EC6020 – EMBEDDED SYSTEMS AND DESIGN

BLUETOOTH – CONTROLLED TABLE TENNIS SERVE MACHINE

Project coordinator

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CONTENTS

INTRODUCTION

Table tennis is a popular sport enjoyed by people of all ages and skill levels. One of the key aspects of table tennis is mastering different types of serves. Practicing table tennis alone can be difficult, as players often struggle to maintain consistency variety in their practice session. Without a training partner to provide feedback and variation in serves, players may find challenging to improve their skills effectively. Traditional table tennis practice often requires the presence of another player to serve the ball. This can be inconvenient and limit the availability of practice sessions. As a result, players need an innovative solution that automates the serving process while offering adjustable parameters tailored to individual skill levels and training objectives.

To address these challenges, we propose the development of a Bluetooth-controlled Table Tennis Serve Machine. This innovative machine autonomously serves table tennis balls with customizable parameters such as speed, spin, and placement. The machine allows players to practice independently. With a user-friendly interface, players can easily adjust settings to suit their individual skill levels and training objectives.

By automating the serving process and offering a range of adjustable parameters. It enables players to practice under consistent and varied conditions, improving their skills more effectively. This project aims to create a reliable and efficient training device that can be used in various settings, such as homes, schools, and table tennis clubs, ultimately supporting players in developing their serving techniques and enhancing their overall performance.

PROJECT DESIGN AND IMPLEMENTATION

I. HARDWARE DESIGN

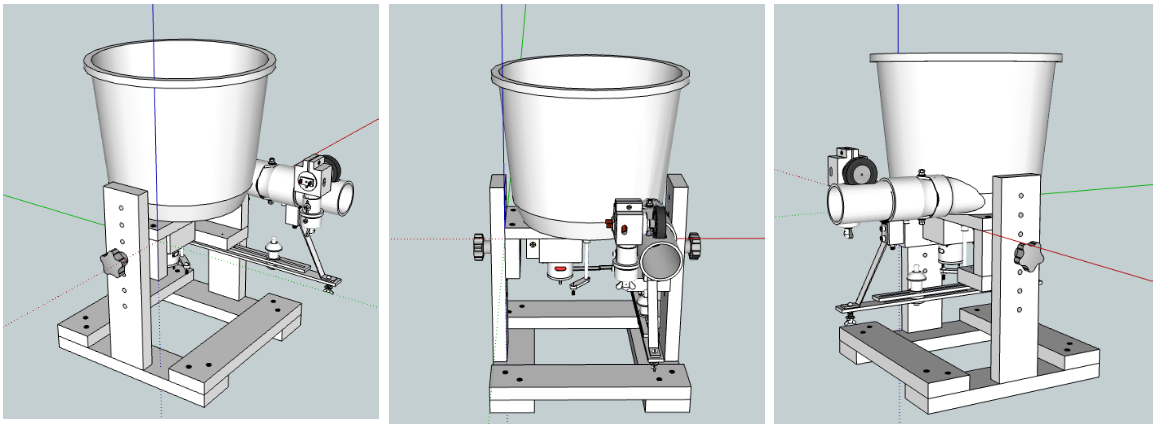

Figure 01: Side and front views of table tennis serve machine

II. INTERFACING

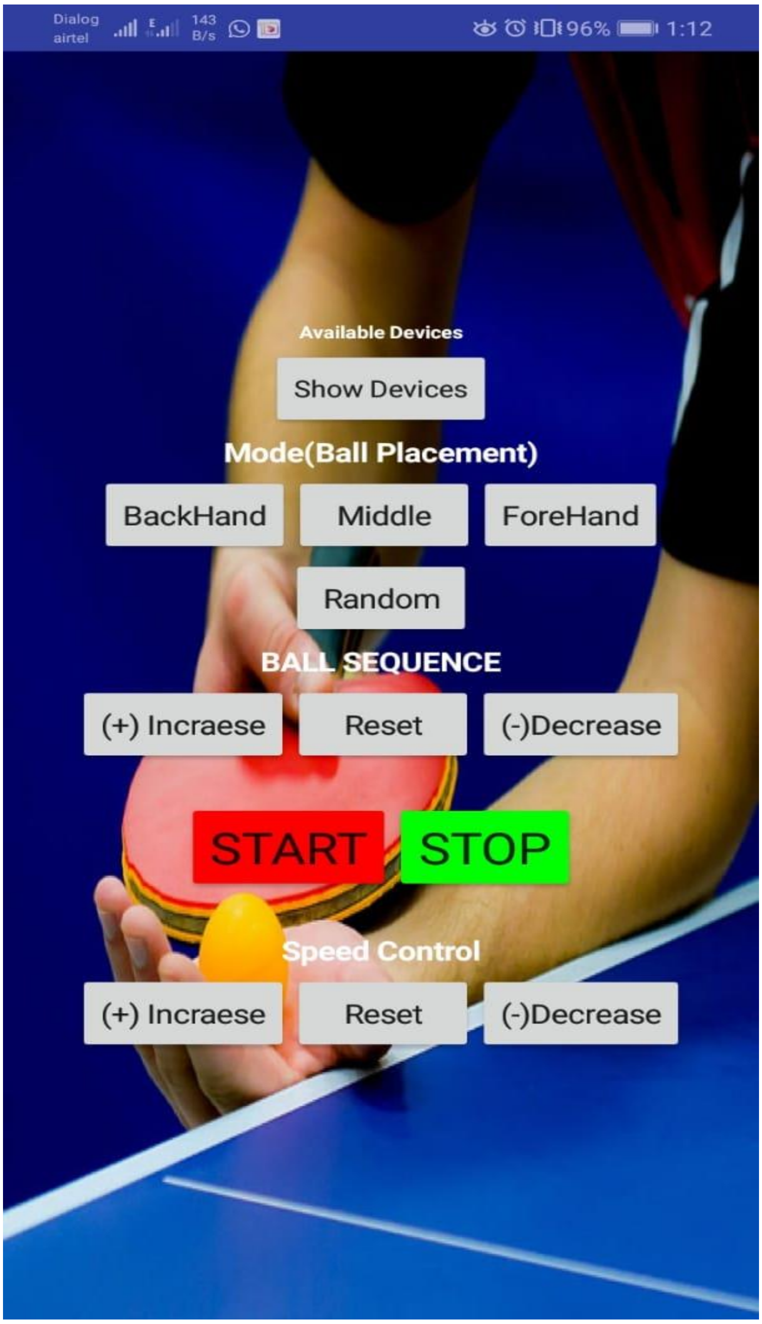

Figure 02: Mobile App Development

- We developed this mobile app using,
  https://ai2.appinventor.mit.edu/#6673731233579008

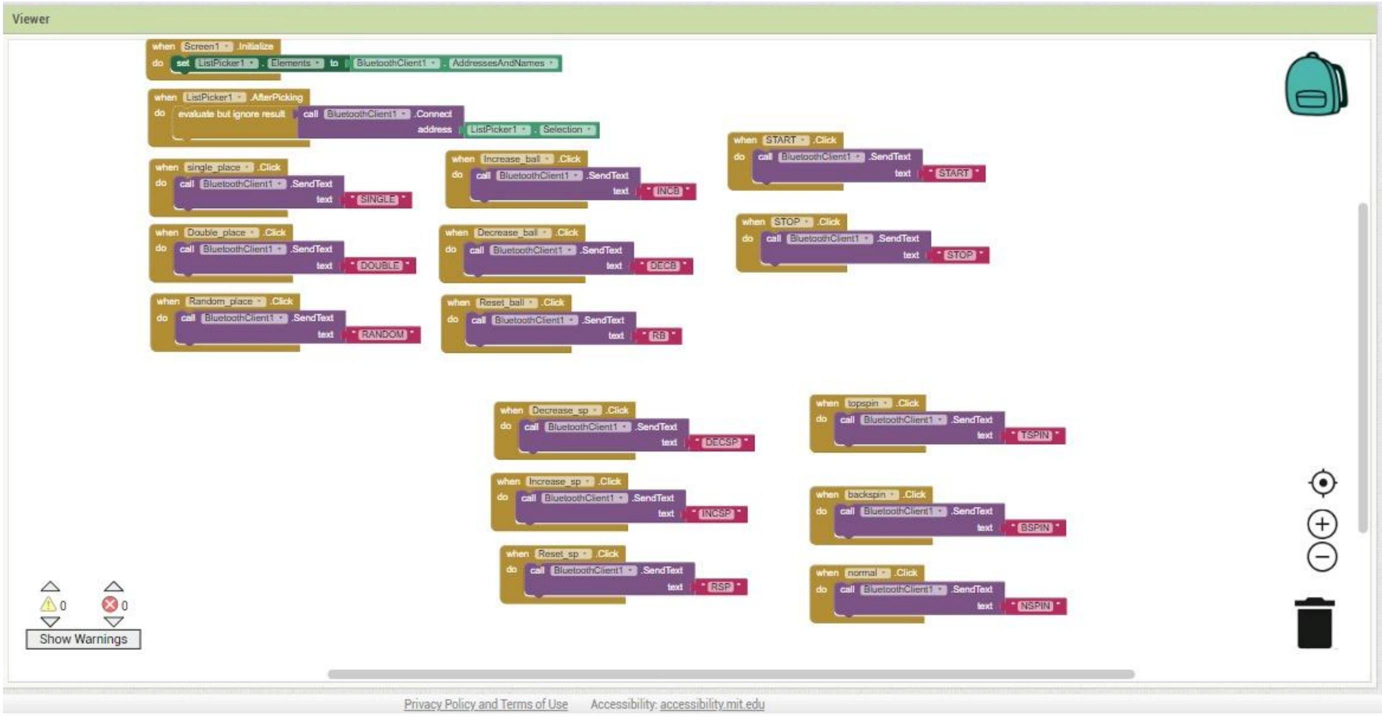

Figure 03: Architecture of Mobile App Development

III. SOFTWARE DESIGN

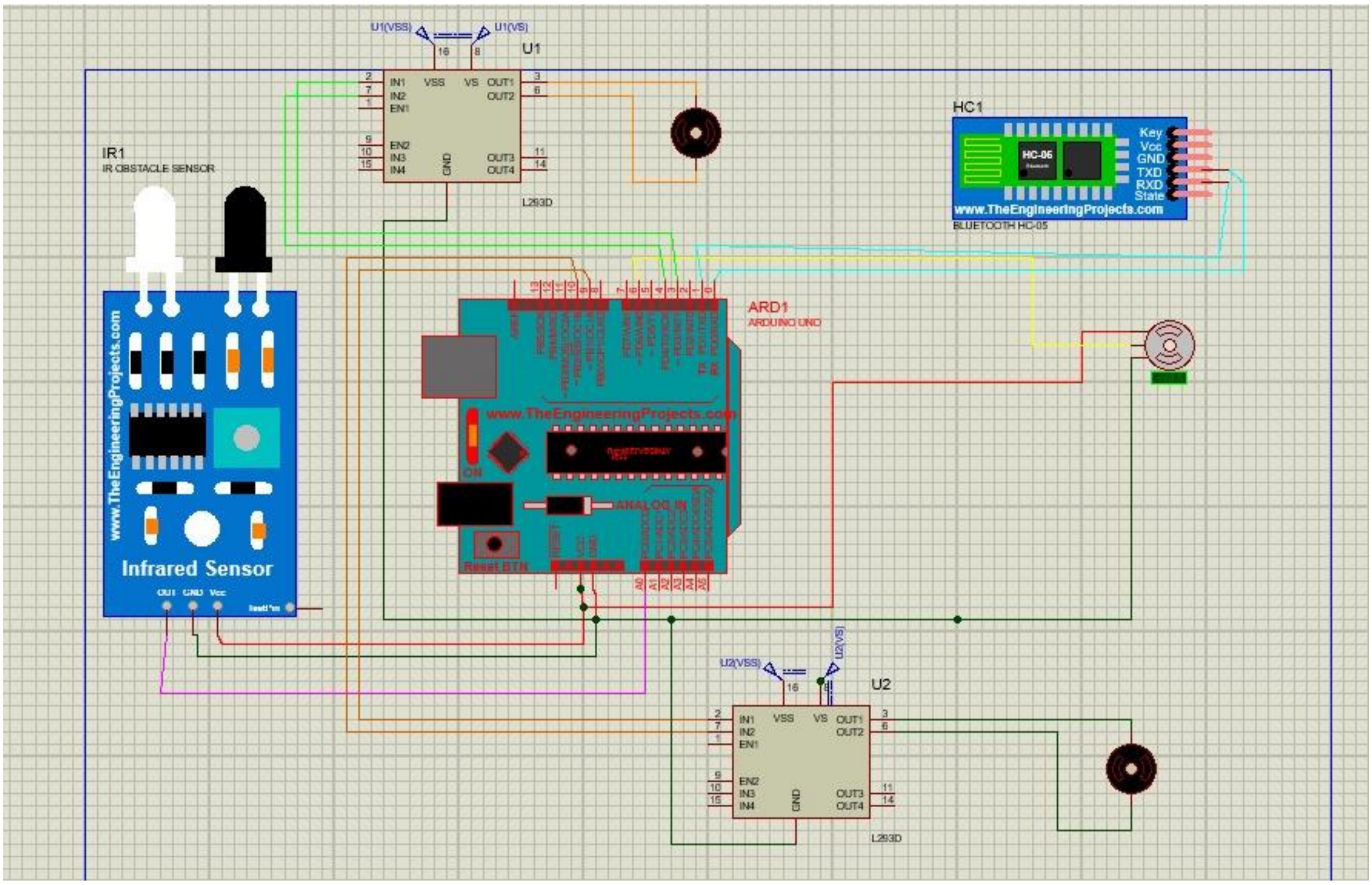

Figure 04: Simulation on Proteous Software

IV. IMPLEMENTATION

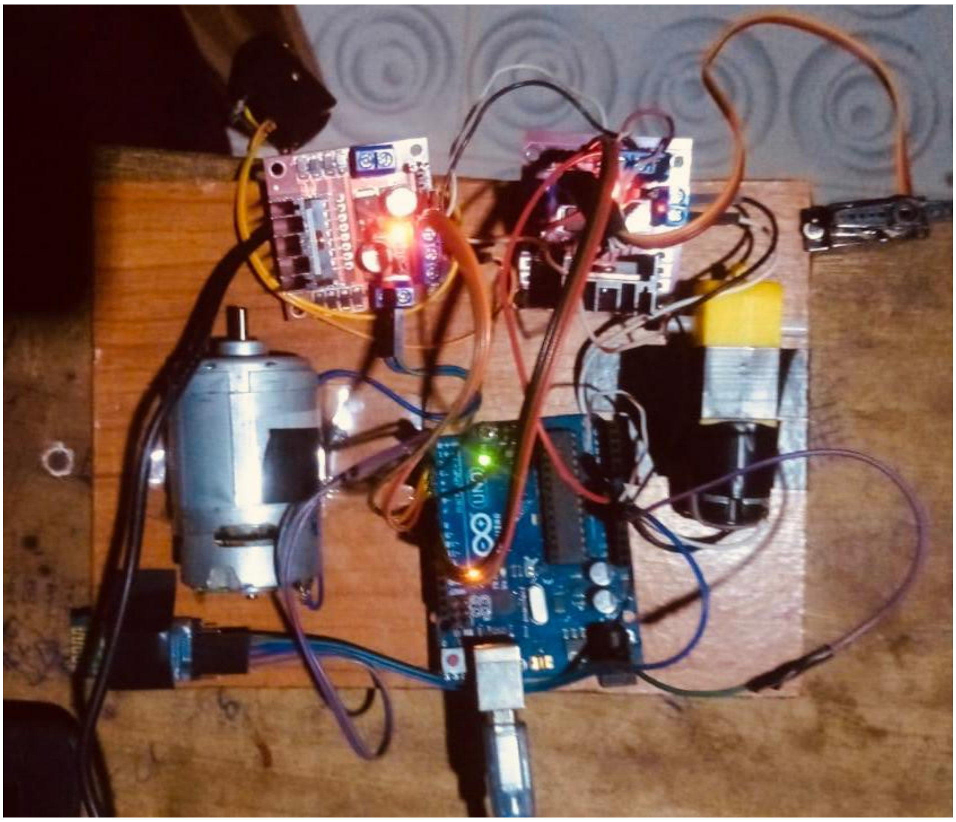

Figure 05: Implementation for electronic part

Figure 06: Implementation of physical structure

CHALLENGES AND SOLUTION

During the implementation of the Bluetooth-Controlled Table Tennis Serve Machine, we faced several challenges:

- **Component searching and finding:**
  Finding and searching the appropriate components for the machine proved to be a difficult task. The availability and compatibility of parts were major concerns, as we needed to ensure that each component would work seamlessly within the overall design.
- **Power management:**
  Managing power distribution among various components, such as the microcontroller, servo motors, and sensors was particularly challenging.
- **Physical testing constraints:**
  We faced constraint in testing the machine's performance without first constructing physical prototypes. This limitation made it difficult to predict how the machine would behave under real-world conditions based on theoretical calculations.
- **Environmental variable:**
  Factors such as wind speed, humidity, and ball material affect the machine's performance. These variables introduce complexity into the design process.

To address these challenges, we implemented following solutions:

- We conducted research to identify reliable suppliers and suitable components. Networking with industry professionals and leveraging online resources helped us locate the parts efficiently.
- We employed robust power management, including using voltage regulators and capacitors to stabilize power supply.
- By building and testing multiple prototypes, we were able to refine the design incrementally, addressing issues as they arise.
- To mitigate the impact of environmental variables, we conducted thorough testing under different conditions. This allowed us to calibrate the machine accurately.

TIMELINE

TASK		Time Duration for Week							
		1	2	3	4	5	6	7	8
1	Topic selection & feasibility study								
2	Project proposal								
3	Software simulation								
4	Sensor calibration								
5	Structural design								
6	Basic initial prototype design								
7	Physical design								
8	Final product design								
9	Final presentation								

COMPONENTS AND COST

NAME	QTY	PRICE
DC 550 (22000 rpm)	1	1000
Servo motor (SG90)	1	360*2
Tt motor(gear)	1	200
IR sensor	1	120
Potential meter (KY040)	3	180*3
Arduino mega, uno	1	--
L293d motor controller	1	520
Bluetooth Arduino module (HC-05 or HC-06)	1	1000
Buzzer module	1	140
Jumper wires	Male-male 10 Female-female10	--
Breadboard	1	--
Power supply 12v	1	--
Additional structure cost		1000
TOTAL	**5240/=**	

REFLECTION

The basic knowledge used for the design and implementation of the Bluetooth-Controlled Table Tennis Serve Machine.

- Deep understanding of electronics and microcontroller programming.
- Developing control algorithms and mobile application.
- Interfacing between the microcontroller, motors, and sensors.
- Managing the complexity of integrating various systems.
- Understanding power management, feedback control, and communication protocols.
- Managing environmental variables.
- Design methodology.

CONCLUSION

The Bluetooth-Controlled Table Tennis Serve Machine comprehensive effort that successfully faced the challenges players face in practicing serves independently. By enabling customizable parameters such as speed, spin, and placement via the mobile app, the machine offers a versatile training solution. The integration of a microcontroller with servo motors, sensors, and a user-friendly mobile app has made the machine both functional and accessible, catering to players of all skill levels.

This project allowed us to apply and integrate various concepts learned throughout our coursework. From hardware design and microcontroller programming to software development and systems integration, we utilized a multidisciplinary approach to bring the machine to life.

We faced and overcame several challenges, including sourcing compatible components, managing power distribution, and dealing with environmental variables that affect machine performance. These obstacles required innovative solutions and iterative testing, further developing our technical and adaptive skills.

In conclusion, the Bluetooth-Controlled Table Tennis Machine project has not only demonstrated our technical proficiency and ability to apply academic knowledge to real-world problems but also created a tool that can significantly enhance table tennis training. This project has the potential to improve player's skills and foster a deeper appreciation for this table tennis game.

REFERENCES

- https://www.mdpi.com/2075-4663/6/4/158
- https://www.mobile01.com/topicdetail.php?f=696&t=5867234
- https://web.ece.ucsb.edu/~yoga/courses/ECE153B/W2022/ProjectProposals/TableTennisBallMachine.pdf
- https://sites.google.com/view/ece-153b-ryan-niu-matthew-tran/home
- https://www.researchgate.net/publication/280557460_A_low_cost_automated_table_tennis_launcher
- https://youtu.be/FFnp2LKFhaU
- https://youtu.be/H-AwH7BTM5s
- https://www.researchgate.net/publication/367023322_DESIGN_OF_TABLE_TENNIS_BALL_FEEDER
- https://www.ijraset.com/research-paper/mobile-app-driven-smart-ball-launch-system
- https://www.researchgate.net/publication/377969059_mTTTbot_Multiple_Style_Table_Tennis_Trainer_Ball_Launcher_Robot
- http://eprints.usm.my/53622/1/ThreeWheel%20Table%20Tennis%20Ball%20Throwing%20Machine_Teo%20Shun%20Yang_E3_2018.pdf
- https://ai2.appinventor.mit.edu/#6673731233579008

APPENDIX

I. CODE

```
#include <Servo.h>

// Define pins for motors and servo
const int motorPin1 = 3;
const int motorPin2 = 4;
const int motorSpeedPin = 5;
const int servoPin = 6;

const int motorPin3 = 9;
const int motorPin4 = 10;
const int motorSpeedPin2 = 11;

const int irSensorPin = A0; // Analog pin connected to IR sensor output
const int threshold = 500;  // Adjust this threshold based on your sensor readings


int speed = 100;
int speedSq =100;
Servo myServo;

void setup() {
  // Initialize motor pins
  pinMode(motorPin1, OUTPUT);
  pinMode(motorPin2, OUTPUT);
  pinMode(motorSpeedPin, OUTPUT);
  pinMode(motorPin3, OUTPUT);
  pinMode(motorPin4, OUTPUT);


  // Initialize servo
  myServo.attach(servoPin);
  myServo.write(90); // Initialize servo to the neutral position
  randomSeed(analogRead(0));

  // Initialize serial communication
  Serial.begin(9600);
}


void loop() {
  if (Serial.available()) {
    String command = Serial.readStringUntil('\n');

    if (command == "START") {
      // Start motors speed dc
      digitalWrite(motorPin1, HIGH);
      digitalWrite(motorPin2, LOW);
      analogWrite(motorSpeedPin, speed);

      //Start motors sequence dc
      digitalWrite(motorPin3, HIGH);
      digitalWrite(motorPin4, LOW);
      analogWrite(motorSpeedPin2, speedSq);

      //SERVO SET 0
      moveServoToAngle(90);
      delay(1000);
```

```
  } else if (command == "STOP") {
    // Stop both motors
    digitalWrite(motorPin1, LOW);
    digitalWrite(motorPin2, LOW);

    digitalWrite(motorPin3, LOW);
    digitalWrite(motorPin4, LOW);

    moveServoToAngle(90);
    delay(1000);

  } else if (command == "INCSP") {
    // Increase speed
    speed = min(255, speed + 20);
    analogWrite(motorSpeedPin, speed);
  } else if (command == "DECSP") {
    // Decrease speed
    speed = max(0, speed - 20);
    analogWrite(motorSpeedPin, speed);
  } else if(command == "RSP"){
    speed = 100;
    analogWrite(motorSpeedPin, speed);

    //*****************
  }else if(command == "INCB"){
    speedSq = min(255, speedSq + 20);
    analogWrite(motorSpeedPin2, speedSq);
  }else if(command == "DECB"){
    speedSq = max(0, speedSq - 20);
    analogWrite(motorSpeedPin2, speedSq);
  }else if(command == "RB"){
    speedSq = 100;
    analogWrite(motorSpeedPin2, speedSq);
  //*********


  }else if (command == "FHAND") {
    // Set servo to single position F
    moveServoToAngle(0);
    delay(500);
    moveServoToAngle(65);
  } else if (command == "BHAND") {
    // Set servo to single position F
    moveServoToAngle(0);
    delay(500);
    moveServoToAngle(110);
  }else if (command == "MID") {
    // Set servo to single position F
    moveServoToAngle(0);
    delay(500);
    moveServoToAngle(90);
```

```
    } else if (command == "RANDOM") {
      randomMode();
    }
  }
}

void moveServoToAngle(int angle) {
  Serial.print("Moving servo to ");
  Serial.print(angle);
  Serial.println(" degrees");

  myServo.write(angle);  // set the servo position
}


void randomMode() {
  bool randomMode = true;  // Variable to control the random mode

  while (randomMode) {
    int sensorValue = analogRead(irSensorPin); // Read analog input from IR sensor
    Serial.println(sensorValue);               // Print sensor value for debugging

    // Check if ball is detected
    if (sensorValue < threshold) {
      // Move servo to a random angle between 65 and 115
      int randomAngle = random(65, 115);
      moveServoToAngle(randomAngle);
      Serial.print("Moved to angle: ");
      Serial.println(randomAngle);
```

```
      // Wait until ball is no longer detected
      while (analogRead(irSensorPin) < threshold) {
        delay(10); // Short delay to avoid rapid rechecking
      }
    }

    // Check for stop command
    if (Serial.available() > 0) {
      String command = Serial.readStringUntil('\n');
      if (command == "STOP") {
        randomMode = false;  // Exit random mode when 'STOP' is received
      }
    }

    delay(10); // Delay for stability
  }
}
```

II. POSTER


BLUETOOTH-CONTROLLED TABLE TENNIS SERVE MACHINE
Unlock Your Ping-Pong Potential
ORDER NOW!
PROBLEM
Practicing table tennis serves alone can be difficult, as players often struggle to maintain consistency variety in their practice session.
Without training partner to provide feedback and variations in serves, players may find challenging to improve their skills effectively.
SOLUTION
Developed a solution, "BLUETOOTH-CONTROLLED TABLE TENNIS SERVE MACHINE".
This can automatically serve table tennis balls with adjustable parameters such as speed, spin, and placement.
It can create a wide range of serve types.
KEY FEATURES
Bluetooth Connectivity
Customizable Settings via Mobile
Automated Ball Feeding
Durable
Light weight Design
START
STOP
BENIFITS
Can improve your reaction time and shot selection.
Can develop your serve skills with consistent, reliable ball delivery.
Can enjoy endless practice sessions without the need for a playing partner.
Can bring the table tennis court to any location.
COMPONENTS
DC 550 (22000 RPM)
Servo motor (SG90)
Tt motor (gear)
IR sensor
Potential meter (KY040)
Arduino mega, uno
L293d motor controller
Bluetooth Arduino module (HC-05 or HC-06)
Buzzer module
12V power supply
TECHNICAL SPECIFICATIONS
Serving speed range
20 km/h – 35 km/h
Ball capacity
6
100 balls
Dimensions and weight
Height -1.5 feet
1 x 1 feet
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