

**Faculty of Information Technology**  
**IN 1900 ICT PROJECT**  
**AUTOMATIC BOXING TRAINING MACHINE**  
**Final Report**

**Group No:40**

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Date of Submission: 08.06.2022

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## **1. Introduction**

Boxing is a sport in which two players are involved. The four basic punches in modern boxing are Jab, Cross, Hook, and Uppercut. Also, there are some other punches too. To practice these punches and become a good player, the player must have good practice. Boxing players cannot practice themselves alone. He needs an opposing player or a partner to do the practice. So, the player face difficulties in practicing. And also, always we can't have a coach, because having a coach is very expensive and the coach can't hang with us always. As well as to become a successful player, he/she has to practice frequently. So, each time he/she has to reach the training center to practice. When the player is practicing with a coach, he/she has to limit only to the coach's knowledge. [7] [8] [9]

In Boxing, the performance of the player depends entirely on the performance of the opposing player. Therefore, training alone is not practical and successful. And also, it's essential to train with the right techniques to produce a good player. To overcome this problem, we hope to introduce an Automatic Boxing Training Machine. So, the player will be able to practice alone without a partner.

The player should have a clear understanding of the combinations (steps of the combination) and he can practice those combinations with the help of this machine. It will help the player to develop his muscle memory.

## **1.1 Brief Introduction on boxing**

### **What is boxing?**

Boxing is a combat sport in which two competitors try to hit each other with their glove-encased fists while trying to avoid each other's blows.

### **What is a punch?**

A punch is a striking blow with the fist. In boxing, it is the only type of offensive technique allowed and players use gloves to protect from injuries. These punches are considered as the fundamental building blocks of a combination.

There are four main punches in boxing

1. Jab — a quick, straight punch thrown with the lead hand
2. Cross — a powerful straight punch thrown with the rear hand
3. Hook — a semi-circular punch thrown with the lead hand to the side of the opponent's head
4. Uppercut — a vertical, rising punch thrown with the rear hand

the boxer should join them together in proper order to build combinations.

### **Basic Boxing Moves**

In addition to learning the above basic punches, it's also important to learn some of the basic boxing moves, such as the slip and roll.

Two of the most fundamental concepts of boxing are defense and offense. As important as it is to learn how to hit, it's equally important to learn defense techniques to avoid your opponents' gloves as they come flying toward you. Boxers learn how to slip and roll in boxing for both offensive and defensive functions. When you move to avoid being punched, you're moving defensively, and when you move to come forward and throw your opponent off balance, you're moving offensively.

### **Slip**

The slip is an effective defensive head movement intended to get you out of the path of an oncoming straight punch from your opponent. Slipping can cause your opponent to miss their punch while, in turn, putting your body in balance for a counter punch.

## **Roll**

The roll is another effective defensive movement used to avoid your opponent's hooks by bending your knees and shifting the weight from the lead side to the backside, and vice versa (rolling in vs. rolling out).

## **What is a Boxing Combo?**

A boxing combo is a sequence of punches and movements that you execute to attack or counter your opponent. A successful boxing combo is one where you manage to:

- land your shots
- protect yourself from any counterattack from an opponent
- quickly get out of your opponent's reach

## **Why Need Combinations?**

Combos are very important in any fighting art. Each move is like a single word. Rather than uttering single words it's better to string them together to make sentences.

It doesn't make sense to throw a single punch because opponent boxing player cannot stop by using a single punch. So, boxers always use punch combinations to hit the opponent.

Combinations make opponent confused and increasing chances of victory.

## **What is the Importance of Practicing Combinations?**

Boxers rely on their muscle memory and movements that they have practiced again and again so that they are able to adequately respond to the perceived dangers posed by their opponent. Boxers don't have much more time think about the punches while in the game.

## **How to Make/Build Combinations?**

Players have freedom to build their fighting combinations in the opinion of their own. But beginners don't have much knowledge to do that. So, they use some popular effective combinations to beat the opponent player efficiently, recommended by the expert players those who have long time experience in boxing game.

We also use some of these combinations to our project.

## **What is the Novelty?**

While many fighters train with a punching bag, it's not really a fair fight – after all, the bag can't punch back. But this machine can do that.

## 2. Literature Survey



*Figure 2. 1*

The above picture shows a machine similar to our machine which includes only working arms. And it is a wall-mounted stationary machine. [2]

We have modified it to move with the player accordingly by turning around the fixed edge of its base. As well as we have included sensors to detect the motion of the player and measure the heartbeat of the player. As well as we have modified it to adjust its height according to the player's height. Also, we upgraded our machine to guide the player using a led light system to punch the correct position according to the sequence of a particular technique.

If the player wants to practice a new punch also the new punch can be programmed into the machine.

There is no such machine in the world with the above modifications.

### **3. Aim & Objectives**

#### **3.1 Aim**

Design and develop an automated machine to practice boxing without a coach.

#### **3.2 Objectives**

1. To guide the player to punch the correct positions
2. To guide the player to punch in sequence
3. To help the player to improve the blocking skill
4. To practice alone without an opposing player or a trainer
5. To practice a particular punch
6. To practice more fighting techniques
7. To improve the safety of the beginners

#### 4. Analysis and Design

Practicing Boxing using heavy bags is the way players use practice nowadays. But we have implemented a practicing robot that can punch back at the player. So, the robot acts as an opposing player and the player will be able to practice without a trainer or an opposing player. Also, players won't get more pain like getting shots from an opposing player. The machine consists of four sponged arms, a head part to practice head punches and a body part to practice body punches.

The machine has an LCD display along with a keypad that allows players to select combinations that players wanted to practice. So, the player can change the combination without using a mobile app.

The robot consists of LED lights in the head part and chest part which indicate the places where the player wanted to punch. If the player punches to the particular place which the LED light indicates, then the piezo sensor detects the punch. Then the light will turn off and the next light will turn on which is the position that the player wants to punch. Likewise, the lights will turn on according to the combination that which player has selected already.

Also, a fitness band that consists of a heartbeat sensor is used to measure the heart rate of the player. The rate will be displayed in the lcd display if the rate is high the display will show a message that the player is not in a good health condition to play. A Bluetooth module is used to transfer the data from the sensor to the lcd display. Players should wear the fitness band on the chest when practicing. So, the machine will be able to measure the heart rate of the player. Also, there is a technique to rotate the machine according to the player's movement.

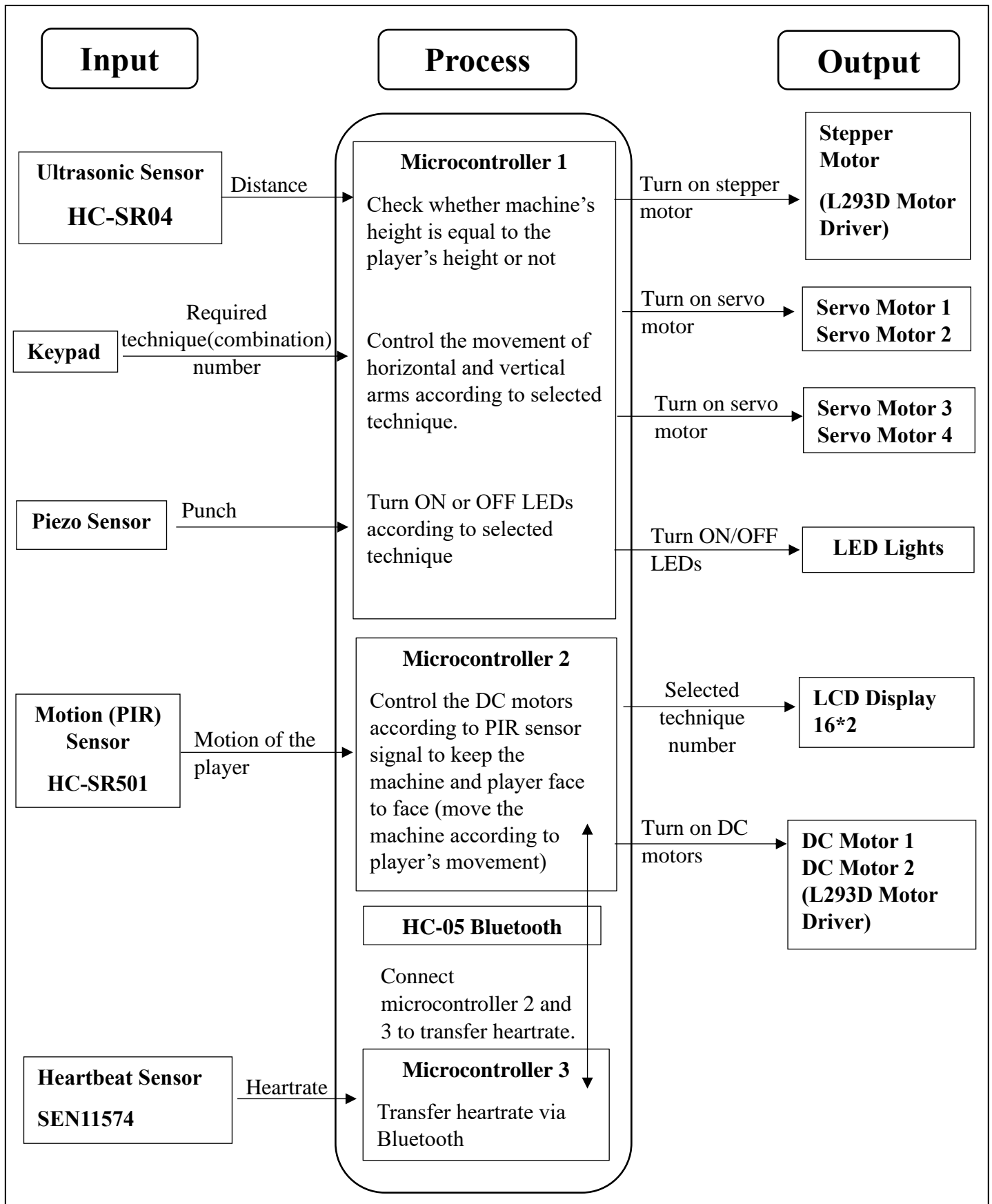


*Figure 4.0.1*



## 4.1 Functional Diagram

### 4.1.1 Input Output Diagram



#### 4.1.2 3D Outer View of the System

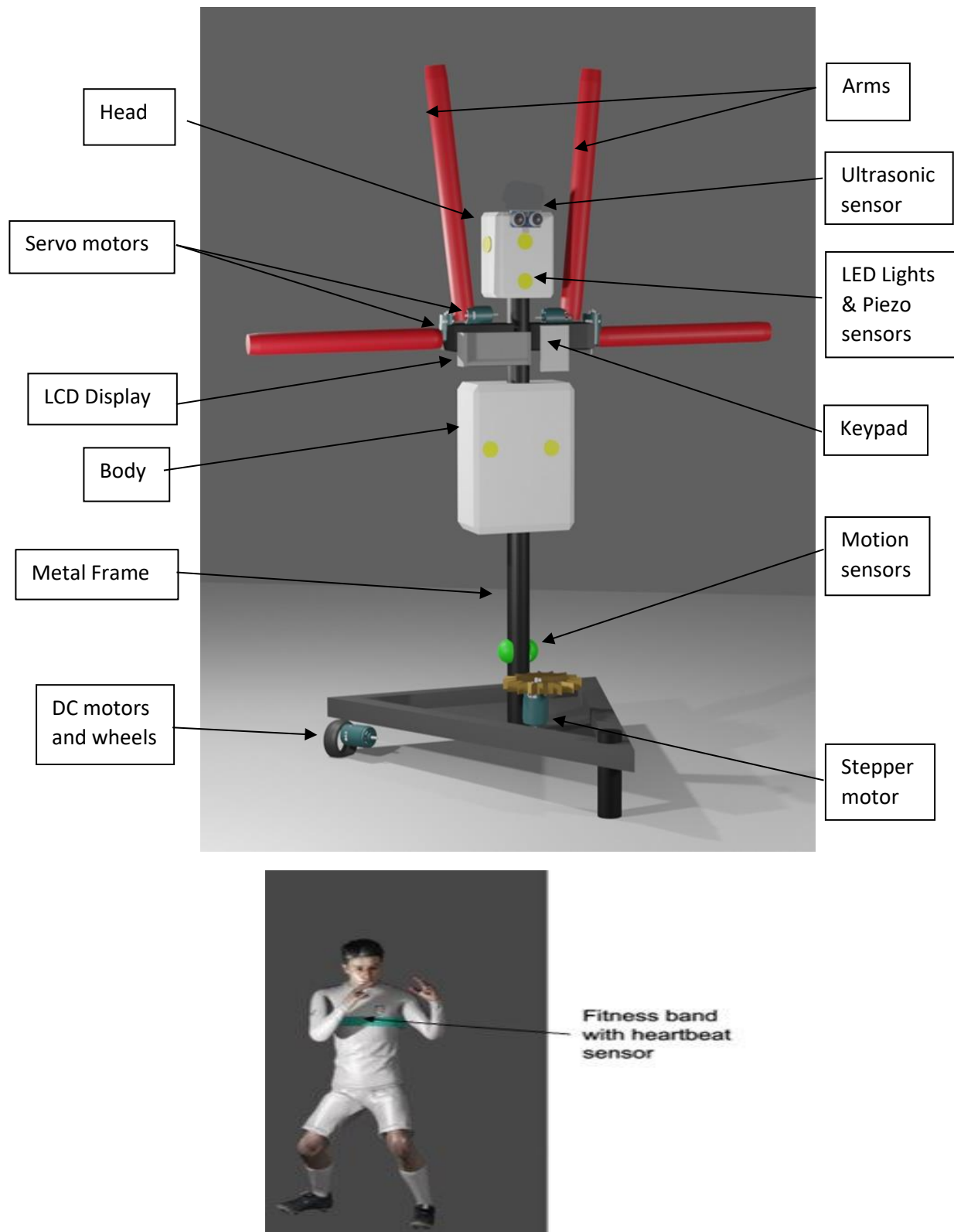
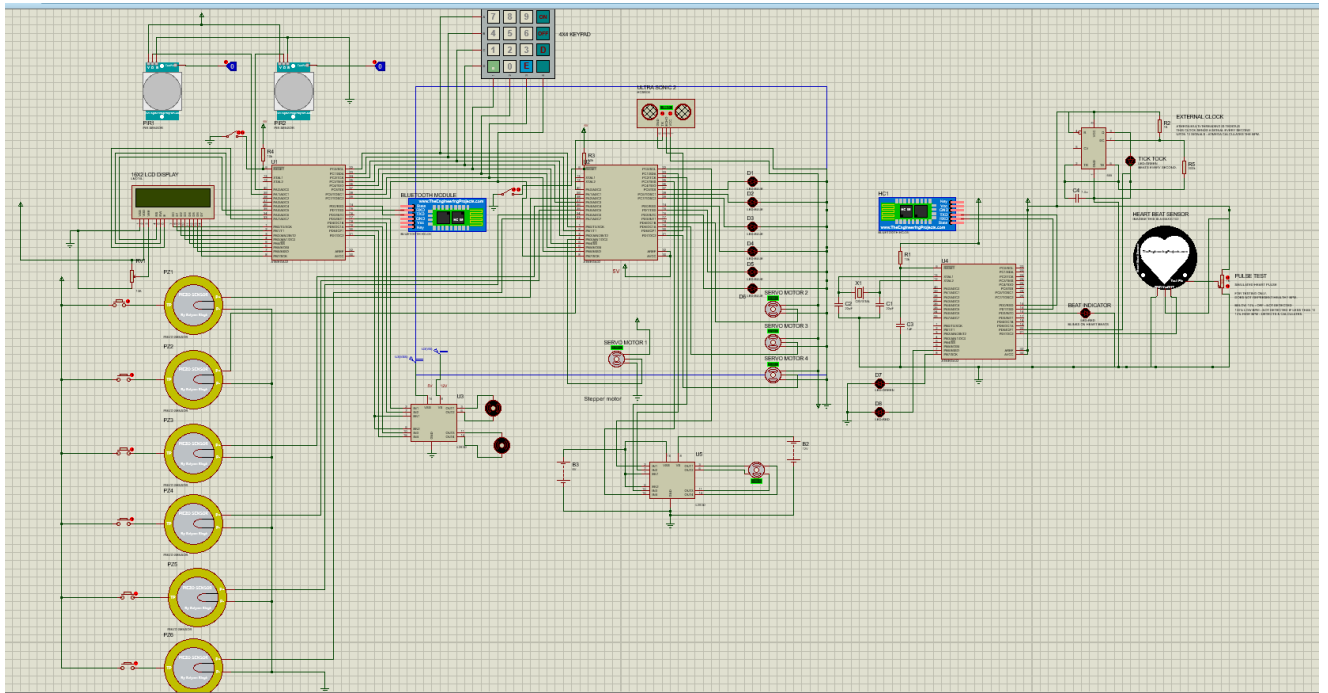


Figure 4.1.2

### 4.1.3 Schematic Diagram



## 4.2 Process

### Height Adjustment



Figure 4.3.1

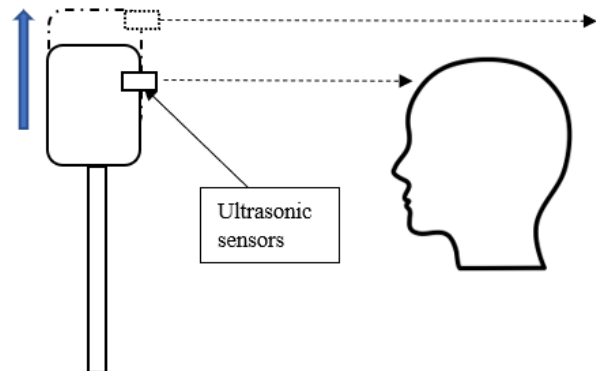


Figure 4.3.2

Detect the height of the player by signal difference of ultrasonic sensors.

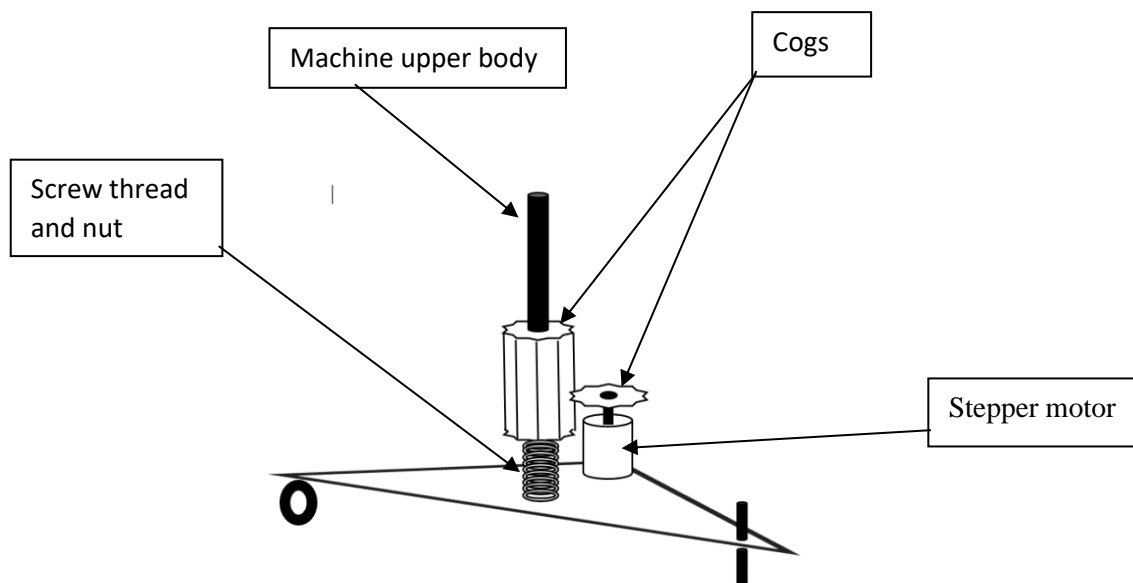


Figure 4.3.3

This part is used to adjust the height of the machine according to the player's height.

The cog which is in the stepper motor rotates according to the ultrasonic sensor's detection. And the cog in the machine rotates according to the cog in the stepper motor and the screw in the bottom of the machine adjusts the height.

## Moving Process

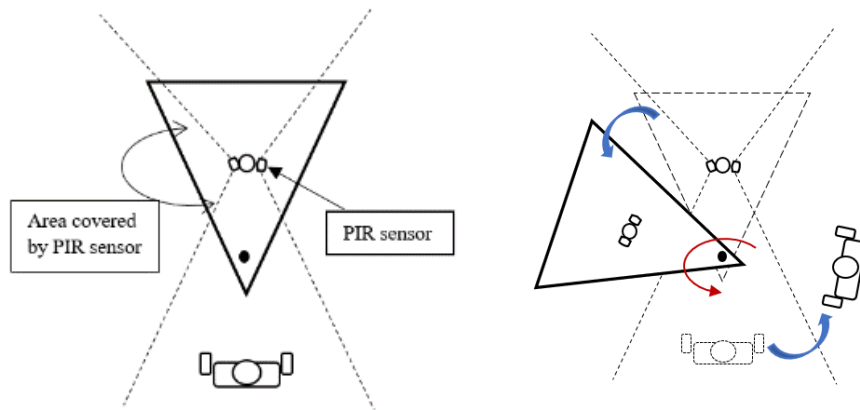


Figure 4.3.4

The machine rotates with the help of DC motors and changes position according to the player. When the player enters the area which is covered by PIR sensors, the sensors detect the movement of the player and the machine rotates according to the player's movement.

The machine rotates until the player comes to the free area that is not covered by the PIR sensor. The machine always tries to keep the player in the area not covered by the PIR sensor

## Motion Mechanism of Arms

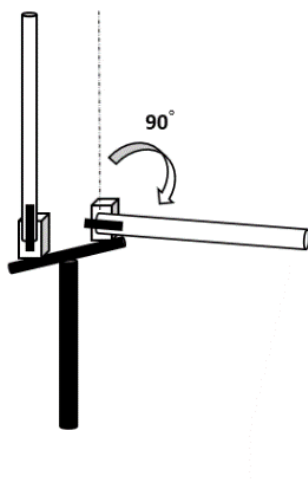
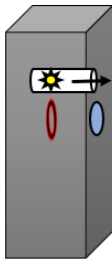


Figure 4.3.5

The robot has 4 arms that move with the help of servo motors. These 4 arms can move in  $90^{\circ}$ . These four arms act as arms of the opposing player.

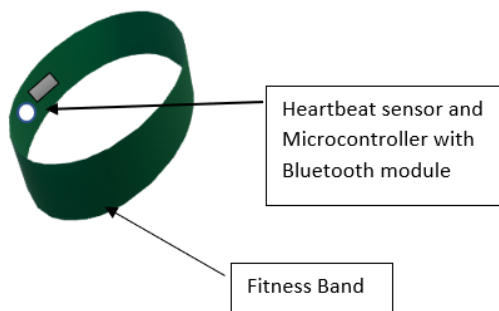
## **LED lights and Piezo Sensors**



*Figure 4.3.7*

LED lights are used to guide the player. Led lights are placed in an unbreakable glass cover to protect them from players' punch. if not, the lights can get broken. These lights indicate the place that the player wanted to punch. If the player punches to the place which the light indicates then the piezo detect the punch and the LED turns off. Then the next LED will turn on where the player wanted to punch next. Likewise, lights turn on in order according to the combination which the player selects.

## **Fitness band**



*Figure 4.3.8*

A fitness band that consists of a heartbeat sensor is used to measure the heart rate of the player. The rate will be displayed in the LCD display. If the rate is high the display will show a message that the player is not in a good health condition to play. A Bluetooth module is used to transfer the data from the sensor to the LCD display. The player should wear the fitness band on chest when practicing. So, the machine will be able to measure the heart rate of the player.

We use a separate microcontroller and a blue tooth module in the fitness band. also, there is a separate Bluetooth module and a microcontroller in the machine. Bluetooth module in the fitness band transfer the heart rate of the player to the machine through serial communication

## 4.3 Combinations

### Combination Example 1

- Step 1 – Jab (Punch by lead arm)
- Step 2 – Cross (Punch by back arm)
- Step 3 – Slip to Left (Move body to left)
- Step 4 – Roll to Right (Walk to right)

#### Step 1 – Jab



Figure 4.4.1

#### Step 2 – Cross



Figure 4.4.2

#### Step 3 – Slip to Left



Figure 4.4.3

#### Step 4 – Roll to Right

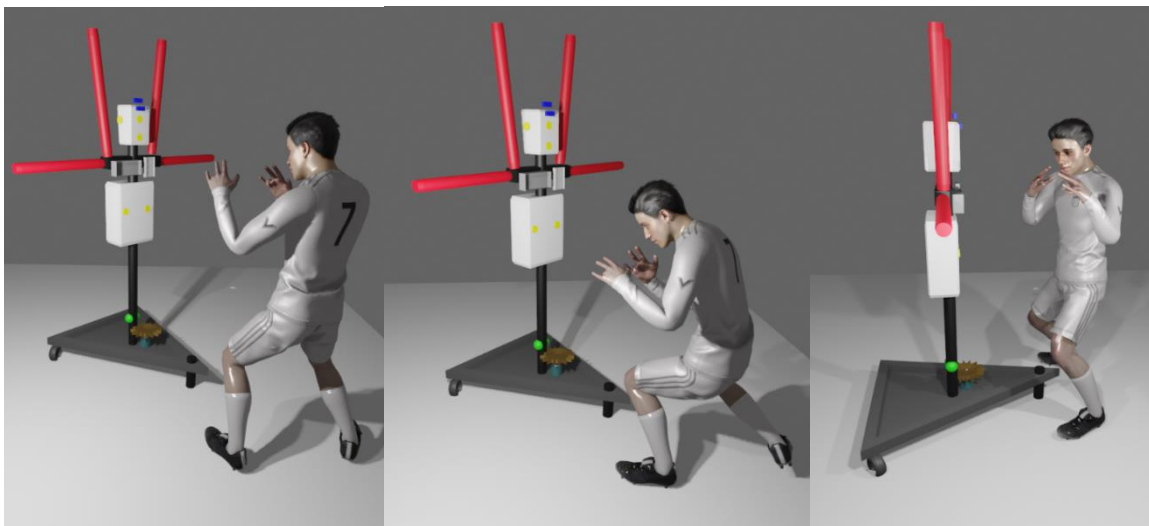


Figure 4.4.4

[1] [5]

## **Combination 2**

- Jab
- Cross
- Slip to left
- Left hook-Head (Punch to left side of head)
- Cross
- Right block (Block right horizontal arm from player's right hand)
- Left hook- Head

### **Step 1 -Jab**



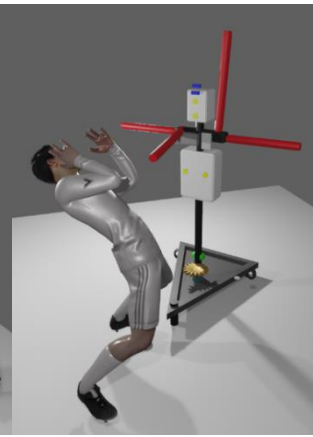
*Figure 4.4.5*

### **Step 2 – Cross**



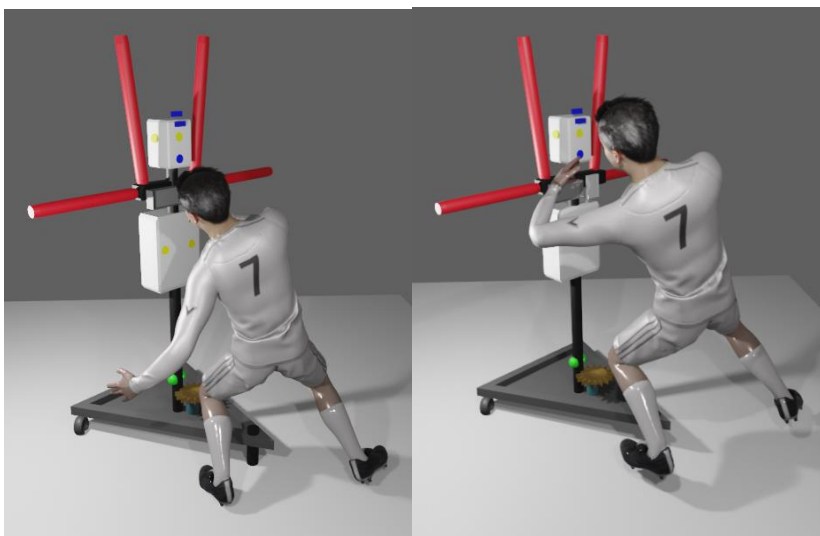
*Figure 4.4.6*

### **Step 3 – Slip to Left**



*Figure 4.4.7*

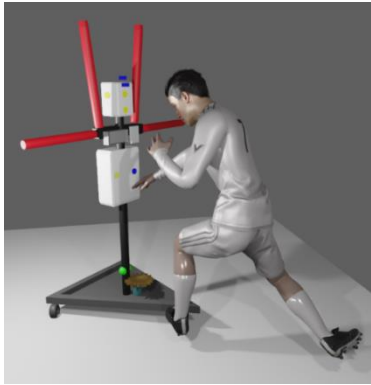
### **Step 4 – Left Hook – Head**



*Figure 4.4.8*



### Step 5 Cross



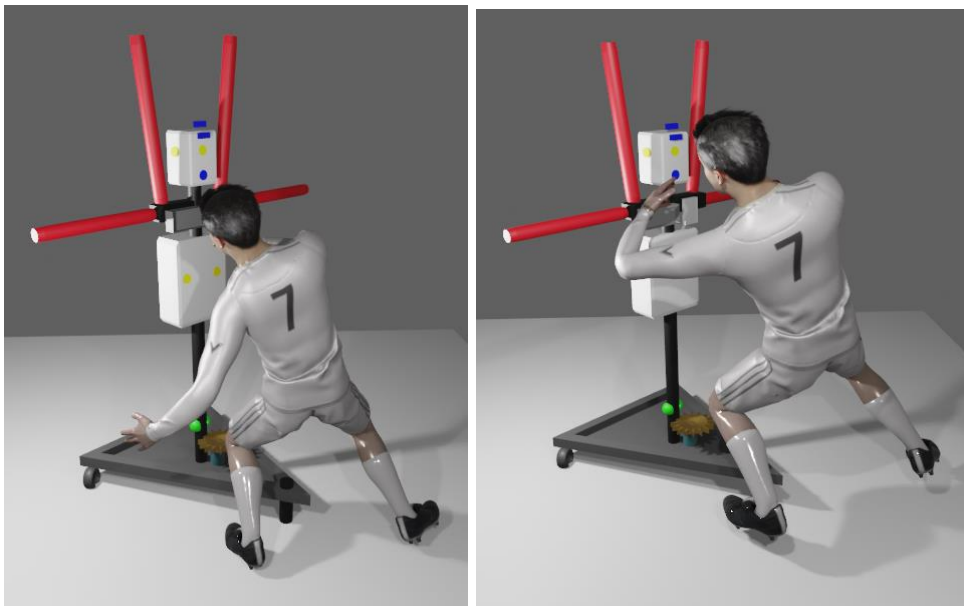
*Figure 4.4.9*

### Step 6 – Right Block



*Figure 4.4.10*

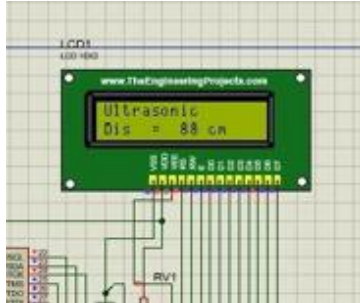
### Step 7 – Left hook - head



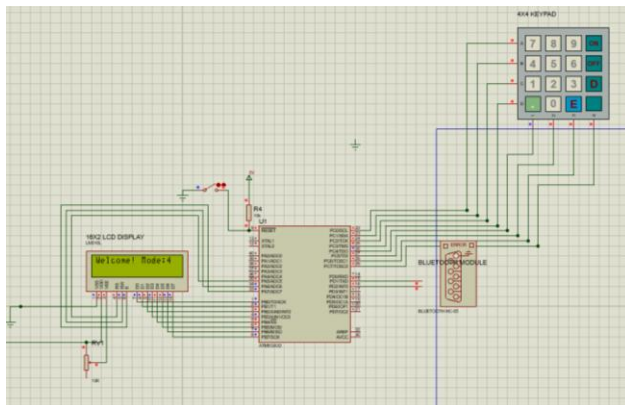
*Figure 4.4.11.*

## 5. Testing and Implementation

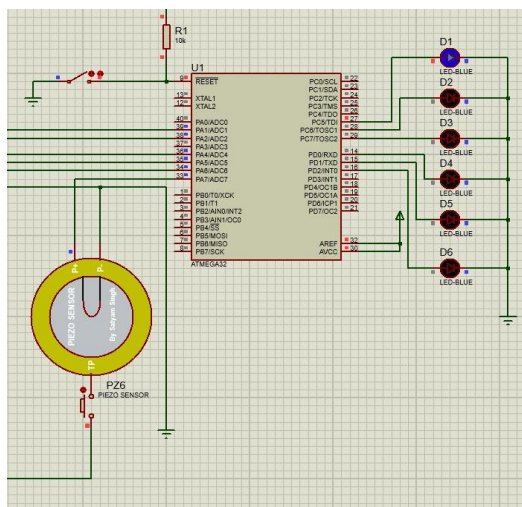
First ultrasonic sensor will measure the distance between player and the machine. Then stepper motor will adjust the machine according to the players height.



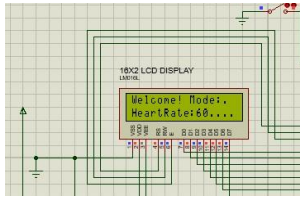
Player can enter the technique number which he is willing to practice. Then the machine will work according to user entered technique (combination). Servo motor will move the arms of the machine according to user entered technique.



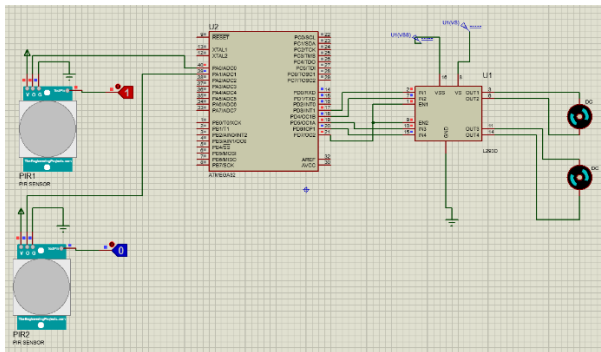
Led lights used to indicate the punching positions. Piezo sensor will detect the punch and according to that LED will get off and next punching position will be indicated



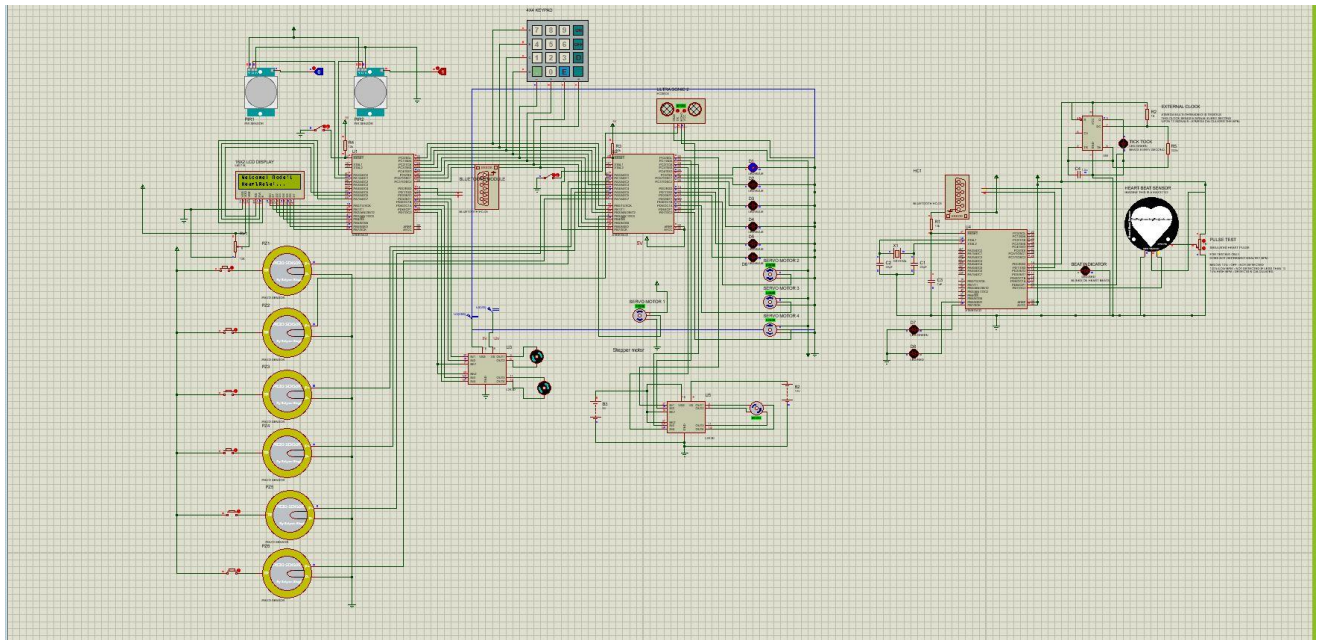
If the player wears the fitness band, then the sensor will measure the heart rate of the player and it will be displayed in the lcd display via Bluetooth.



When first PIR sensor detects a motion, dc motors start to rotate clockwise. When second PIR sensor detects a motion, dc motors start to rotate anticlockwise.

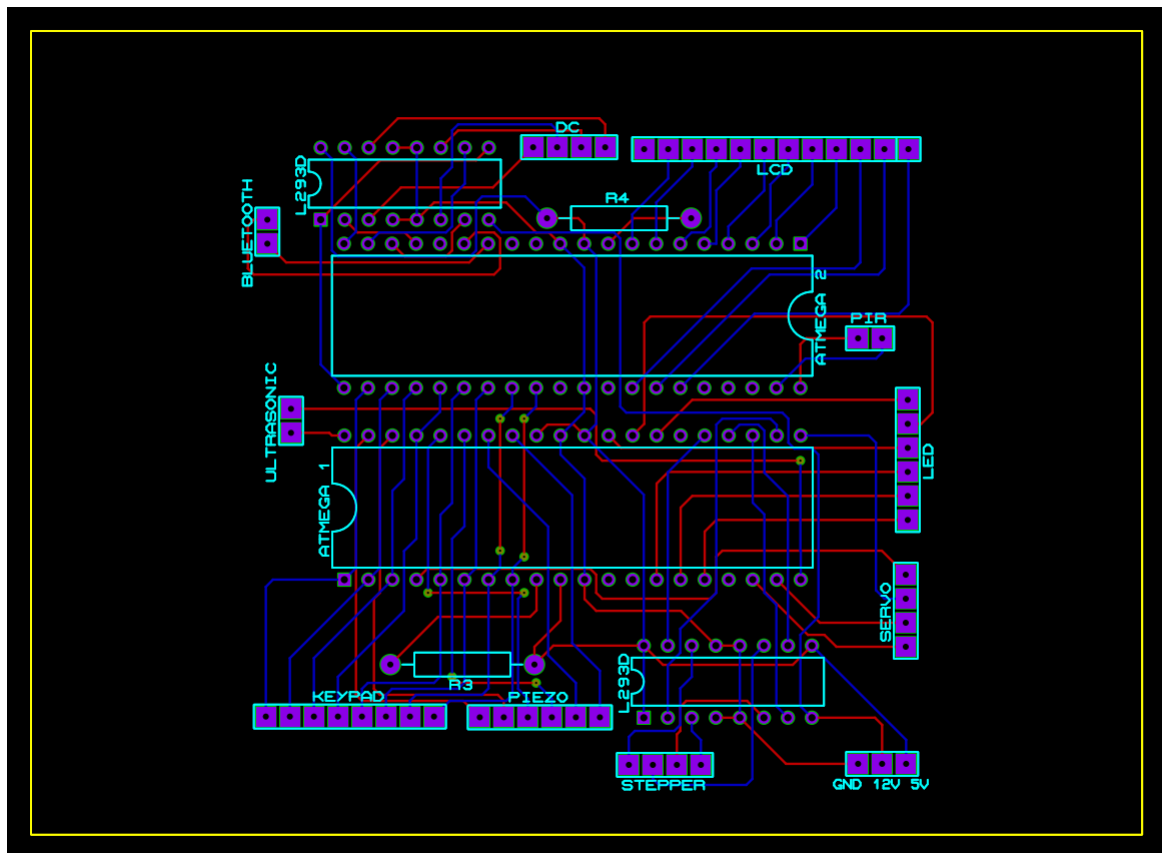


We developed the **Full circuit** using Proteus and Microchip Studio

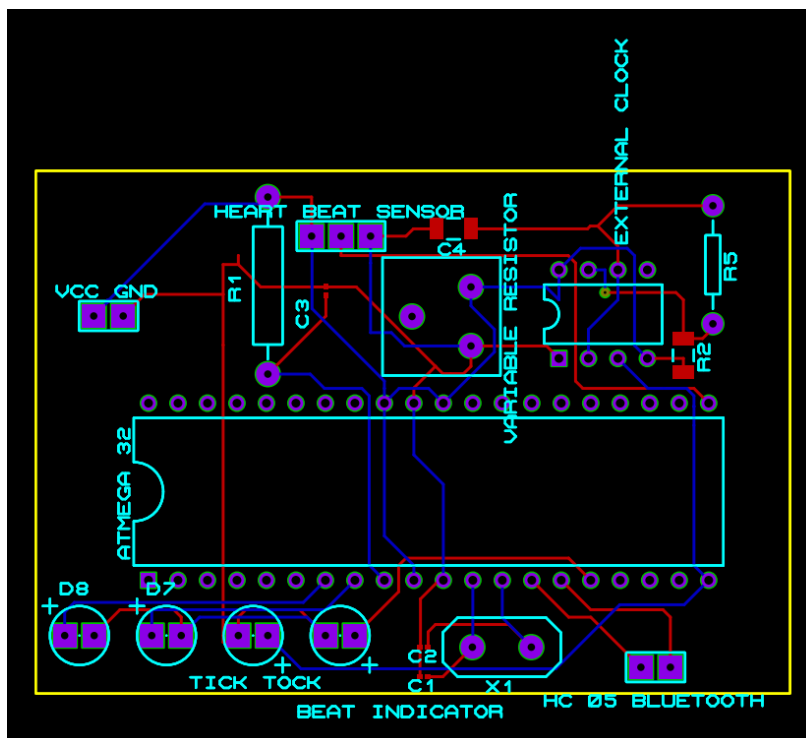


## PCB design

PCB design for machine side



PCB design for Fitness Band



## 6. Total Estimated Cost

[4] [6]

Name	Unit Price (Rs)	Quantity	Amount
At mega 32 microcontroller	660.00	3	1980.00
Servo Motor	600.00	5	3000.00
Motion Sensor	250.00	2	500.00
Piezo Sensor	25.00	6	150.00
LED light	30.00	5	150.00
Keypad & key	200.00	1	200.00
Ultrasonic Sensor	370.00	2	740.00
Heartbeat Sensor	650.00	1	650.00
Stepper Motor	1800.00	1	1800.00
DC Gear Motor	700.00	2	1400.00
LCD display	550.00	1	550.00
Rexene	510.00	2 meters	1020.00
Sponge sheet	600.00	2	1200.00
Box bar	100.00	12 feet	1200.00
Rubber tire wheels	60.00	2	120.00
L293D DC motor driver	490.00	2	980.00
ULN2003 Stepper Motor driver	200.00	1	200.00
HC-05 Bluetooth Module	1000.00	2	2000.00
Power Supply			2000.00
Total			19840.00

Table 7.1.1

## 7. Individual Contribution

Attached as [appendixes](#)

## 8. References

- [1] Blog.joinfightcamp.com. 2021. *6 Basic Punches Every Boxer Needs To Know*. [online] Available at: <<https://blog.joinfightcamp.com/training/six-6-basic-boxing-punches/>> [Accessed 13 Dec 2021].
- [2] CoolThings.com | Cool Gadgets, Gifts & Stuff |. 2021. *Stryk RXT-1 Robot Punching Trainer*. [online] Available at: <<https://www.coolthings.com/stryk-rxt-1-sparring-robot-boxing-trainer/>> [Accessed 13 Dec 2021].
- [3] Electronicwings.com. 2021. *ATmega Inside / AVR ATmega Controllers*. [online] Available at: <<https://www.electronicwings.com/avr-atmega/inside>> [Accessed 10 Dec 2021].
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- [9] Youtube.com. 2021. [online] Available at: <<https://www.youtube.com/watch?v=jhcIjFgz2bI>> [Accessed 23 Dec 2021].

## 9. Appendixes

Individual Contribution

## Individuals Contribution to the Project

**Name of Student:** 204059X Gamage T.T.P.D.

**Responsibilities-**

1. Piezo sensor and programming.
2. LCD Display and programming.
3. Design a power supply unit.

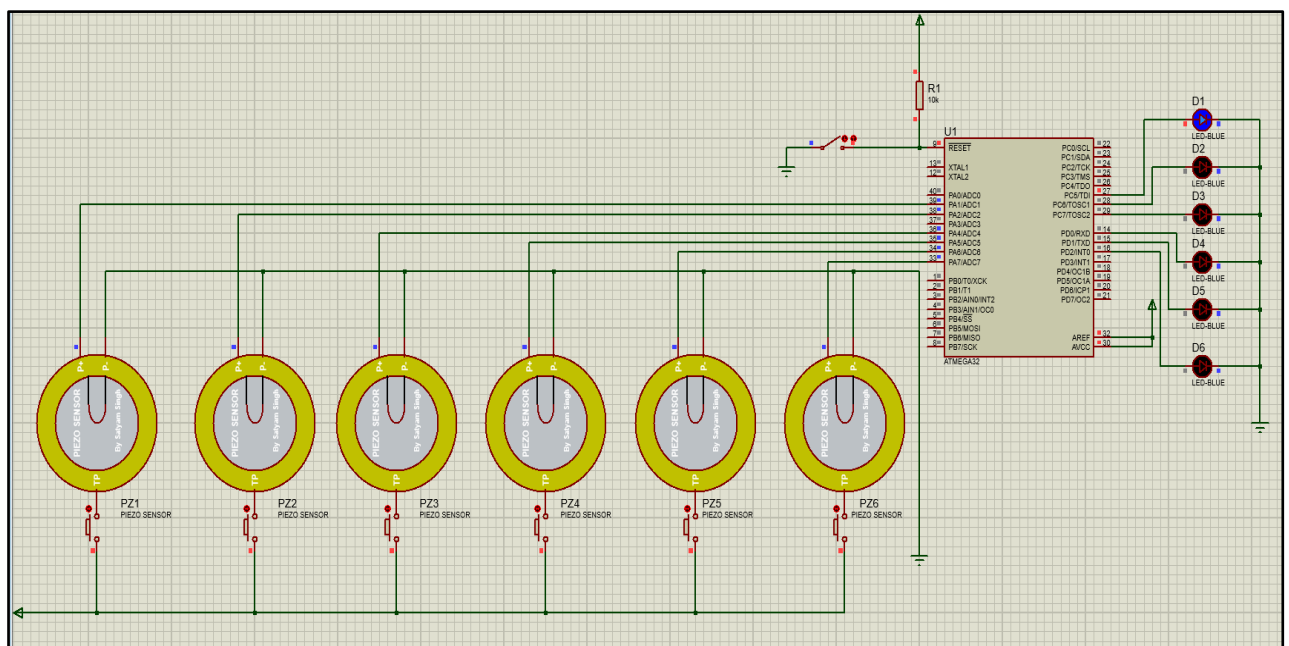
**Piezo Sensor-**

Piezo sensor is the first component that I am responsible for in our project. In our project, we need to quickly identify and respond to the shot made by the player. When the player made a punch sensor is squeezed and voltage generated. Piezo sensors detect the punch by using generated voltage in the sensor. Then the machine guides the player to punch the most suitable position for the next attack by lighting LED bulbs in sequence according to each technique.

### ❖ Specification

- Impedance:  $\leq 500\Omega$
- Voltage:  $\leq 30V_{dc}$
- Maximum current: 15mA
- Operating temperature:  $-20^{\circ}C \sim +60^{\circ}C$
- Strain sensitivity:  $5V/\mu\epsilon$

### Schematic Diagram





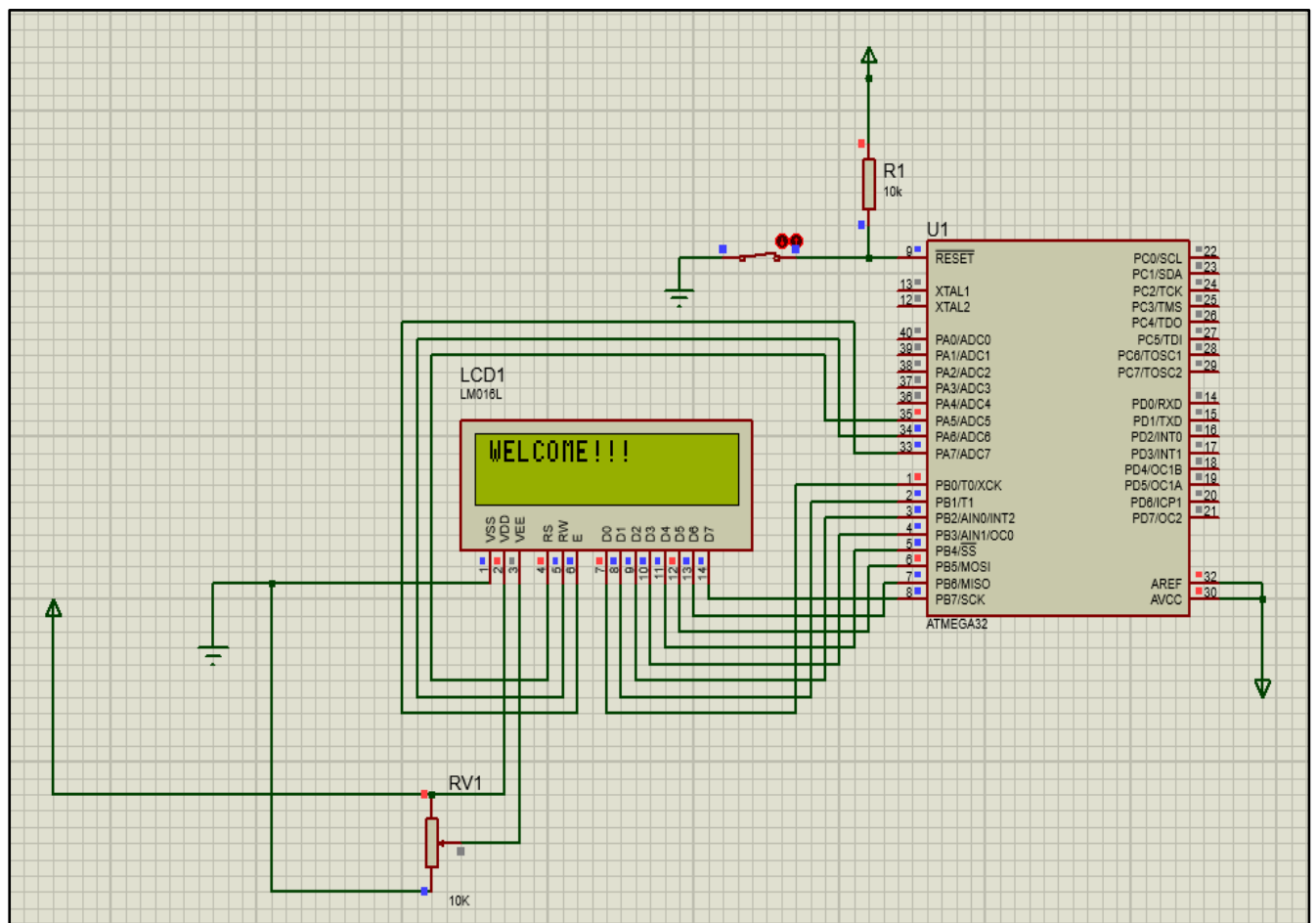
## LCD Display-

My next component is LCD Display. We have used an LCD display to show boxing techniques as well as relevant details of the punch and boxing player. The player can select any technique according to their desire.

### ❖ Specification

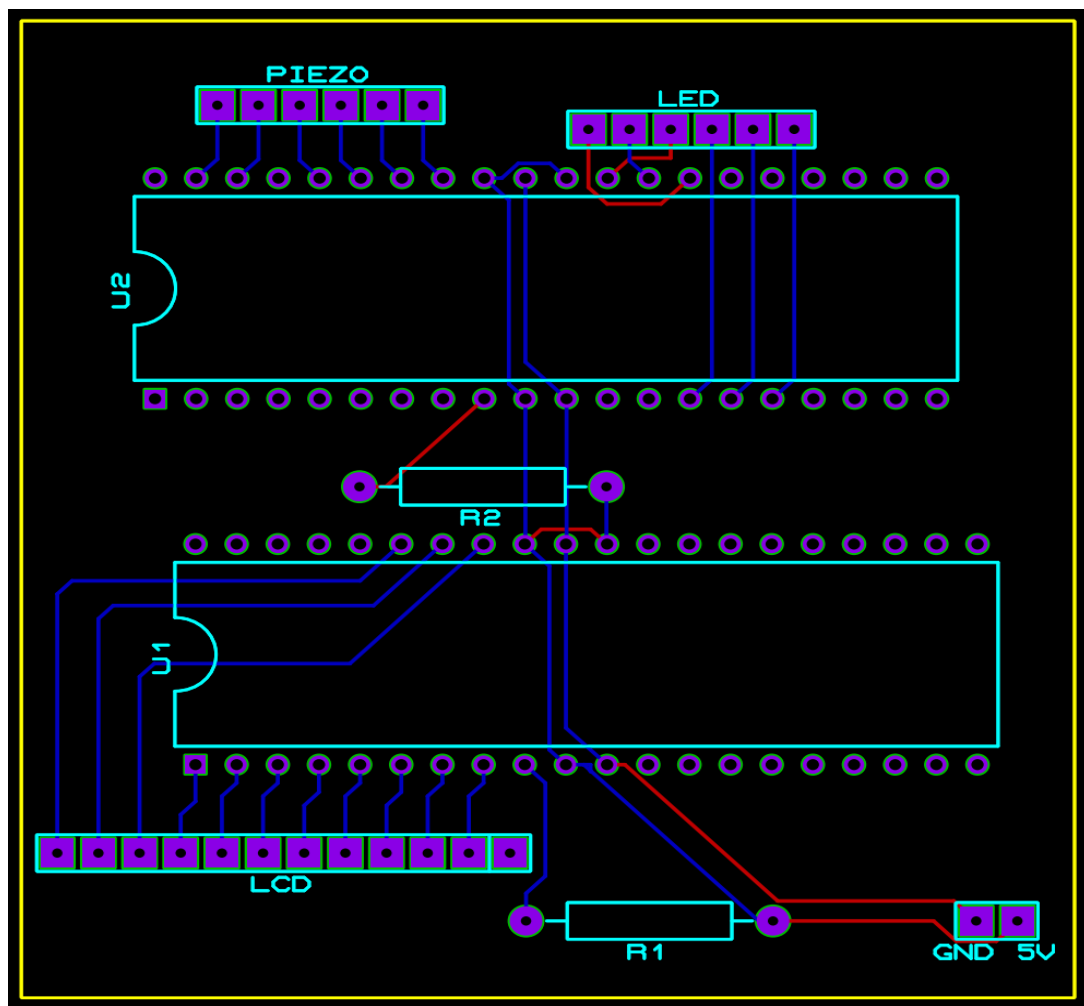
- Operating Voltage 4.7V to 5.3V
- Current range: 1.5-2.5mA

## Schematic Diagram





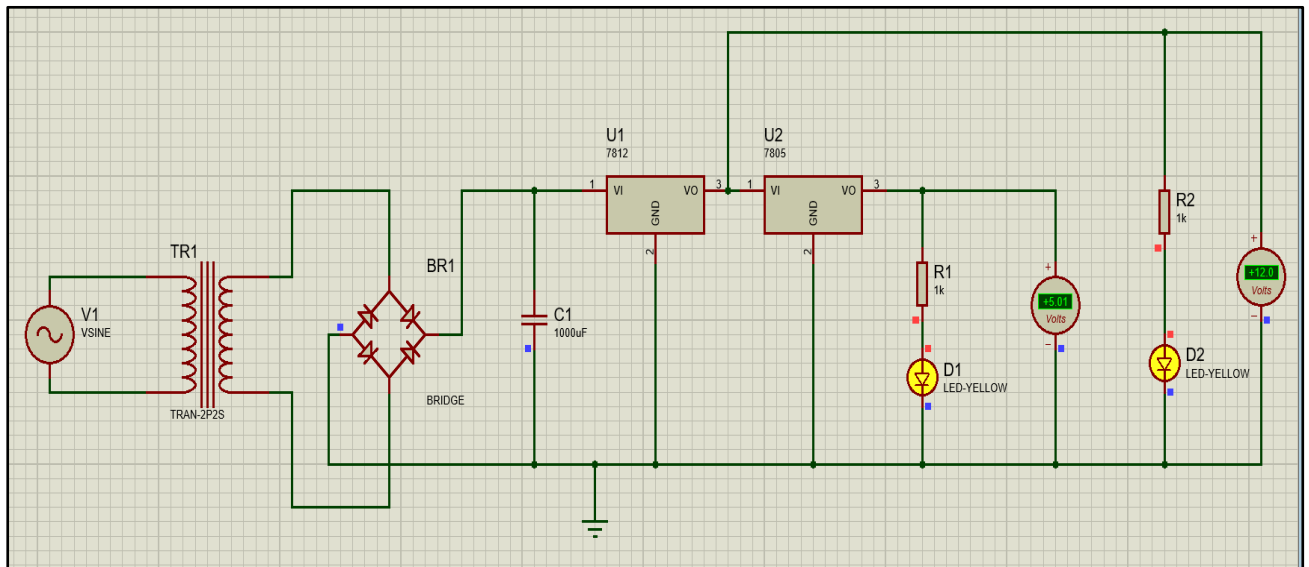
## PCB Design - Piezo Sensors and LCD Display



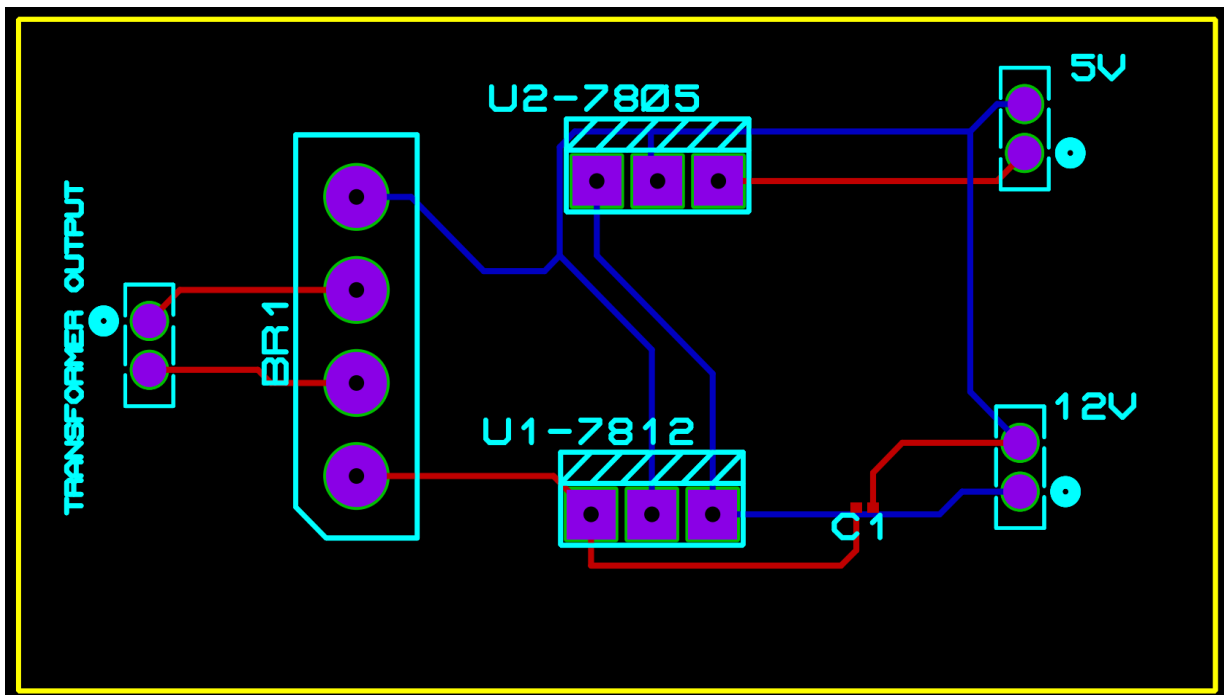
### Power Supply-

Also, I am responsible for designing the power supply unit. When supplying power to our automatic boxing training machine we can't connect it directly to the domestic power supply. Since we have used several sensors and different types of motors, we have to convert 230V AC domestic power supply to DC values like 5V and 12V. Therefore, it's needed to create a DC power supply from the 230V AC main supply.

## Schematic Diagram-



## PCB Design-



**Name of Student:** 204101V Kavishka T.A.

Responsibilities:

1. 4 Servo motors and programming.
2. Keypad and programming.
3. Programming fighting techniques.

First component that I am responsible for is the servo motor. Servo motor is used to rotate something. It can rotate  $180^0$  angles (in each direction). As well as it is very small in size. So it can be placed in a very small space. It has three wires. Orange color wire to connect the servo motor to the microcontroller. Red color wire to power up the servo motor. Brown color wire to ground the servo motor.

❖ Specifications:

- Maximum current - 250mA
- Maximum Voltage - 5V
- Speed -  $0.1s/60^0$  degrees

In our project we have to use four servo motors which can rotate  $90^0$  angles and it must rotate fast. So, I selected SG90 servo motors to do the task. This servo motor is very light. It weighs about 9g. And this servo motor can lift about 1kg of weight. Otherwise, this operates at a very high speed. In our design there are 4 arms which have light weight. And those 4 arms connected to the body of the robot by using 4 servo motors. From those 4 servo motors 2 rotates vertically while the other 2 rotates horizontally.

As well as I am also responsible for the keypad. I used a 4x4 matrix keypad which has 16 keys with 4 rows and 4 columns and 8 pins. Maximum voltage is 24VDC and maximum current is 30mA. In the keypad each key is a pushbutton, with one end connected to one row, and the other end connected to one column. We use keypad to select fighting techniques. We fix the keypad to the body of the robot and the player can input the fighting technique number easily using the keypad.

The diagram illustrates the hardware setup for a robotic arm. It consists of two ATMEGA32 microcontrollers. ATMEGA32 1 is connected to an LCD and a POWER module. ATMEGA32 2 is connected to a SERVO motor and a KEYPAD. The connections are shown as lines between the components and the PCB pads, with labels for each component: SERVO, KEYPAD, ATMEGA32 2, ATMEGA32 1, LCD, and POWER.

**Name of Student:** 204145H Nuska M.F.F.

**Responsibilities:**

1. Bluetooth module and programming
2. Heart beat sensor and programming
3. Designing the fitness band

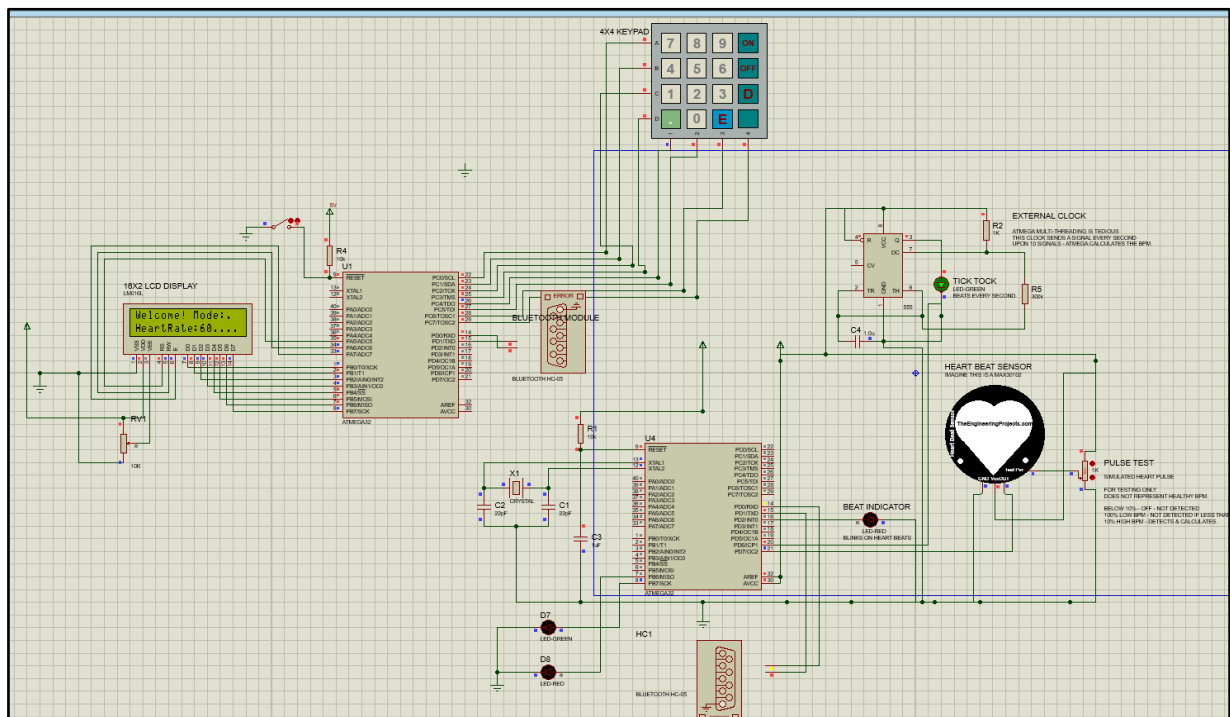
A fitness band that consists of a heartbeat sensor is used to measure the heart rate of the player. The rate will be displayed in the LCD display.

**Bluetooth Module-**

Bluetooth is a component that I'm responsible for in this project. The Bluetooth module is used to transfer the data from the sensor to the LCD display. The Bluetooth module in the fitness band transfers the heart rate of the player to the machine through serial communication.

- Operating Voltage: 4V to 6V (Typically +5V)
- Maximum Current: 40mA
- Model: HC-05
- Communication Method: Serial Communication
- Transmission Distance: 10m.

### Schematic Diagram

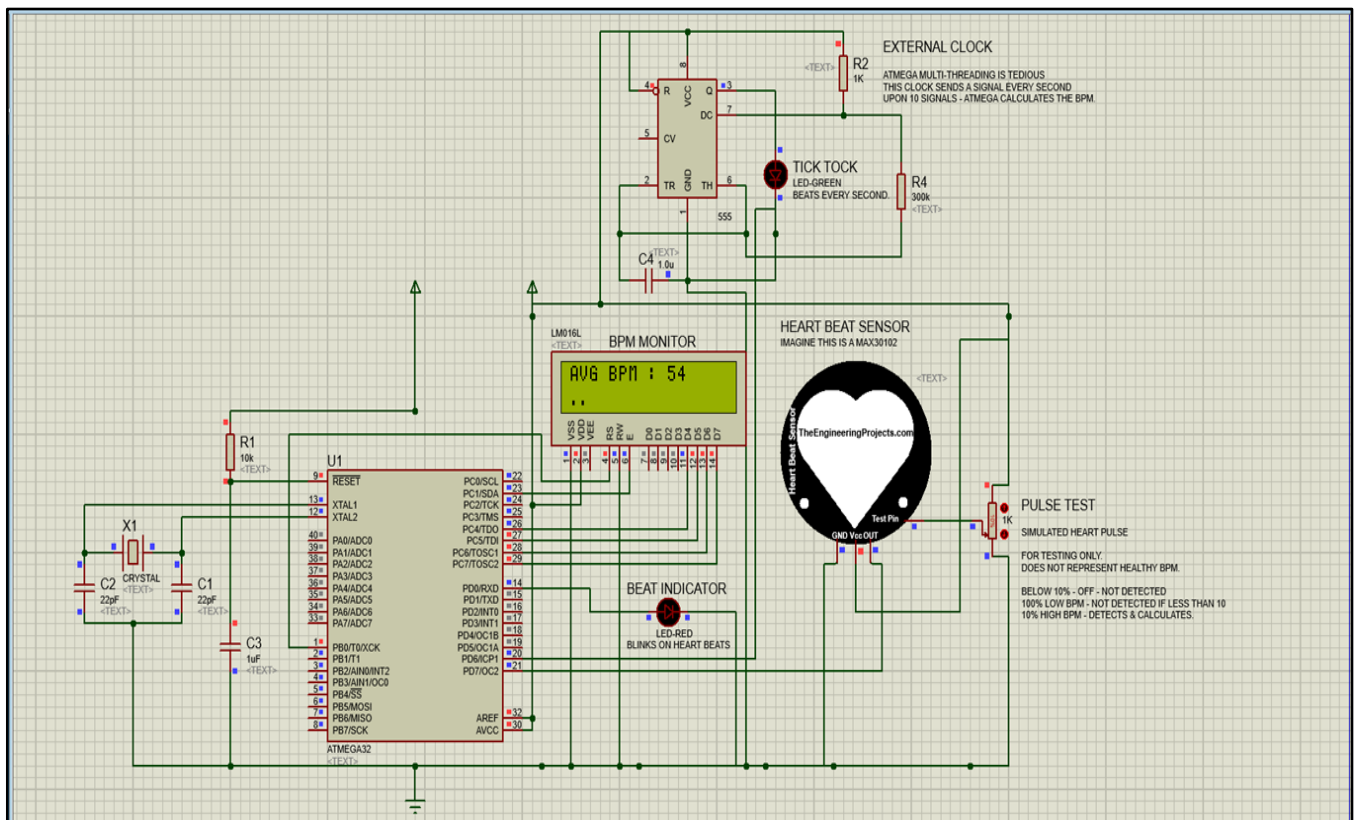


## Heartbeat sensor-

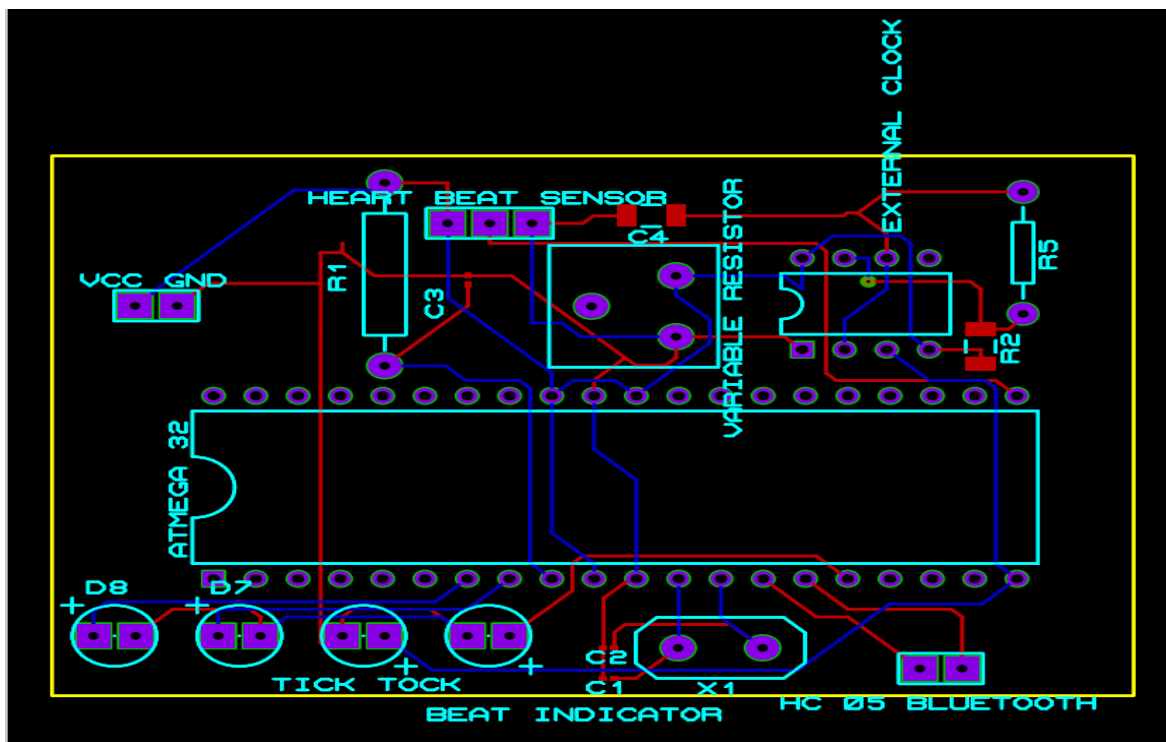
I'm also responsible for the heartbeat sensor and its programming. It is used to measure the heart rate of the player. we placed in the fitness band. While practicing, the player should wear it on his chest. So, It will be able to measure the heart rate of the player.

- Maximum Current: 4mA
- Maximum voltage: 5.5v
- Operating Temperature Range: -40°C to 85°C

## Schematic Diagram-



## PCB Design for heartbeat sensor and Bluetooth module



**Name of Student:** 204203K Siriwardena P.T.Y.

Responsibilities-

1. Design a mechanical system to move the machine
2. DC motor and programming
3. PIR sensor and programming

#### PIR Sensor

PIR sensor is the first component that I am responsible for in our project. We use two PIR sensors in bottom part (in vertical metal frame) of our machine for detect the player's motion. Left side PIR sensor used for detect the player's left side motion and right side sensor used for detect the player's right side motion.

- Maximum voltage - 20V
- Maximum current - 50 $\mu$ A
- Delay time: Adjustable (0.3->5min)

#### DC Motor

My second component is DC motor. We use two DC motors in bottom part (in two corners of triangular base) of our machine to move the machine in a circular way.

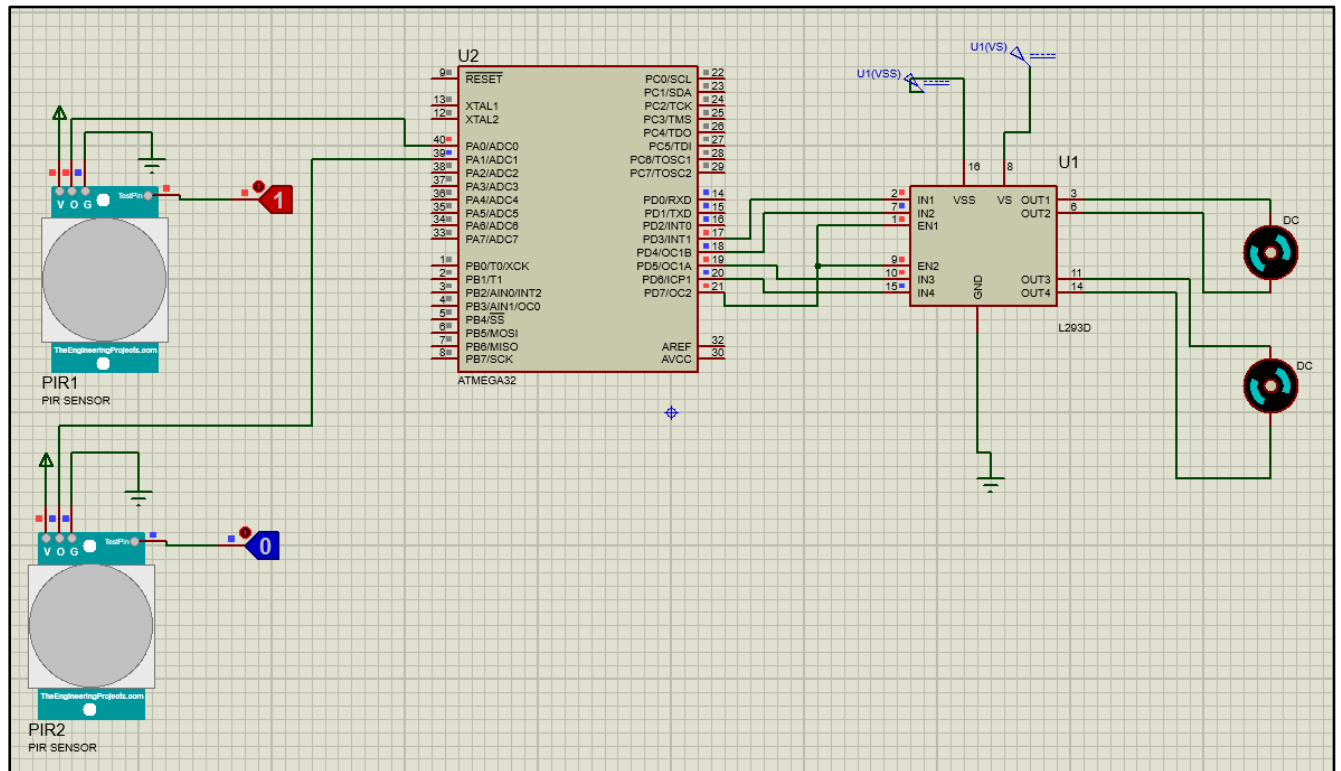
- Maximum voltage - 15V
- Maximum current – 1.2A
- Free-run speed: 295 RPM @ 12V
- Stall torque: 15N/cm @12V

When the player tries to enter the area that is covered by a PIR sensor, it detects the players motion and gives a signal to DC motors to turn on and move machine to same side. Likewise for other sensor machine do the same thing by moving to other side.

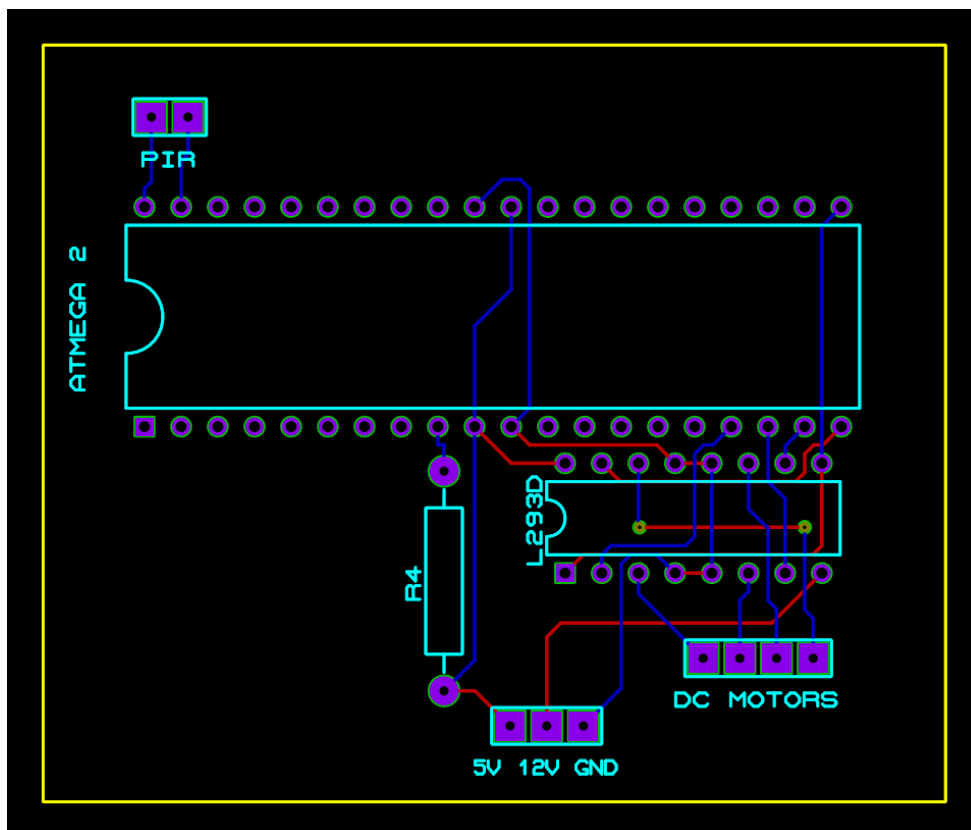
There is free space (not covers by PIR sensor) in front of the machine and machine always try to keep player in that place like in real boxing game. In real boxing game two opponent players try to fight face to face.



### Schematic Diagram-



## PCB Design-



**Name of Student:** 204239B Ekanayaka Y.M.

Responsibilities-

1. Stepper motor and programming.
2. Ultrasonic sensor and programming.
3. Design implementation of stepper motor and circuit diagram.
4. Integrate sub codes and implement final code and work on test run for find out errors

Ultrasonic Sensor

In our project ultrasonic sensor is used to measure the distance between machine and player or measure the distance between machine and beyond the player at the beginning before start. Then according to our constraints code will find out how to adjust.

Here technical specifications,

- Maximum voltage - 5V
- Maximum current – 15mA

Stepper Motor-

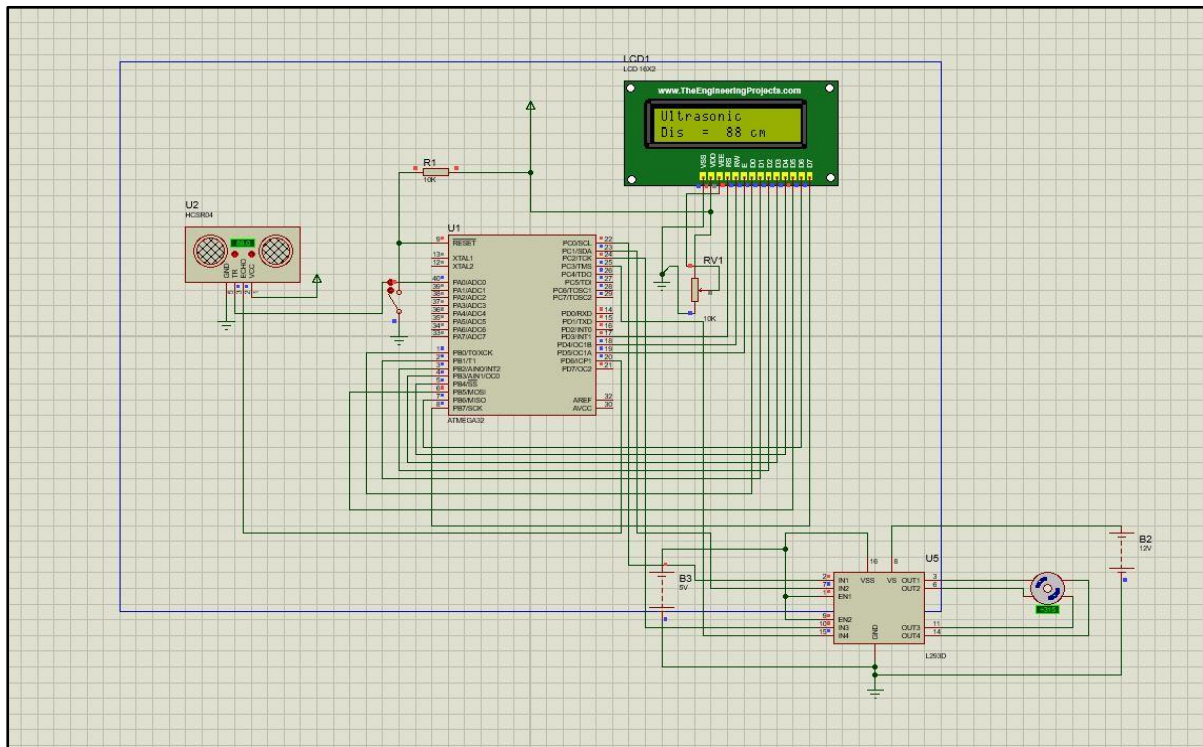
After measuring distance if it is not full fill our constraints stepper motor will rotate clockwise or anticlockwise until full fill our constraints. That constraint is if distance is far more than limit motor will rotate anticlockwise until distance less than limit vice versa.

Here technical specifications,

Bipolar stepper motor has 5 pins one for input power and others for control the motor, through the driver.

- Maximum current -:1.7A
- Maximum Voltage-:12V

### Schematic Diagram-



## PCB Design-

