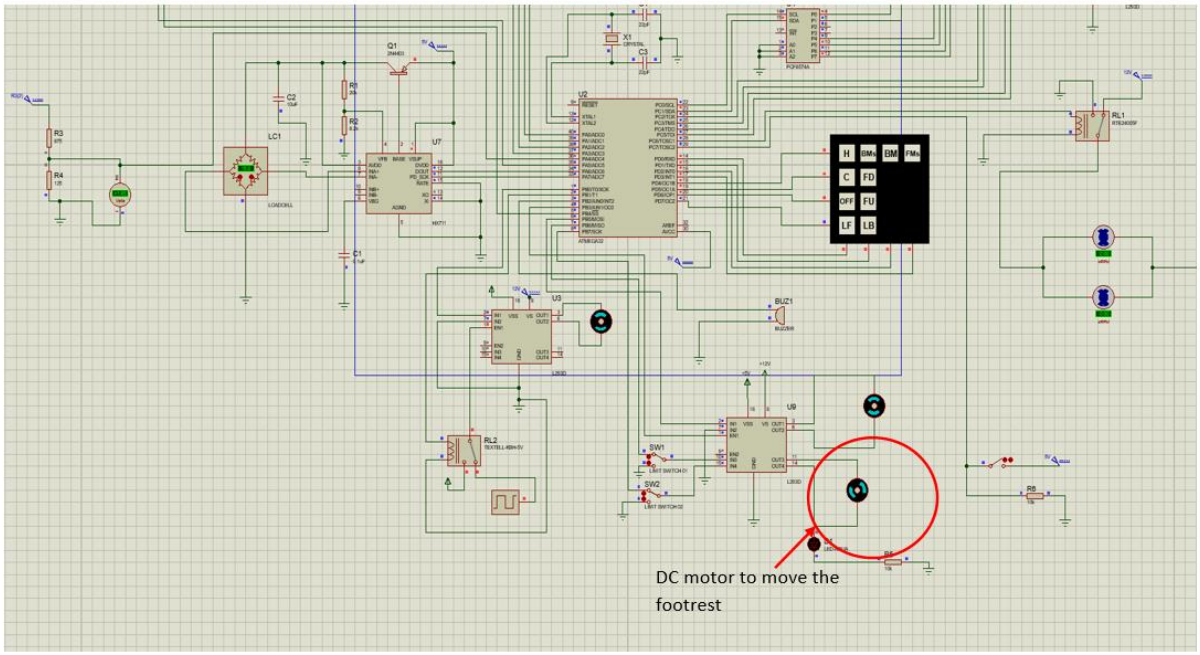


Figure 3. 23: Testing the footrest 1

If the user press the FD(footrest Down) the Dc motor rotate anti-clockwise

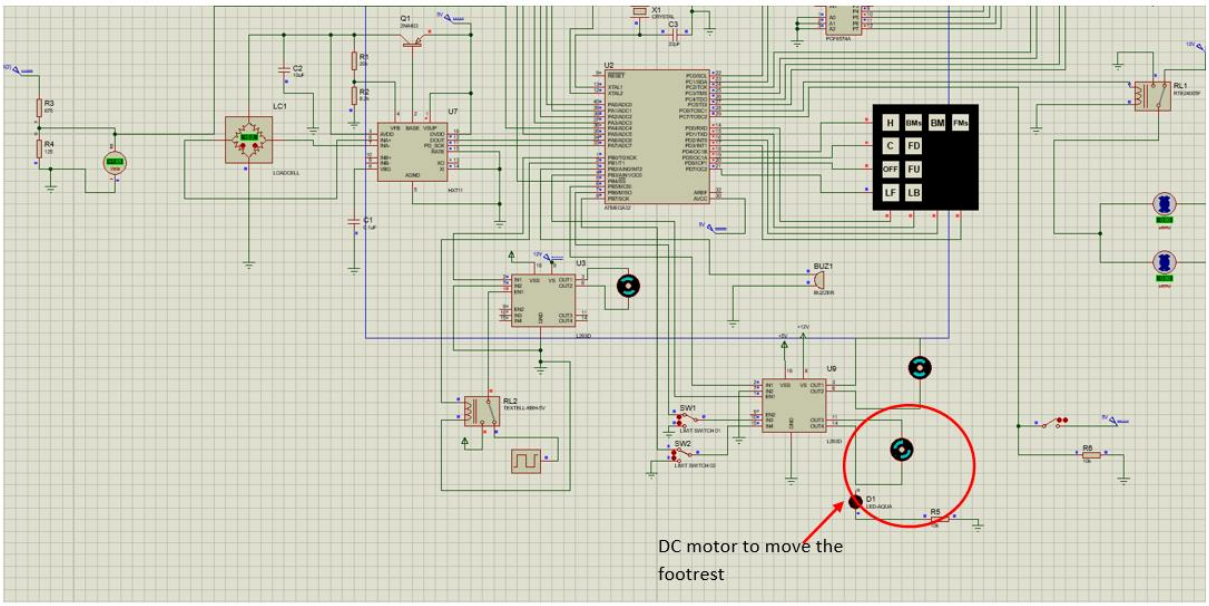


Figure 3. 24: Testing the footrest 2

Power supply

Check the power supply's operation.

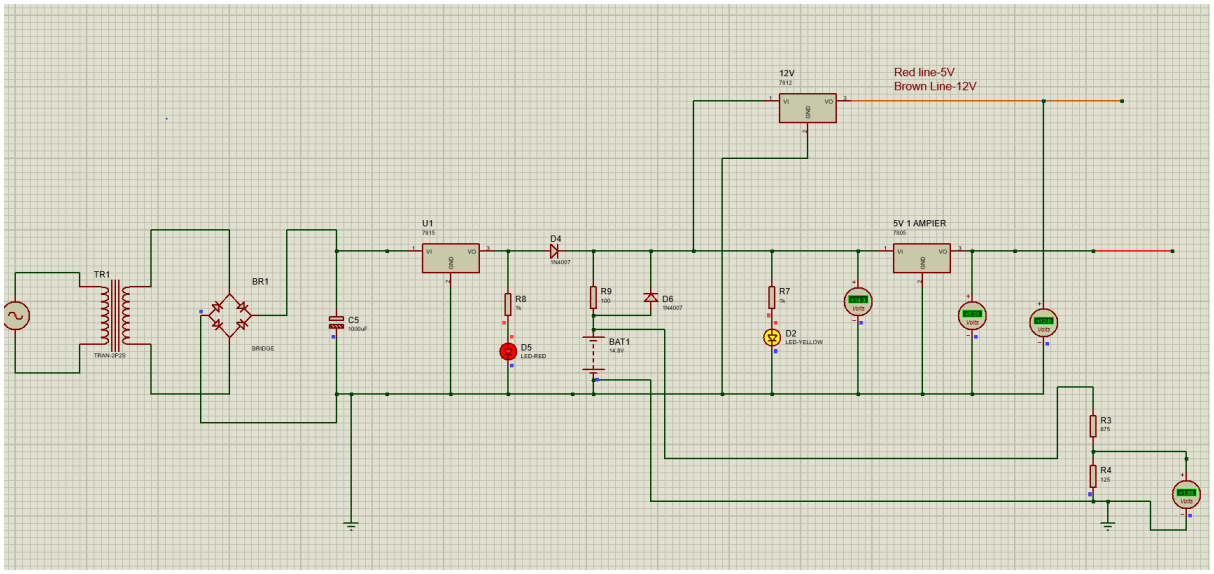


Figure 3. 25:Testing the power supply

Finally, we use KiCad 6.0 to create PCB designs for our components as well as the overall PCB design.

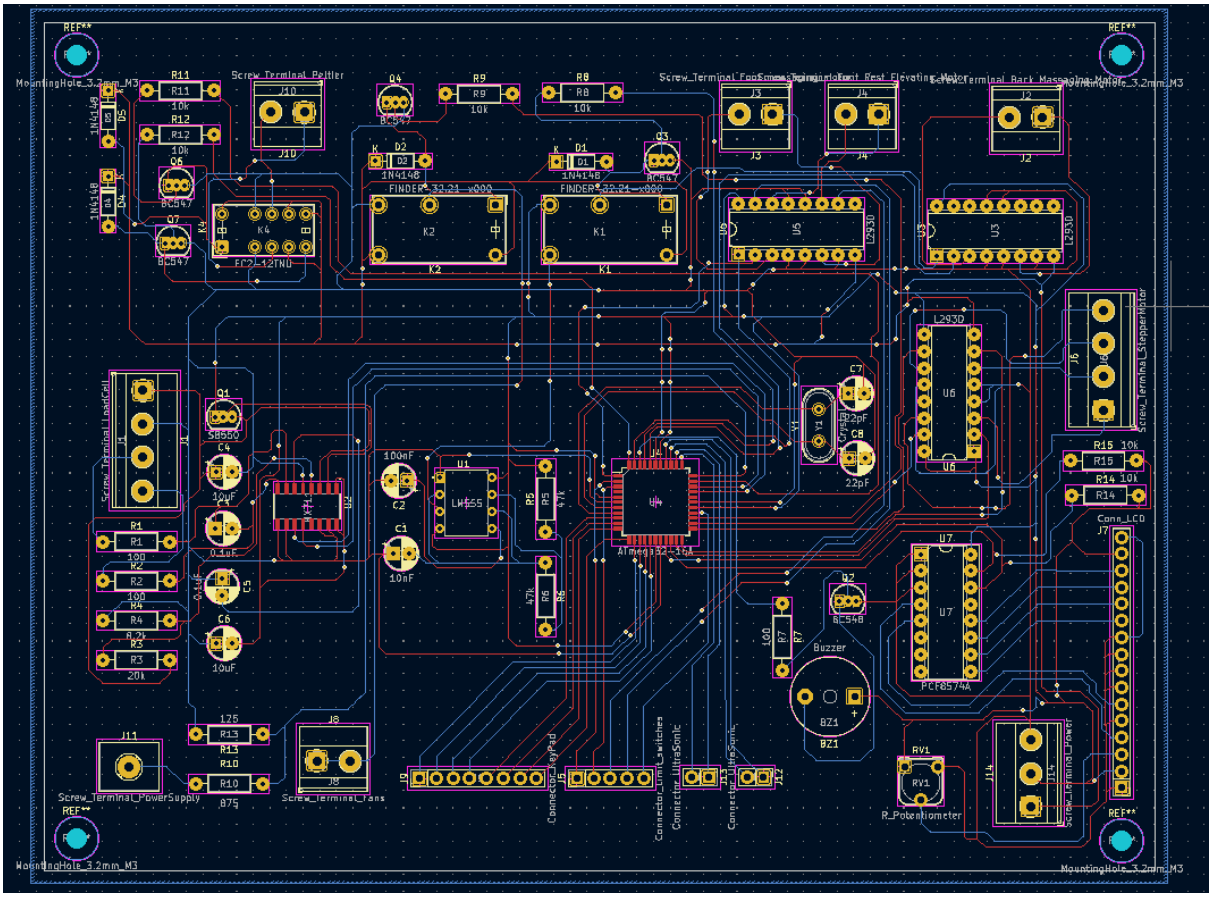


Figure 3. 26: PCB Design

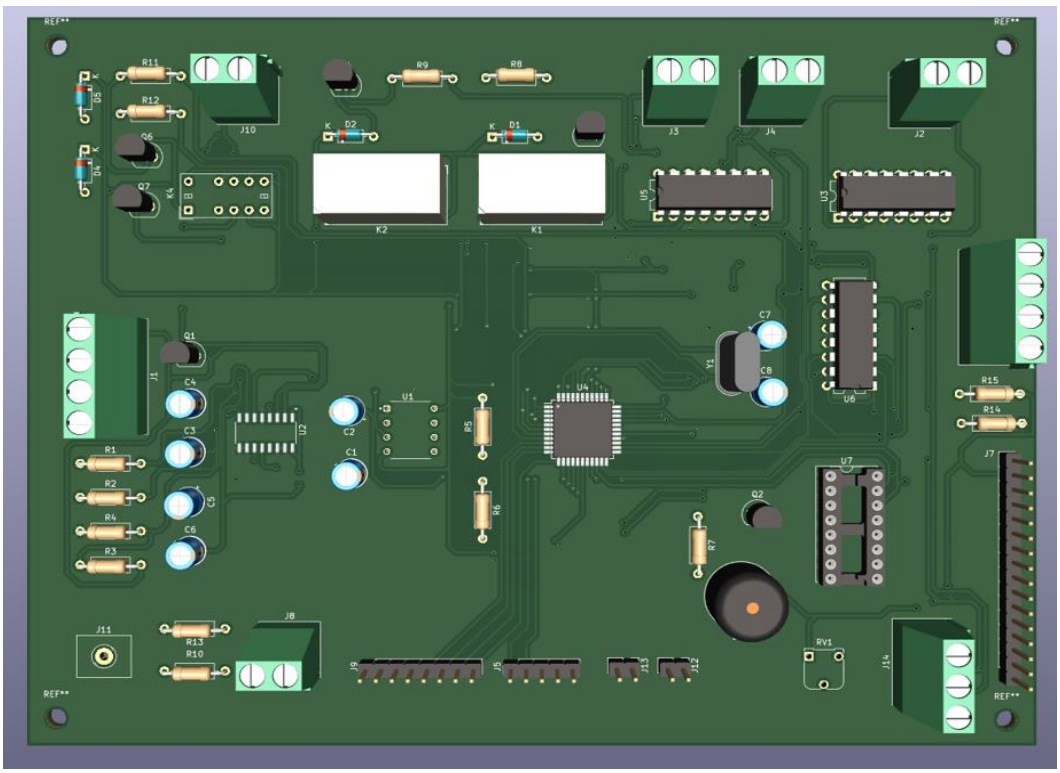


Figure 3. 27 : 3D view of PCB

6. Estimated Cost & Expenditure

Sensor/Component	Quantity	Price(Rs.)
LM35-Temperature Sensor	2	220.00
Load sensor	1	520.00
HC-SR04 Ultrasonic sensor	1	280.00
Keypad	1	250.00
LCD Display	1	550.00
Peltier Device	1	560.00
Gear Motor	3	1500.00
PGS sheets	1	1500.00
Blowing Fan	1	3000.00
Cooling Fan	1	900.00
Dicky Shocks	2	2000.00
Heatsink	2	2400.00
Wooden Massage Rollers	2	800.00
L293D Motor drive	4	1600.00
potentiometer	1	350.00
Stepper motor	1	850.00
Buzzer	1	170.00
Transformer	1	300.00
7815-IC	1	260.00
7812-IC	2	520.00
7805-IC	1	250.00
3.7V 2600mA rechargeable Lithium iron battery	8	5200.00
Pcf8574A	1	300.00
	Total	24280.00

7. Further work

We can expand this system with more features. such as

An automated chair elevating system.

controlling the system via voice command.

function capable of remembering the location of lumbar support and reusing it based on user interest

as future work.

204120D (A.K.I.Madushan)

Responsible Part: GML692 Load cell**,** WD1160 DC motor

Technique and Specification

GML692

Maximum voltage-10V

Measuring Range(Max)-50kg

To identify the load which is generated by the user when he/she leans to the back rest, the GML692 load cell is used in our project. The internal structure of this load cell is created by using resistors. Those resistors are formed according to the Wheatstone Bridge. When objects are placed upon the load cell. The resistance values of the resistors will change according to the magnitude of the weight. *(Figure 4. 1)*

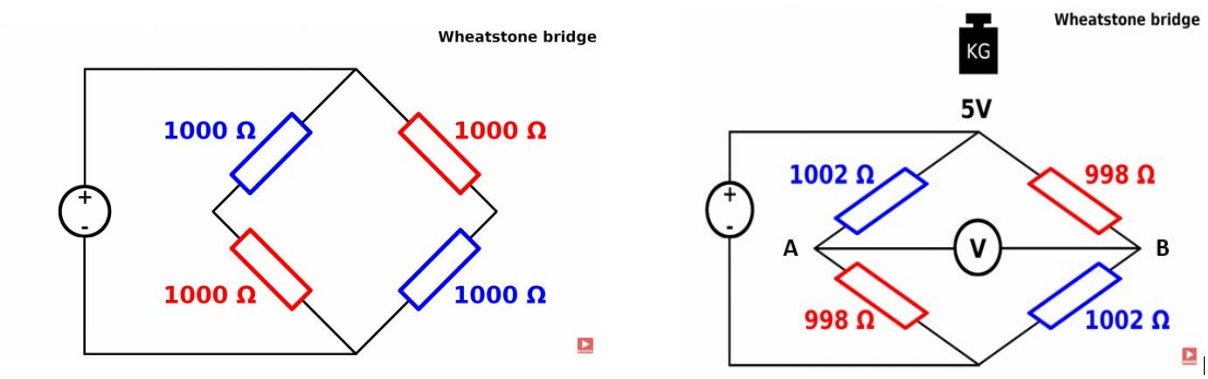


Figure 4. 1

We can identify the magnitude of the weight by measuring the voltage difference between A and B points. But these voltage values are in the millivolts range. So, ACD mechanism of Atmega32 doesn't have the capability to sense those low-level voltage signals.[6]

HX711

Maximum voltage-5.5V

Maximum current-<1.5mA

HX711 amplifier module is used to identify the low level voltage signals which can't be sensed by MCU.This module has three selectable gain amplifiers such as 128,64 and 32.By selecting one gain,we can amplify the low level voltage signals.Inbuilt onchip power supply regulator is used to give the relevant power to the load cell and measured signals can be given to A channel or B channel of the module.*(Figure 4.2)*

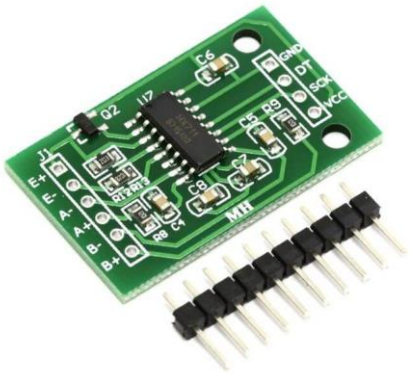


Figure 4. 2

Channel A or B reads sensor output through an input mux and programmable gain amplifier.The digital interface circuit converts the analog input signal into 24-bit output signal.This 24-bit digital value needs to be retrieved from the module through the DT(DOUT) pin.To do that,continuos clock pulses should be given to the PD_SCK pin. *(Figure 4.3)*

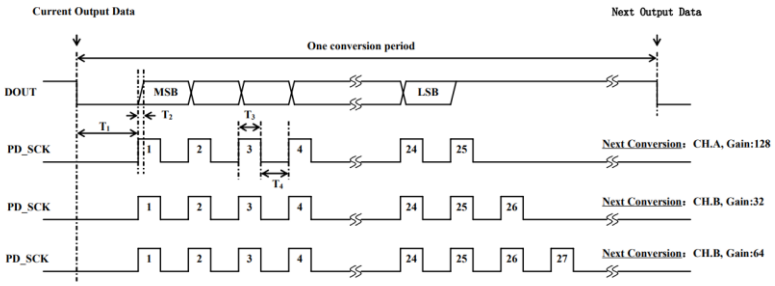


Figure 4. 3

Then we can obtain 24-bit digital value bit by bit by using clock pulses.The retrieved 24 bits of data is in 2's complement format.Before using this value for further calculations,the value should be converted to its standard form.Then we need to find out what is the calibration factor of the load cell.After finding that value, the final value can be calculated by multiplying calibration factor and standard form of retrieved 24-bit data.[1][25]

WD1160 DC motor

Maximum voltage -12V
Maximum current-5.6A
Torque-5.2Nm

WD1160 DC motor is used to rotate the massaging plate of the chair.This DC motor is a wiper motor which is used in motor vehicles.This DC motor has low RPM value(24 RPM) andalso the shape of motor is flat.Space is very essential in our project.So that the motor can be planted easily inside the chair without wasting considerable amount of space.[16] *(Figure 4.4)*

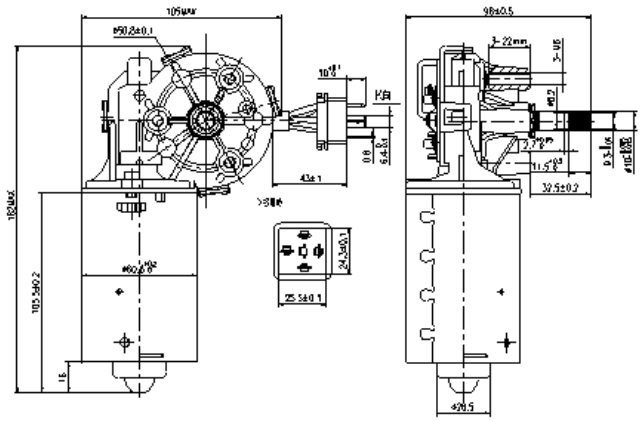


Figure 4. 4

L293D Motor Driver

To drive a WD1160 DC motor 12V voltage is required,but the magnitude of voltage signals which are provided by micro controller is not sufficient to perform this task.

So that L293D motor driver is required to drive our motor.This L293D motor driver is 16 pin IC, with 8 pins of each sides,allowing us to control the motor.Two motors can be connected

with one L293D driver.There are 2 OUTPUT pins, 2 INPUT pins, and 1 ENABLE pin for driving each motor.Voltage signals which provide to input pins will decide the rotating direction of the DC motor.Enable pin is used to enable or disable the DC motor.PWM pulses can be given to enable pin for varying the speed of the DC motor. *(Figure 4.25)*

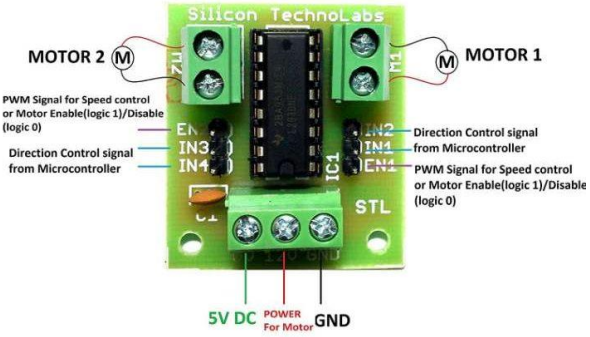


Figure 4. 5

Schematic Diagram

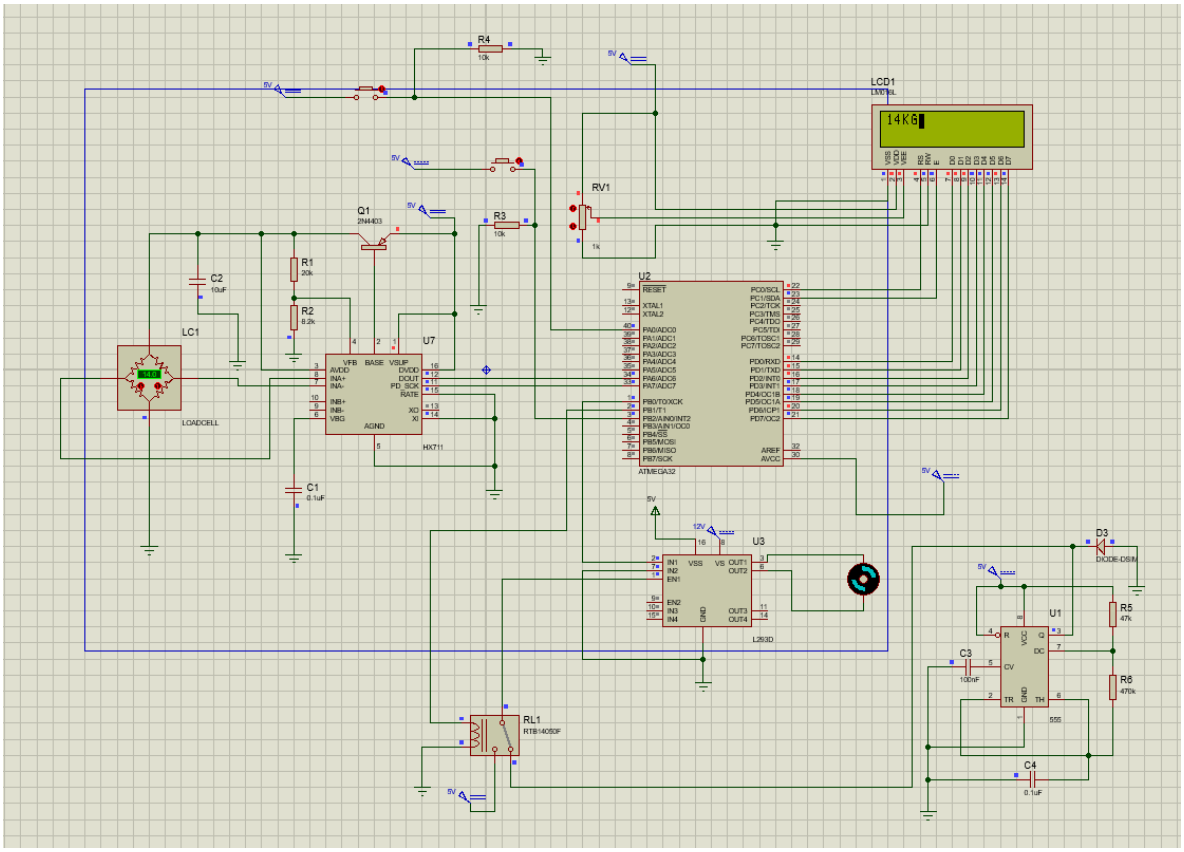


Figure 4. 6

PCB design

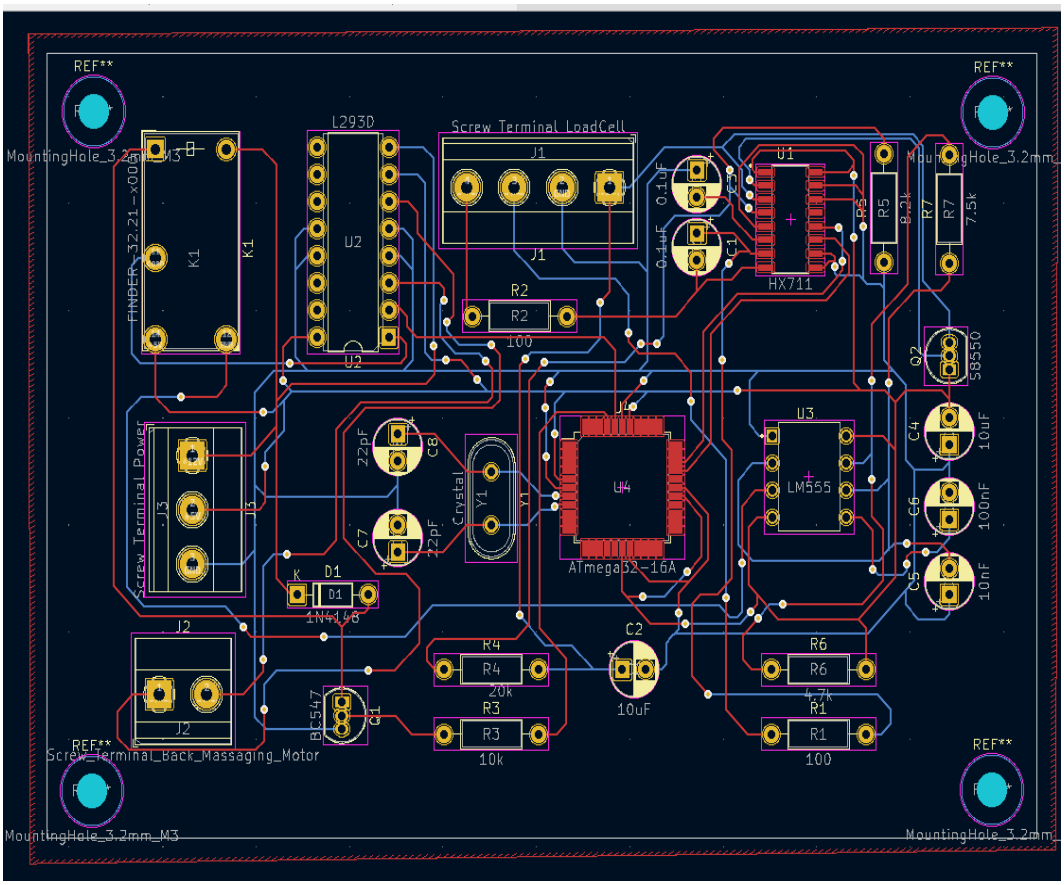


Figure 4. 7

Code

https://dms.uom.lk/s/qr64syrpCKyoyEC

204204N (K.V.Siromin)

Responsible Part: LM35 Temperature sensor , Peltier module and fans

Technique and Specification

LM35 Temperature sensor

Maximum voltage - 30 V
Maximum current - 60 microA

The output voltage of the LM35 sensor is linearly proportional to the centigrade temperature. This provides accuracies of 0.250C at room temperature and 0.750C over a full -550C to 1500C temperature. There will be a 10mV rise for every 10C in temperature. In the project, two sensors are used to measure the surface temperatures of the two sides of the Peltier module. The surface temperature of the Peltier module that is related to the blower fan, will be displayed on an LCD display. Also, that temperature is used to check the condition of whether the temperature has reached appropriate temperatures. Further, both temperature sensors are used to check whether their temperatures of them exceeds 700C or not. This technique is used protect the Peltier module from extreme situations. Otherwise, Peltier module is damaged.[12][15][23]

Peltier module

Maximum voltage - 16.4 V
Maximum current - 6.4A

The Peltier module operates according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. A voltage is applied across joined conductors to create an electric current. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. Heat is deposited at the other junction.

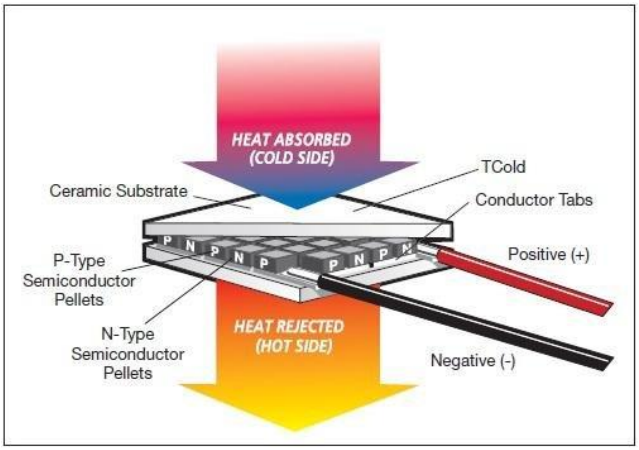


Figure 5. 1

Cooling and heating are the main requirements of the project. Peltier Module is used to fulfill that requirement. When a user wants to cool the system, the user will press the relevant key on the keypad and according to that, the system will give positive and zero voltages for the two ends of the Peltier module and start to cool. Also, when the user wants to heat the system, the user will press a relevant key and then the system will give opposite voltages to the Peltier module. So, the current through the Peltier module.[7]

Blower fan

- Maximum voltage - 13.8V
- Maximum current - 230 mA

Blower is also used to circular the air. But blower fan has specialties than other fans. Bellow table shows the difference between the normal fan and a blower.

	Fan	Blower
Definition	A fan circulates air around an entire room, or space.	A blower circulates the air only on the specific or pointed area.
Pressure	It uses less pressure to produce large amounts of gas.	It uses high pressure to produce large amounts of gas.
Pressure	The ratio of pressure is below 1.1	The ratio of pressure is from 1.1 to

ratio		1.2
Air area	It provides air in the complete area.	It provides air in a specific location or point.

In the cooling unit, it is needed to provide air to the horse pipe with high pressure. So, the blower fan is the best option to fulfill that requirement. Also, that is used to reduce the temperature of the heat sink located on the blower fan side when heating.

Cooling fan

- Maximum voltage - 13.8 V
- Maximum current - 64mA

This is a normal type of fan. This consumes less power than blower fan. This helps to take away heat from the cooling unit to the outer.[28]

Schematic Diagram

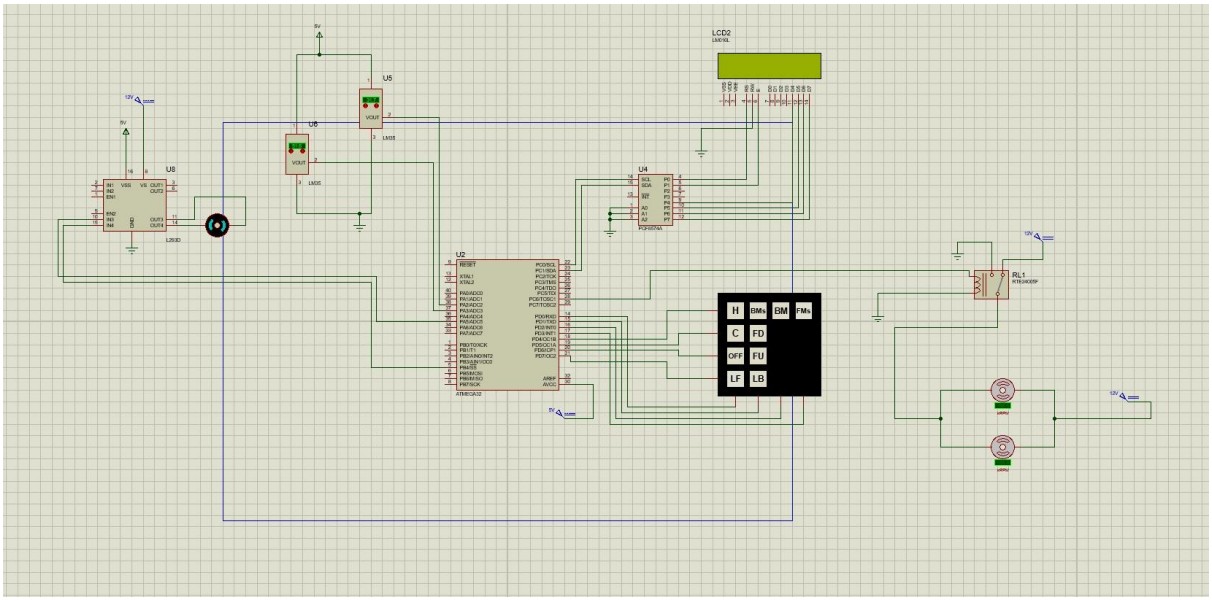


Figure 5. 2

PCB design

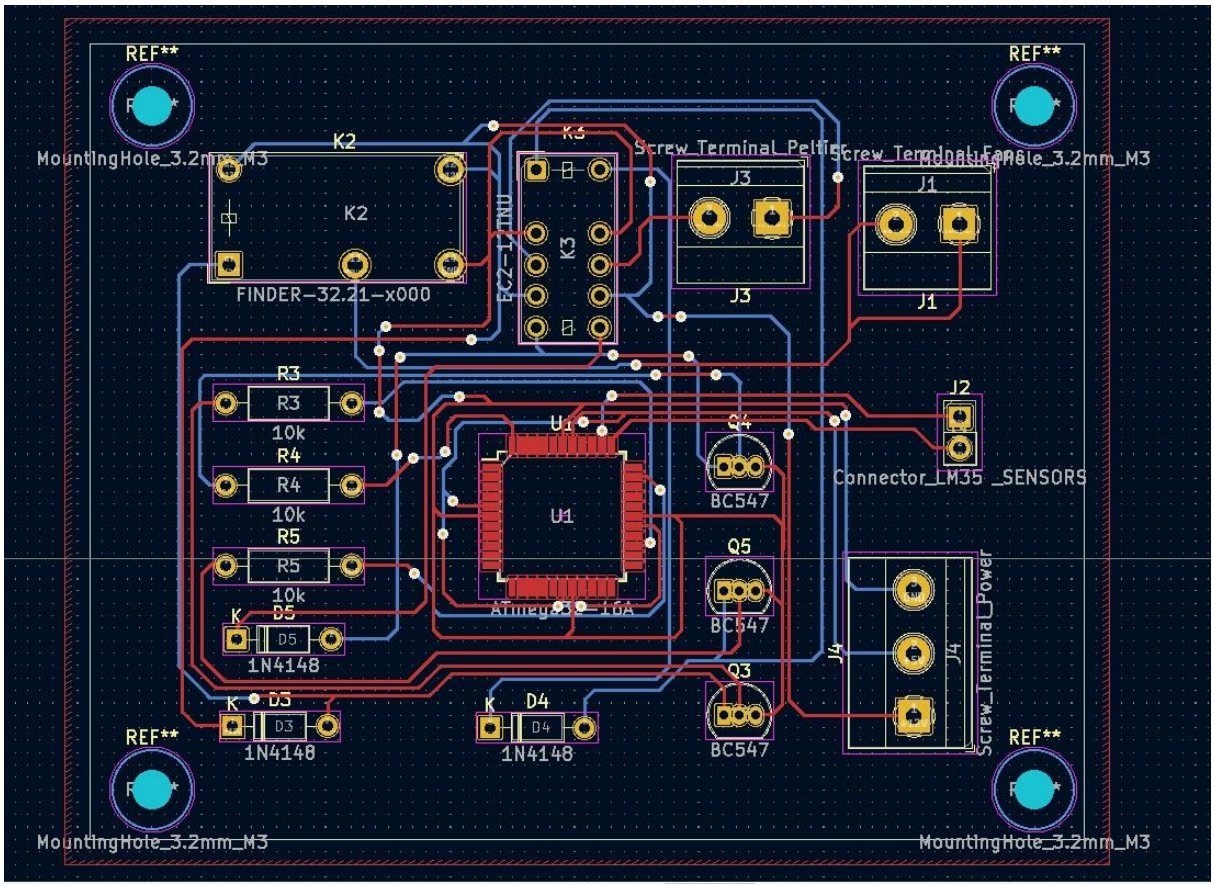


Figure 5. 3

Code

https://dms.uom.lk/s/sSmcY42zJ5nydsn [5]

204167C (K.A.P.S. Priyadarshana)

Responsible Part : DC motors, power supply, battery pack

Technique and Specification

DC Gear motor

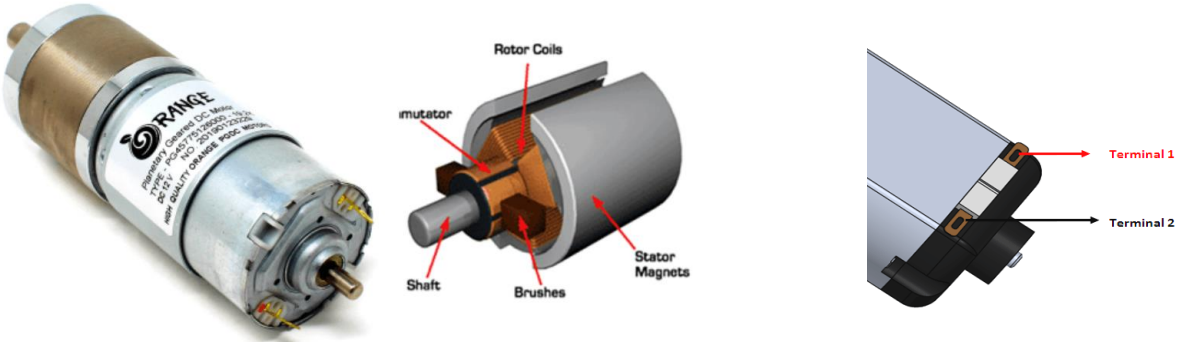


Figure 6. 1

Maximum current:1.1A

Rated Torque: 42 kg.cm

A DC motor is a type of electric motor that converts electrical energy into mechanical energy. The DC motor's primary working concept is that whenever a current carrying conductor enters the magnetic field, it is subjected to a mechanical force. *(Figure 6.1)*

The magnitude of Fleming's left-hand rule determines the force's direction.

If we stretch the first finger, second finger and thumb of our left hand to be perpendicular to each other, and first finger represents the direction of the magnetic field, the second finger represents the direction of the current, then the thumb represents the direction of the force experienced by the current carrying conductor. *(Figure 6.2)*

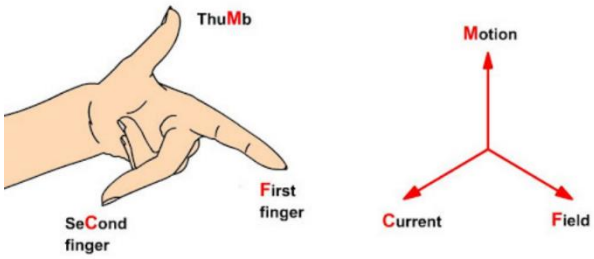


Figure 6. 2

Bottom Gear Assembly

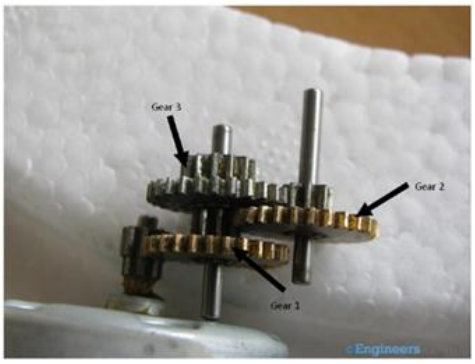


Figure 6. 3

The addition of a gear head to a motor reduces the speed while increasing the torque output.The working of the gears can be explained by the principle of conservation of angular momentum. The gear having smaller radius will cover more RPM than the one with larger radius. However, the larger gear will give more torque to the smaller gear than vice versa. *(Figure 6.3)*

I use two gear motors in footrest.there are power shutter motor(MR573877) and FIT0492-B gear motor.

Power Shutter motor(Window Regulator Motor- MR573877)

Maximum voltage:12V
Maximum current:15A
Rated Torque:13Nm

This is a one of the two gear motors I use And also I use that power shutter motor to move the foot rest up and down. There are two type of power shutter motor as cable type and geared drive type. I use cable type power shutter motor because cable as needed.

In this motor can change the rotation of the motor by changing the direction of the power supply. *(Figure 6.4)*

Figure 6. 4

DC gear motor(FIT0492-B)

Maximum voltage:12V
Maximum current:1.1A
Rated Torque: 4.5 kg.cm

Other gear DC motor I use the massaging function of foot rest. I use that motor to control the speed of the massaging function.[27] *(Figure 6.5)*

Figure 6. 5

L293D Motor Driver

A 12V voltage is necessary to operate an MR573877 motor and a FIT0492-B motor, but the quantity of voltage signals delivered by the micro controller is insufficient to do this task.

Because I'm doing this with an L293D motor driver. This L293D motor driver is a 16-pin IC with eight pins on each side for controlling the motor. A single L293D driver may drive two motors. Each motor is driven by two OUTPUT pins, two INPUT pins, and one ENABLE pin. The rotational direction of the DC motor is determined by the voltage signals sent to input pins. The enable pin is used to turn on or off the DC motor. PWM pulses can be sent to the enable pin to control the DC motor's speed. *(Figure 6.6)*

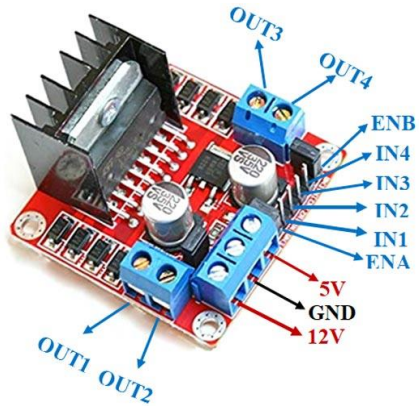


Figure 6. 6

Dicky shock absorbers

Gas spring size:6mm rod dia-15mm tube dia

Range of Stroke (Rod Lengths):60-200mm

Range of Tube Lengths: 90-235mm

Force Range:50-400N

Figure 6. 7

Dickey shock is the gas spring.Gas spring can be defined as hydro pneumatic (pressurized air and water)energy storage elements.Nitrogen gas and oil are utilized for providing compressible and damping (motion control) medium. *(Figure 6.7)*

Gas spring consist of precision rod attached to a piston moving with a sealed cylinder containing pressurized nitrogen gas and oil.The force is equal to pressure differential between internal and external pressure. *(Figure 6.8)*

I use dickey shocks as supports to move the footrest up and down.

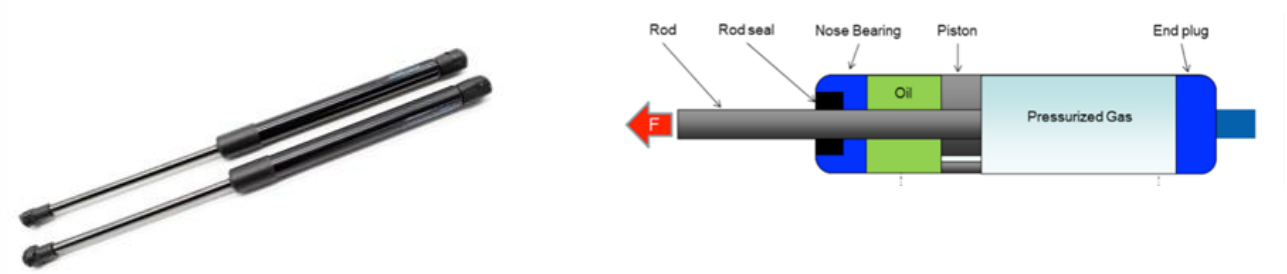


Figure 6. 8

Micro Switch(DB1C-A1RC)

Maximum voltage -12V

Maximum current- 6A

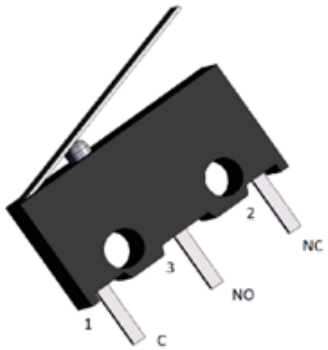


Figure 6. 9

Micro switch have used to disconnect the power in power shutter motor when footrest move to highest and lowest position in footrest.

Micro switch has used to automatically detect or sense the presence indicate whether the movement limits of the object have been exceeded. Micro switch has 3 pin as shows in the figure. Such as common , normally open and normally closed. *(Figure 6.9)*

In micro switches,When the actuator is depressed, there is a point at which the switch activates, connecting the Common contact to the normally open (NO) contact. As pressure on the actuator decreases, the point at which the switch reverts to its non-activated state, with the Common contact falling back onto the normally closed (NC) contact, is not the same as the activation point, it’s later. The distance between the actuating point and the release point is called differential movement.[26] *(Figure 6.10)*

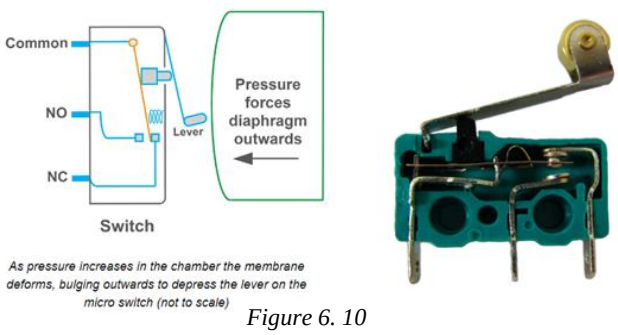


Figure 6. 10

Power supply

The power supply is used to supply electric power to all modules and the microcontroller.Required voltages are +15V ,+12V and +5V. Therefore the power supply of our project is used to produce +15V ,+12V and +5V.

The components that we use require stepped down voltage from standard AC outlets. For this we use a step down transformer to convert 230V to 18V.

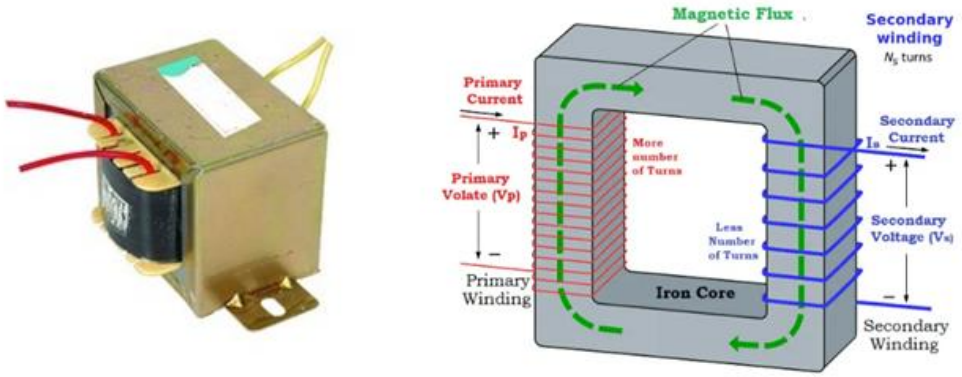


Figure 6. 11

AC power enter the transformer through the primary winding. From the secondary winding the electricity outgoes. These two windings don't have physical connection between them. That isolation ensures that the safety of the transformer. Electromagnetic energy is induced on the secondary winding from the primary winding according to faraday's law. *(Figure 6.11)*

$$\frac{E_1}{N_1} = \frac{E_2}{N_2}$$

N_1 - number of turns in primary.

N_2 - number of turns in secondary.

E1 - supply voltage on the primary winding.

E2 - terminal voltage (theoretical or calculated) on the secondary winding

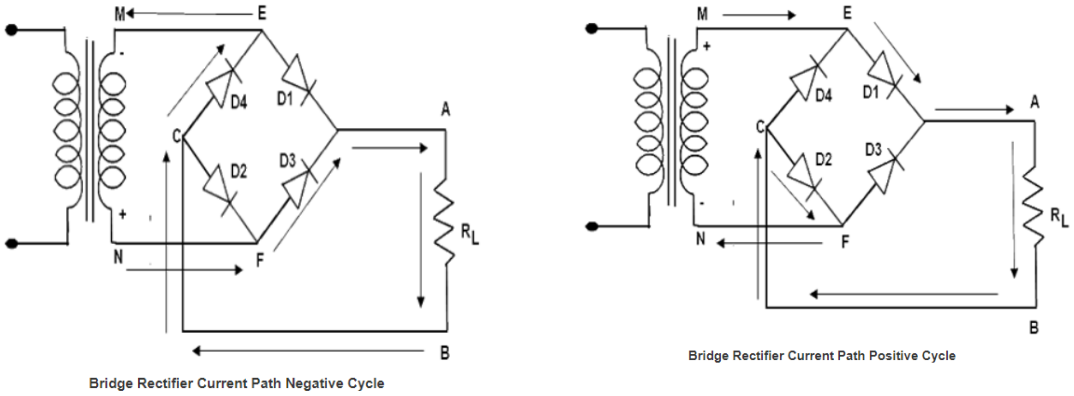


Figure 6. 12

The part which converts the AC current which is sent by the transformer into DC is called a rectifier. Here we are using . It has four diodes(1N4007).

The diodes D1 and D2 become forward biased and conduct during the first positive half cycle of the AC signal. The diodes D3 and D4 will be reverse biased and will not conduct at the same time. The two forward-biased diodes will carry the current through the load resistor. At terminal d, the voltage seen at the output will be positive, whereas at terminal c, it will be negative.

The diodes D3 and D4 will now be forward biased during the negative half cycle of the AC signal, while diodes D1 and D2 will be reverse biased. D3's anode will receive a positive voltage, while D4's cathode will receive a negative voltage. It's worth noting that the current flowing through the load resistor will be in the same direction as the current flowing through the positive half cycle. As a result, the output polarity will always be the same, regardless of the polarity of the input signal. *(Figure 6.12) (Figure 6.13)*

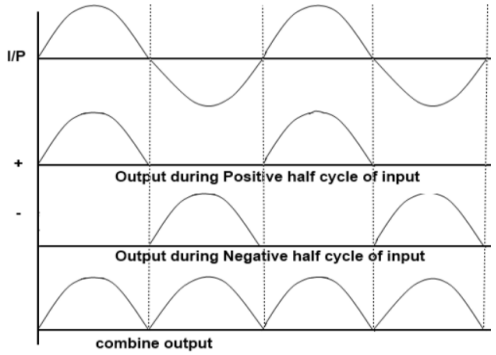


Figure 6. 13

Even after conversion, DC power is still having output ripple. The capacitor directly filters out the ripple of the power that the rectifier freed. The capacitor holds electrons. At peaks, enough amount of electrons is moved. When the current wave drops respectively, the need for electrons increases. At that time the capacitor feeds electrons into the current. So, the current becomes smoother. *(Figure 6.14)*

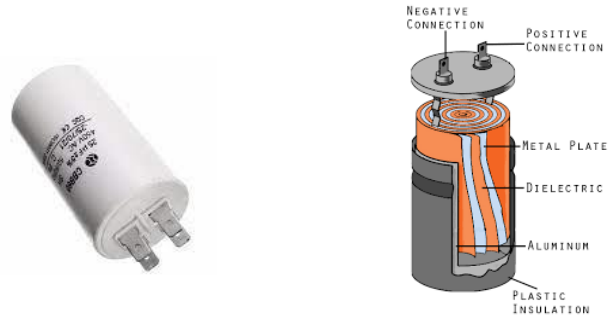


Figure 6. 14

Even if it becomes smooth, the current still has some ripple. DC power passes through a regulator to clean it by reducing the ripple voltage.

Here I use 3 voltage regulators. One LM7815 regulator to get 15v, one LM7812 regulator to get 12v and LM7805 regulator to get 5v.

I use 7815 ic to charge the battery pack in foot massager. *(Figure 6.15)*

Figure 6. 15

7815 Regulator Features

15V Positive Voltage Regulator

Minimum Input Voltage is 17V

Maximum Input Voltage is 35V

Output Current: 1 A

I use 7812 ic to get 12V to give 12V input voltage components. *(Figure 6.16)*

7812 Regulator Features

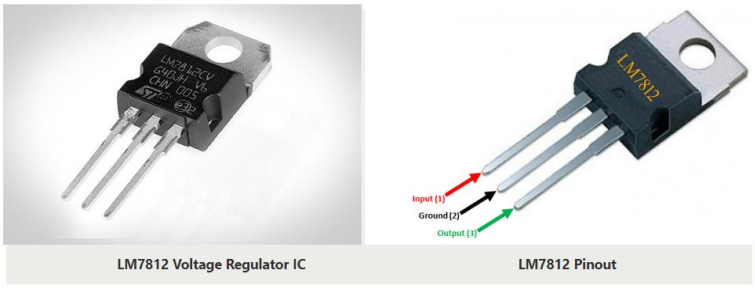


Figure 6. 16

This section mentions some of the important features and specifications of the 7812 [8]IC:

Input Voltage: 14.5V to 27V DC

Output Voltage: 11.75V - 12.25V DC

Output Current (Typical): 1A

I use 7805 ic to get 5V to give 5V input voltage components. *(Figure 6.17)*

7805 Regulator Features

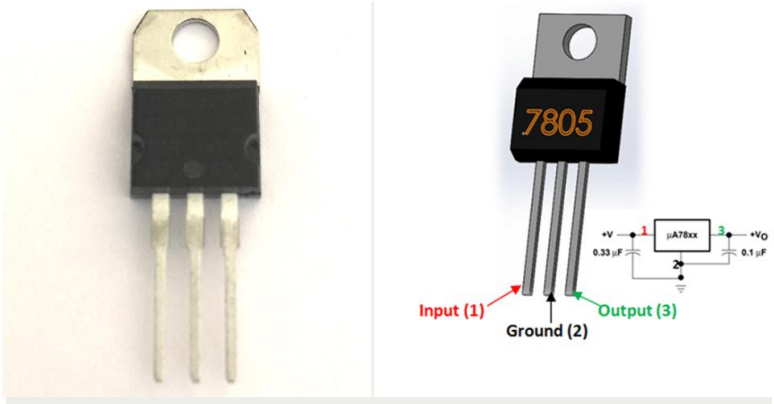


Figure 6. 17

5V Positive Voltage Regulator

Minimum Input Voltage is 7V

Maximum Input Voltage is 25V

Output Current (Typical): 1A

Battery pack

Lithium-ion Battery(LIR18650 2600mAh)

Nominal Voltage	:3.7V
Discharge Cut-off Voltage	:3.0V
Nominal Capacity	:2600mAh
Standard Charge Current	:0.52A
Standard Discharge Current	:0.52A

This rechargeable lithium-ion battery.I use this battery to create a battery pack in our project.

the battery pack is made up of two pairs of four series lithium-ion batteries(LIR18650 2600mAh) running parallel to each other to get 14.8V for input of 7812 regulator ic.

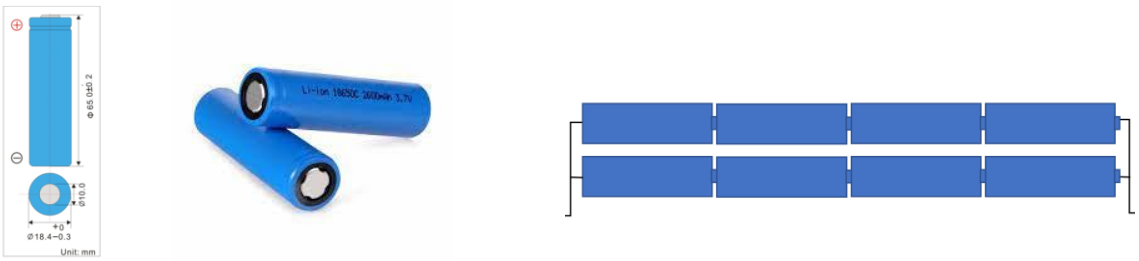


Figure 6. 18

Schematic Diagram

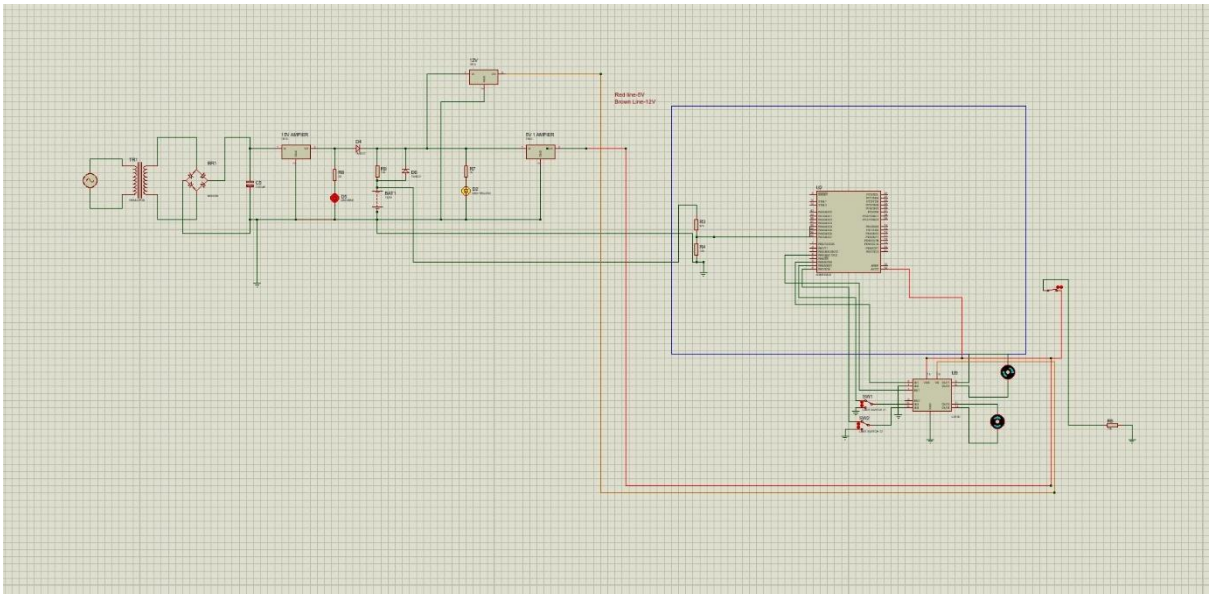


Figure 6. 19

PCB design

DC motors(Foot massager)

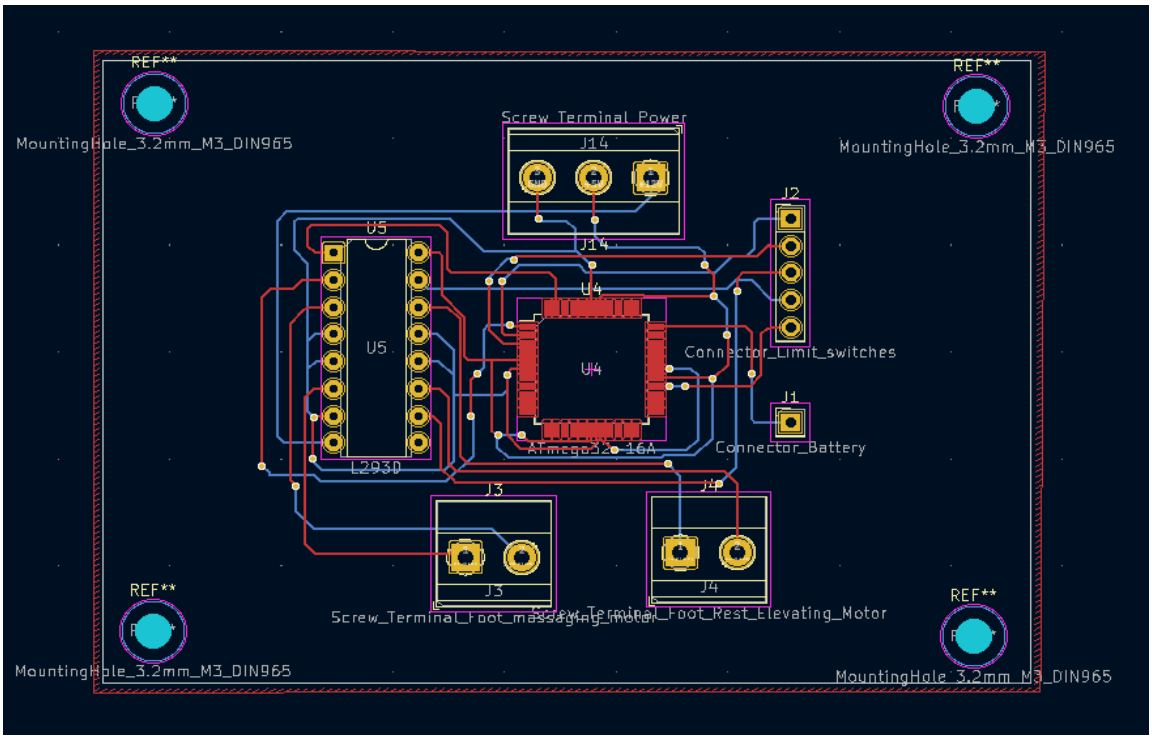


Figure 6. 20

Power supply and battery pack

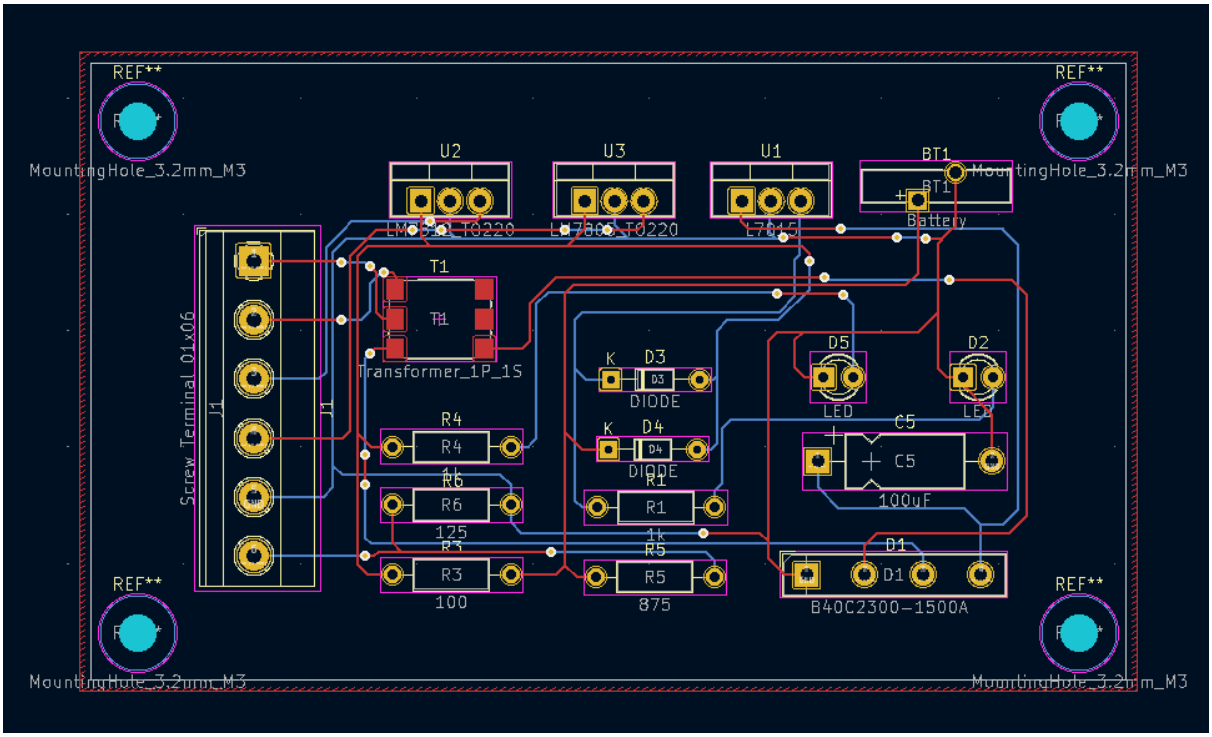


Figure 6. 21

Code

https://dms.uom.lk/s/zCwpXdkE2PNJGQK

204190N(B.L.P.Sankalpana)

Responsible Part: Ultrasonic sensor(HC-SR04), 4x4 Keypad

Technique and Specification

4X4 Keypad

Maximum Voltage across each segment - 24V
Maximum Current through each segment - 30mA
Maximum operating temperature - 0°C to + 50°C

We collect user inputs using a 4x4 keypad. The structure of the keypad is a matrix. there are 4 columns and 4 rows. Because of the matrix structure, we can reduce the number of pins required. *(Figure 7.1)*

The internal structure is visualized in the figure below. There is no connection between rows and columns if we do not press any keys. However, when we press a key, the specific column and row of that key will be contacted.

First, the keypad determines whether a key is pressed. To accomplish this, first, the microcontroller grounds all rows by providing a value of 0. And start examining the column values

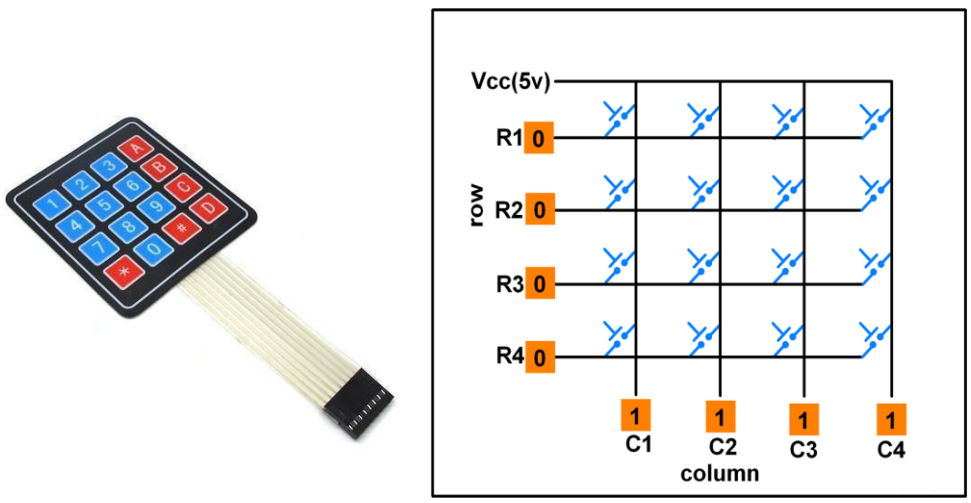


Figure 7. 1

No key has been pressed if all columns read '1'. If any of the four columns show a '0,' it means a key has been pressed.

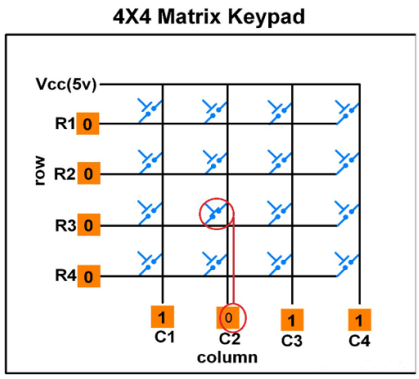


Figure 7. 2

The next step is to identify the pressed key. First, the microcontroller grounds the first row, then checks each column. If all of the columns are '1', the pressed key is not from the first row. Following that, ground the second row and read all of the columns. This procedure will be repeated until a column value is recognized as '0.' *(Figure 7.2)*

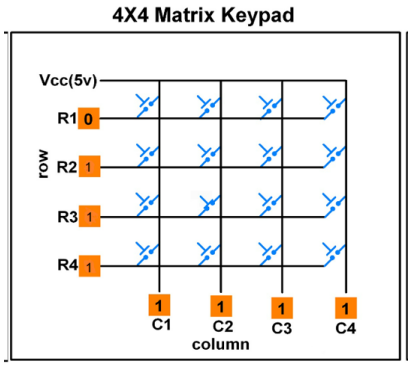


Figure 7. 3

In the example below, when we ground the third row and check the second column, the column value is '0'. That is, the pressed key corresponds to the key represented by the third row, the second column.[10][19] *(Figure 7.3) (Figure 7.4)*

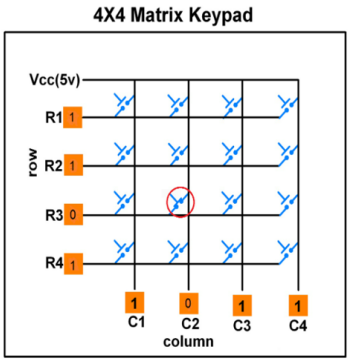


Figure 7. 4

HC-SR04 Ultrasonic sensor

Maximum voltage - 5V

Maximum current - 15 mA

Dimension - 45mm x 20mm x 15mm

Ranging Distance - 2 cm – 400 cm

In our project, we use the ultrasonic sensor to determine whether or not a user is sitting in the chair. If the user is not seated, we can reduce our system's power consumption by turning off some functions.

This sensor is based on sonar principles. There are three major components: transmitter, receiver, and control circuit. Vcc, Gnd, Trigger, and echo are the 4 pins available in this sensor. *(Figure 7.5)*

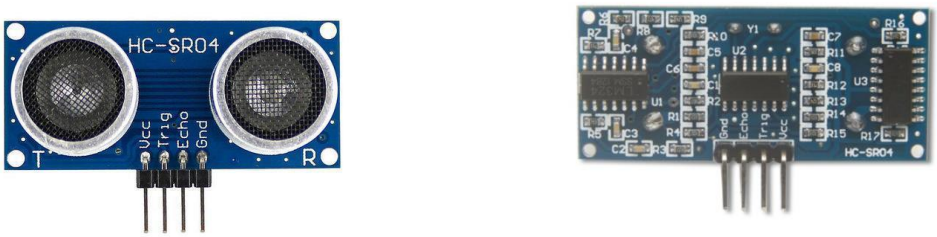


Figure 7. 5

In simple terms, we can say that the transmitter emits a high-frequency sound wave that engages with an object. The sound wave will then be reflected and reach the sensor's receiver. We can calculate the distance by measuring the time it takes the wave to travel from transmitter to receiver. *(Figure 7.6)*

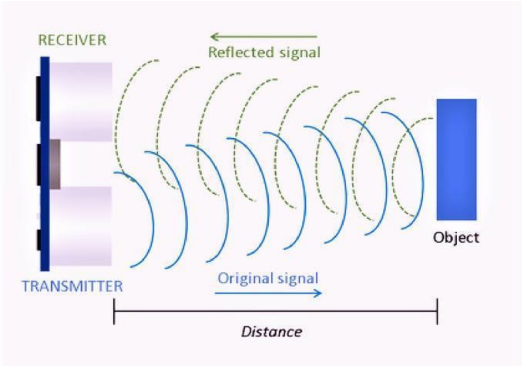


Figure 7. 6

In technical terms, We should first send a trigger pulse of at least 10 us to the Trigger Pin. Then it will produce an ultrasound with a frequency of 40 kHz (8 pulses). Next makes the echo pin high. Starts the timer. Then the echo pin stays high until the echo sound is not returned. Read the Timer count as soon as the falling edge is captured at the Echo pin. This is the time it takes the wave to travel to the object and back. *(Figure 7.7)*

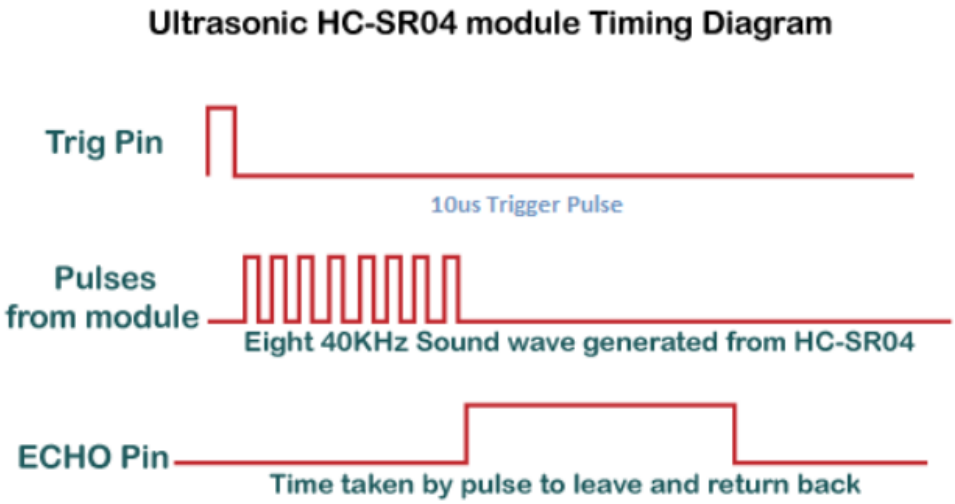


Figure 7. 7

We can calculate the distance using the formula distance= speed * time. speed = 343 m/s, time = the measured time/2(We should always divide the distance by two because the time we measured was spent traveling to and returning from the object.)[13][14][17]

Schematic Diagram

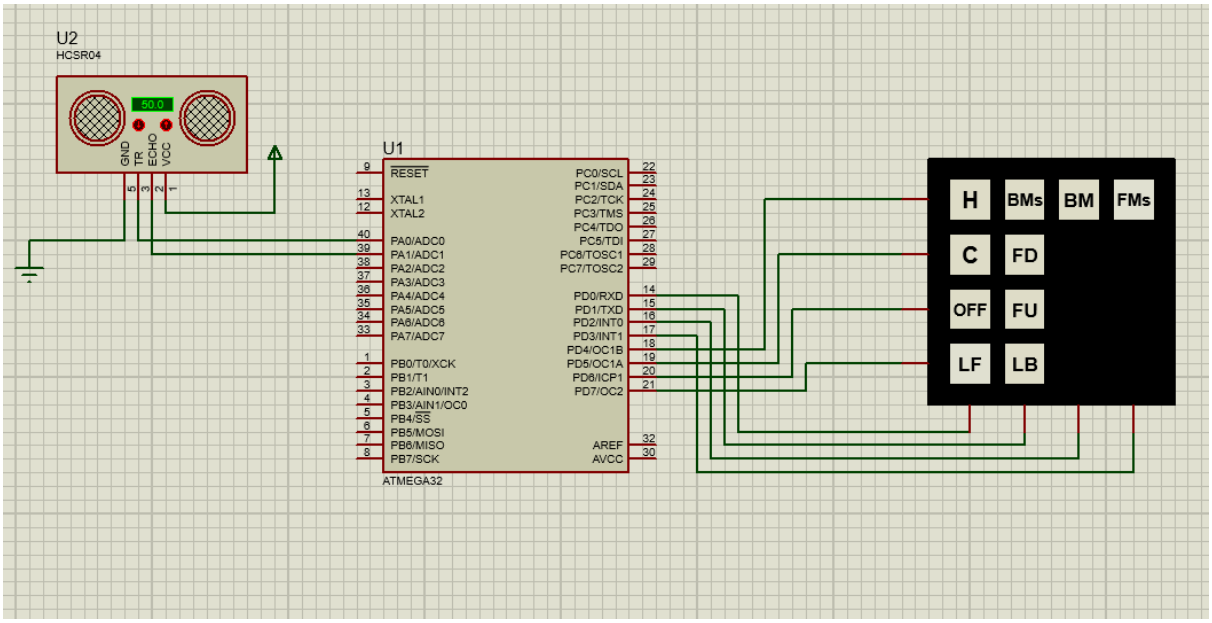


Figure 7. 8

PCB design

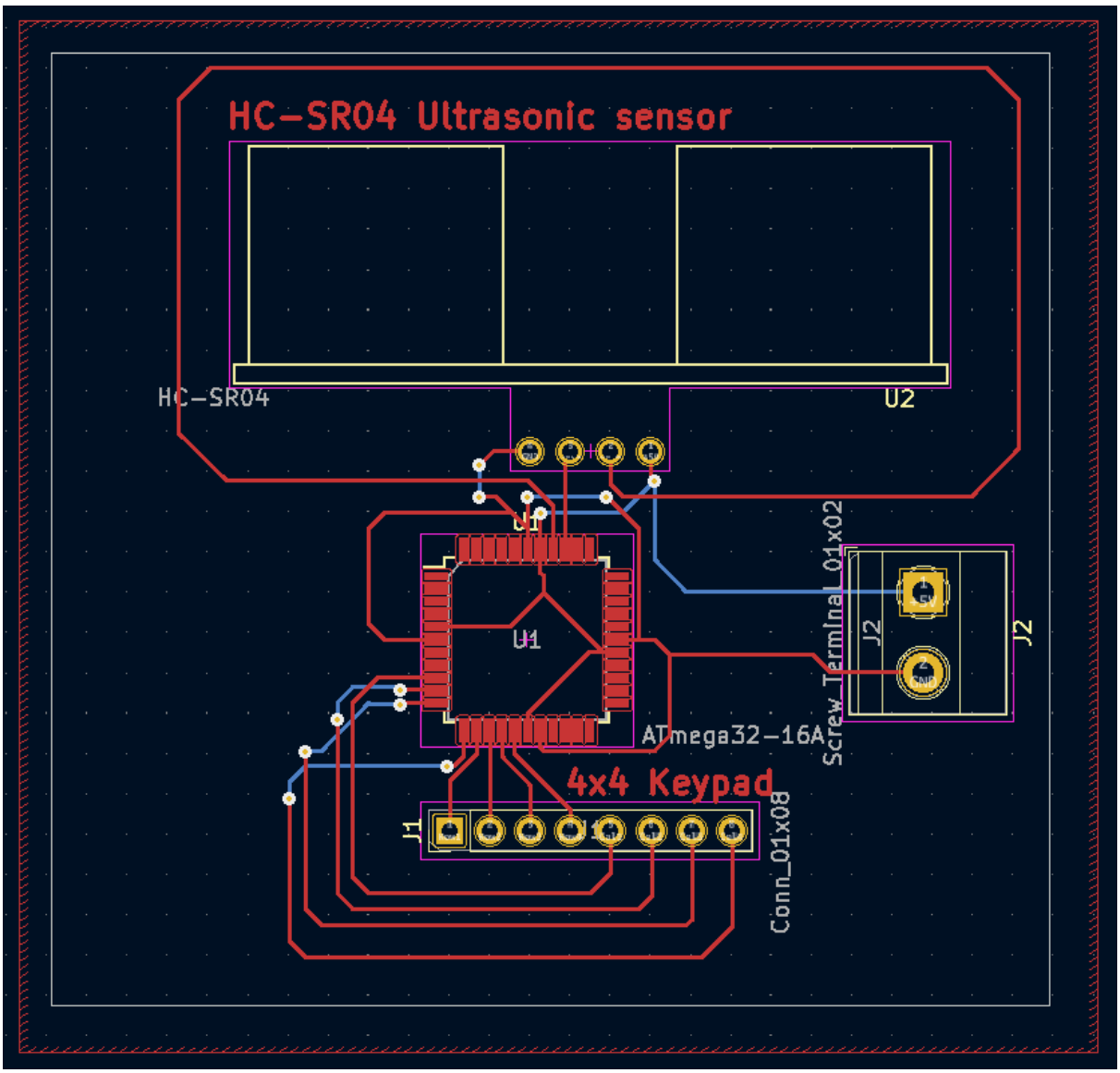


Figure 7. 9

Code

https://dms.uom.lk/s/46GHqNJnexLJQs6

204137K (S.A.R.Nethmini)

Responsible Part : LCD ,I2C , Stepper Motor

Technique and Specification

LCD(16x2)

Maximum voltage: 5V

Maximum current:1.5 mA

In our project, we have to display the battery percentage and the surface temperature of the peltier device. So I used a 16x2 LCD. That means 16 number of characters per line and 2 lines.There are 2 modes that we can connect the LCD. They are 4 bit mode and 8 bit mode.4 bit mode uses 4 data pins while 8 bit mode uses 8 data pins. As the number of pins in the microcontroller is not sufficient, I connected the LCD using 4 bit mode.[20] *(Figure 7.7)*

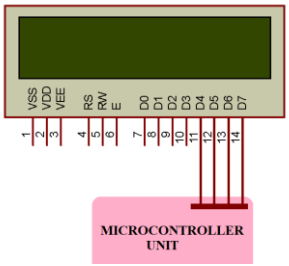


Figure 8. 1

Pin Description:

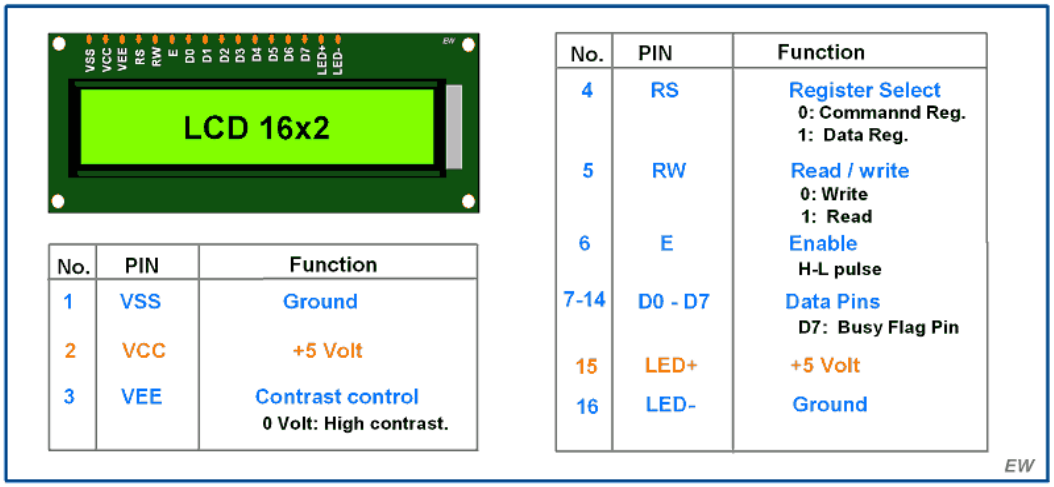


Figure 8. 2

I2C(PCF8574A-Remote 8 bit I/O expander for I2C)

Maximum voltage:6V
Maximum current:25 mA

As the number of pins of the microcontroller is not sufficient to connect the LCD, I have used the PCF8574A-Remote 8 bit I/O expander for I2C. It only takes 2 pins from the microcontroller.They are SCL and SDA. SCL means serial clock, while SDA means serial data. SDA transfers the data that takes place through the pin. SCL carries the clock signal. All devices on the I2C bus are connected to the SCL and SDA lines. Because the LCD is connected to the Atmega via PCF8574A, the Atmega is referred to as the master device, and the LCD is referred to as the slave device. Four pins are used to send data to the LCD.[3][9] *(Figure 8.3)*

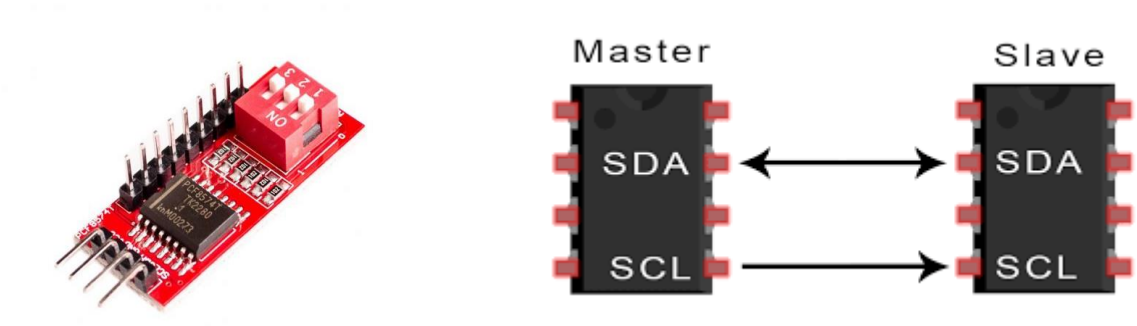


Figure 8. 3

Stepper Motor(Bipolar)

Maximum voltage:12V
Maximum current:1.7A
Torque:3.7 kg-cm

In our project, the stepper motor is used to move the lumbar support. We have used the stepper motor because the stepper motor has the ability to control the position of the rotor.Basically, there are two types of stepper motors: unipolar and bipolar. The bipolar stepper motor has more torque when compared with the unipolar stepper motor. Because of that, we have used a bipolar stepper motor. The bipolar stepper motor doesn't have the center tap wire, which splits the full coils of the winding in half. *(Figure 8.4) (Figure 8.5)*

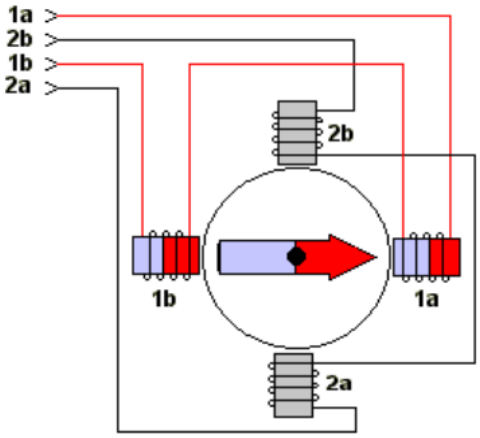


Figure 8. 4

The driving pattern of the bipolar stepper motor:

Coil A is driven with positive current, then the current is removed. Then coil B is driven with positive current. Then the current is removed. Then coil A is driven with negative current, then the current is removed from coil A and then coil B is driven with negative current. *(Figure 8.5)*

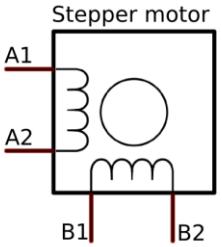


Figure 8. 5

The voltage given by the microcontroller is not sufficient to run the stepper motor.Therefore, I used the motor driver L293D to drive the stepper motor.[29][30]

Schematic Diagram

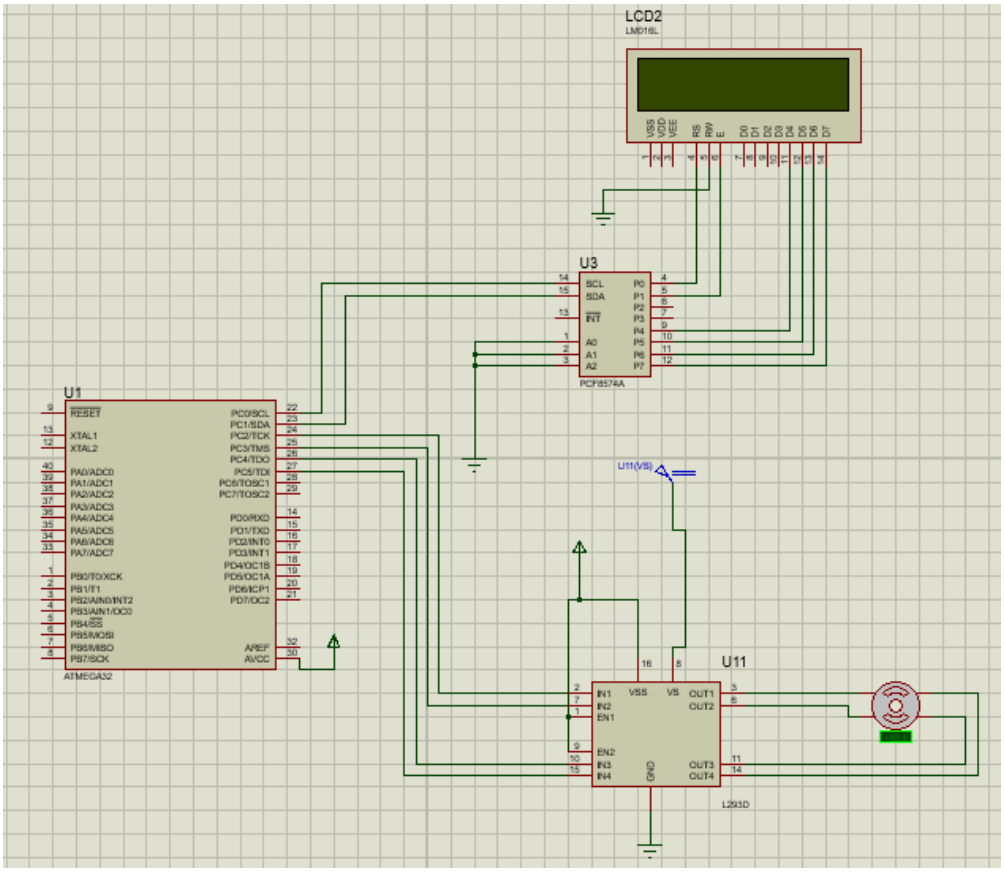


Figure 8. 6

PCB design

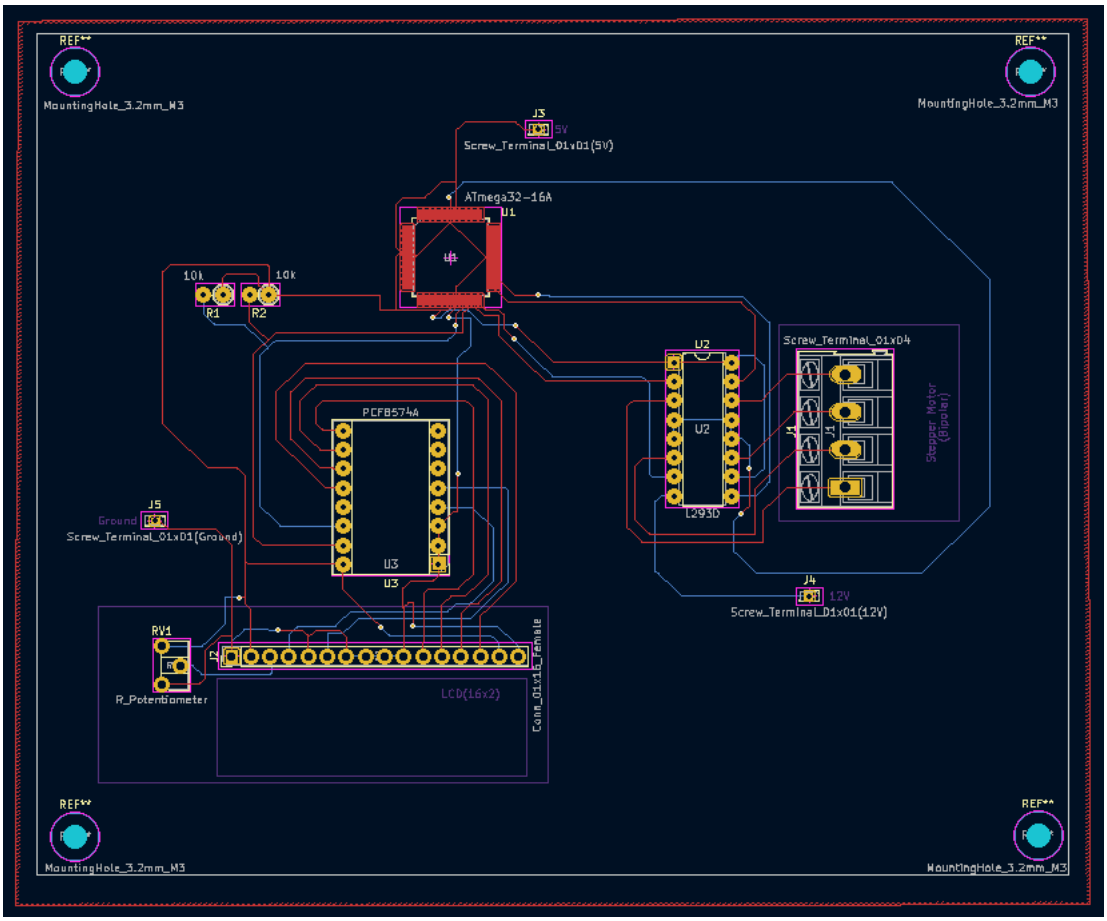


Figure 8. 7

Code

https://dms.uom.lk/s/ZAaKXiYqio7Q3CX

Main Code

https://dms.uom.lk/s/WieiD8a7TkL7tnx

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