

# **PROTOTYPING- SS25**

## **Line Follower Robot**

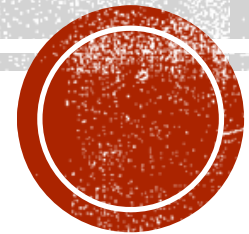
**By**

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Faysal Ahammed Tonmoy

Md Ratul Ahmed Alvi

Soaib Ferdous



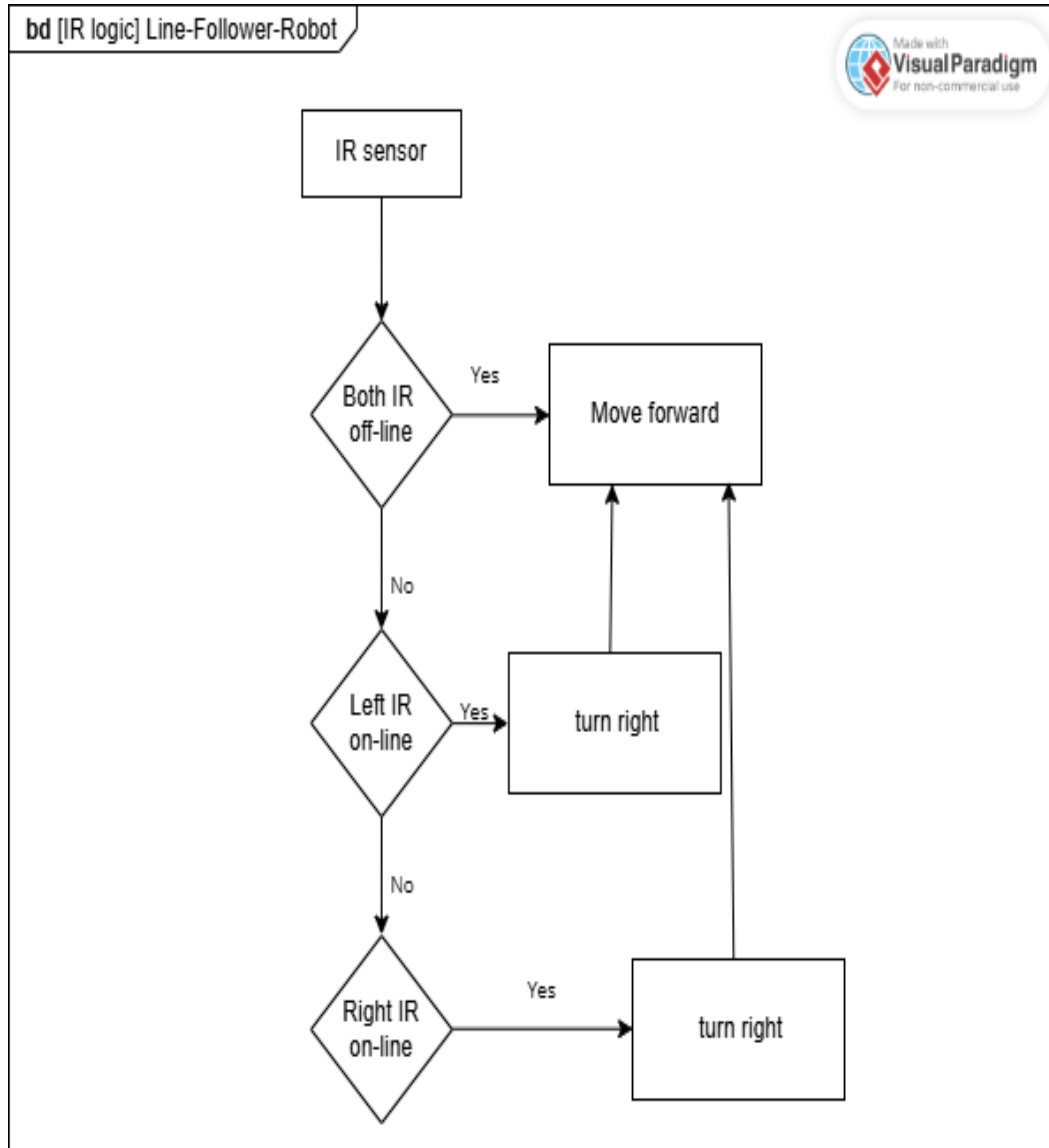
# PROJECT OVERVIEW

- Building Line Follower Robot powered by Arduino
- Equipped with ultrasonic sensors for detecting obstacles
- Follows black lines using infrared (IR) sensors
- Detects object colors using a color recognition sensor
- Driven by dual DC motors for smooth movement
- Includes a servo motor to help remove or bypass obstacles

Goal: To showcase intelligent navigation, smart obstacle detection and avoidance, color-based decision making, and adaptive robotic behavior using sensors and actuators.

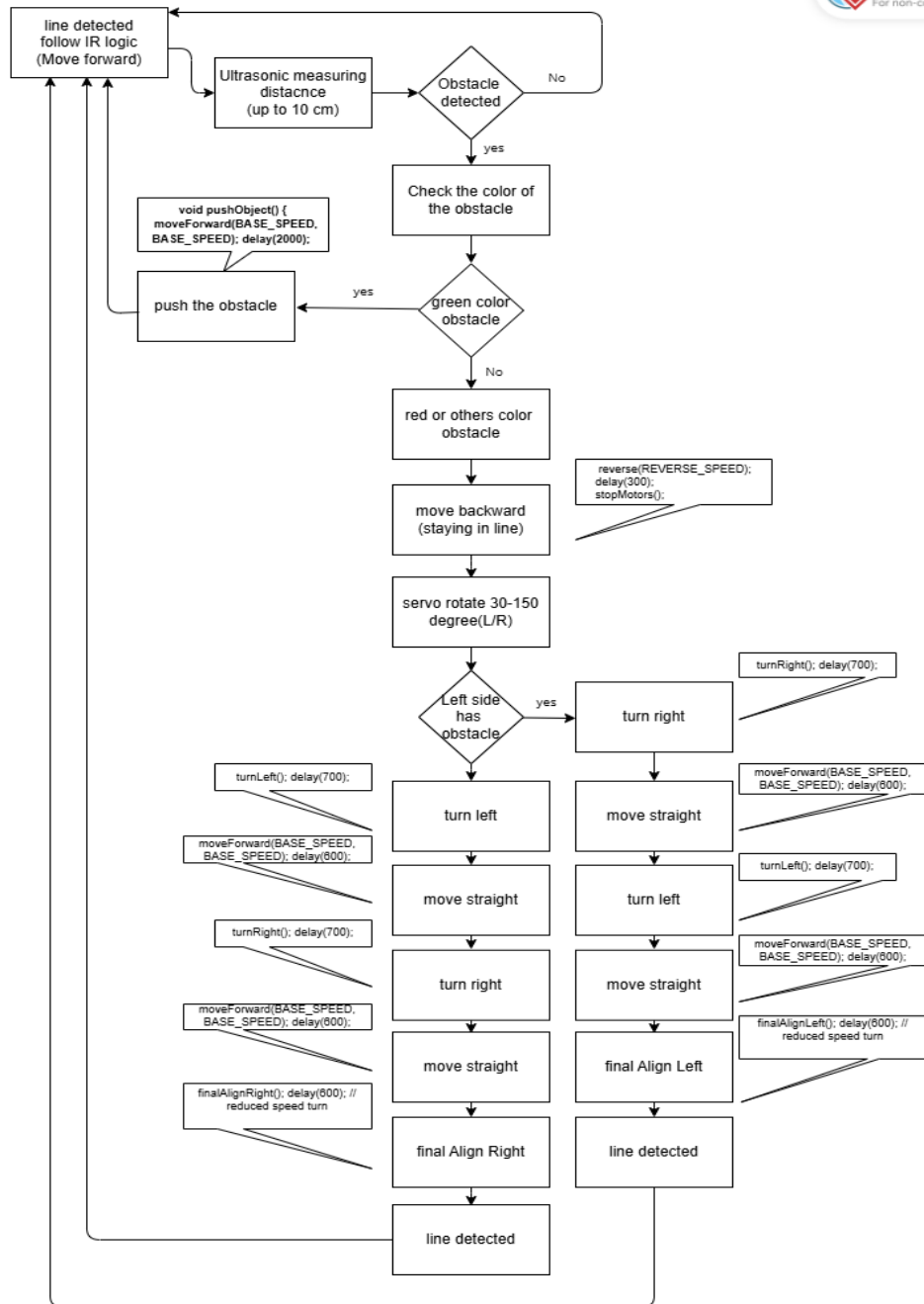


## Block Diagram and IR sensor's logic:



```
167 void executeLineFollowing() {
168     if (!leftOnLine && !rightOnLine) moveForward(BASE_SPEED, BASE_SPEED);
169     else if (leftOnLine && !rightOnLine) rightSensorReliable ? turnRight() : gentleTurnRight();
170     else if (!leftOnLine && rightOnLine) turnLeft();
171     else moveForward(BASE_SPEED * 0.6, BASE_SPEED * 0.6);
172
173     if (!rightSensorReliable && leftOnLine)
174     |   moveForwardWithBias(BASE_SPEED, 0.8, 1.0);
175 }
```





```

63 void loop() {
64     unsigned long currentTime = millis();
65     int distance = readDistance();
66
67     if (distance > 0 && distance <= OBSTACLE_DISTANCE_THRESHOLD) {
68         stopMotors(); delay(300);

```

```

String getDetectedColor() {
    if (redFrequency < greenFrequency && redFrequency < blueFrequency) return "Red";
    if (greenFrequency < redFrequency && greenFrequency < blueFrequency) return "Green";
    if (blueFrequency < redFrequency && blueFrequency < greenFrequency) return "Blue";
    return "Unknown";
}

```

```

readColor();
String color = getDetectedColor();
if (color == "Green") {
    pushObject(); // push if green
} else {
    reverse(REVERSE_SPEED); delay(300);
    stopMotors();
    ...
}

```

```

230 void pushObject() {
231     moveForward(BASE_SPEED, BASE_SPEED); delay(2000); // updated from 1000 to 2000
232     stopMotors(); delay(500);
233 }

```

```

90     if (distLeft > distRight) {
91         turnLeft(); delay(700);
92         moveForward(BASE_SPEED, BASE_SPEED); delay(600);
93         turnRight(); delay(700);
94         moveForward(BASE_SPEED, BASE_SPEED); delay(600);
95         finalAlignRight(); delay(600); // reduced speed turn
96     } else {
97         turnRight(); delay(700);
98         moveForward(BASE_SPEED, BASE_SPEED); delay(600);
99         turnLeft(); delay(700);
100        moveForward(BASE_SPEED, BASE_SPEED); delay(600);
101        finalAlignLeft(); delay(600); // reduced speed turn
102    }
103    stopMotors();
104    return;
105 }
106 }

```

```

235 void finalAlignRight() {
236     digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW); analogWrite(ENA, 60);
237     digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH); analogWrite(ENB, 60);
238 }

```

```

239
240 void finalAlignLeft() {
241     digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH); analogWrite(ENA, 60);
242     digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW); analogWrite(ENB, 60);
243 }

```



# MODEL-WISE CODE EXPLANATION

## ➤ IR Sensor Code for following the line:

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/IR%20Sensor%20Code%20for%20following%20the%20line%3A>

## ➤ Color Sensor Code:

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/Color%20Sensor%20Code%3A%20RGB>

## ➤ Ultrasonic Sensor Code:

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/Ultrasonic%20Sensor%20Code%3A>

## ➤ Servo Code:

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/4.%20Code%20for%20servo%20motor>



# MODEL-WISE CODE EXPLANATION

## ➤ Line Following Robot: Line Tracking + Smart Obstacle Bypass

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/6.%20Line%20Following%20Robot%3A%20Line%20Tracking%20%2B%20Smart%20Obstacle%20Bypass>

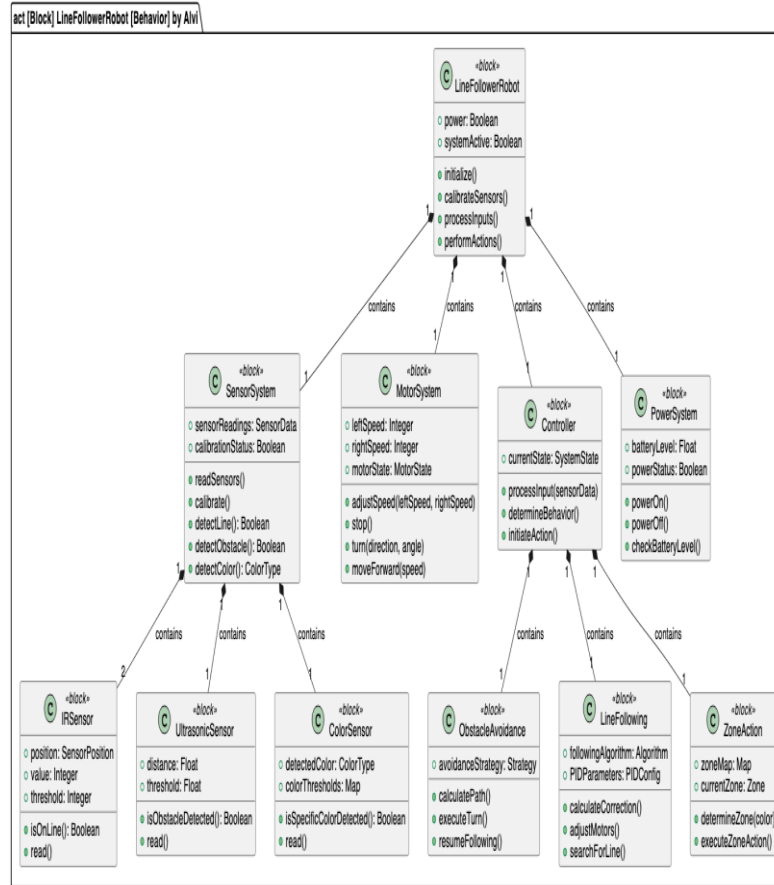
## ➤ Line Following Robot with Line, Obstacle, and Color Sensing

<https://github.com/alvi231078/D2---Line-Follower-Robot/blob/main/Main%20Code/Code%20for%20presentation/7.%20Line%20Following%20Robot%20with%20Line%2C%20Obstacle%2C%20and%20Color%20Sensing>



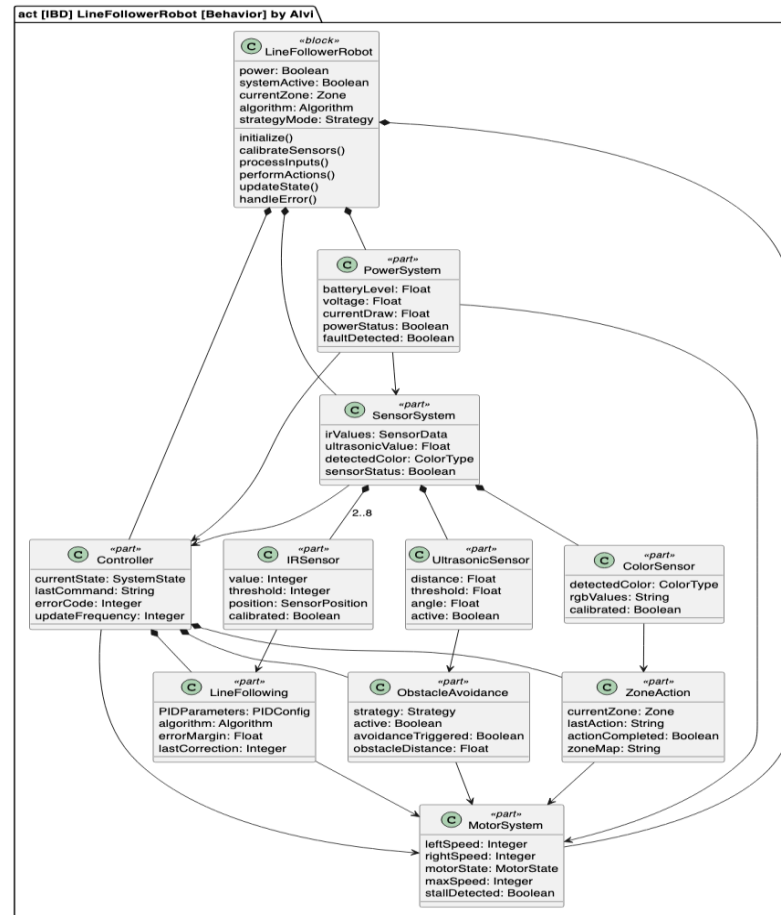
# SYSTEM MODELING USING SYSML

bdd [Block Definition Diagram] LineFollowerRobot by Alvi



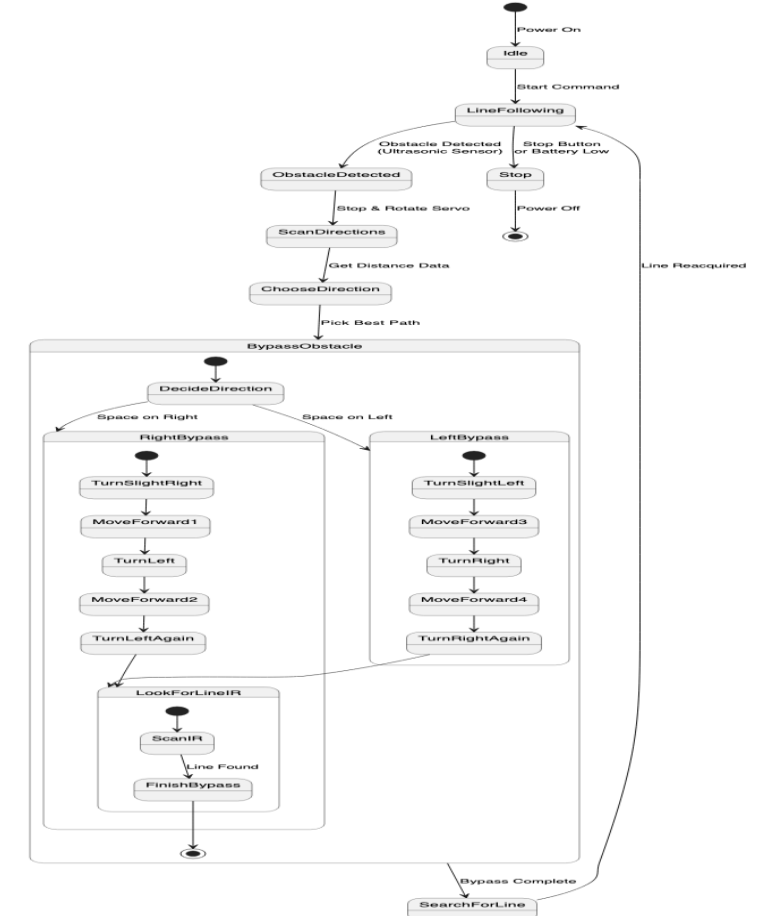
Block Definition Diagram

IBD [Internal Block Diagram] LineFollowerRobot by Alvi



Internal Block Diagram

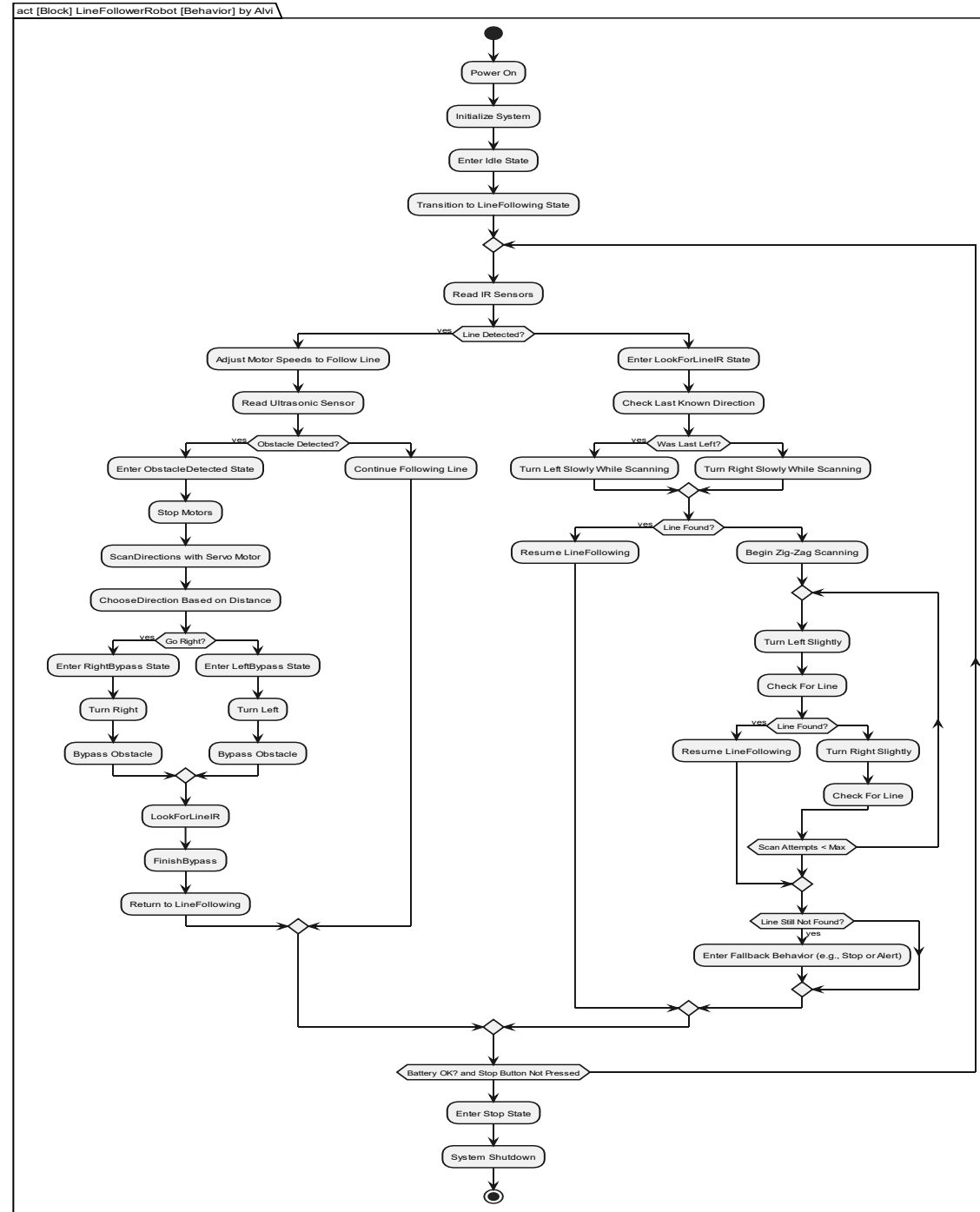
Line Follower Robot - State Machine Diagram by Alvi



State Machine Diagram



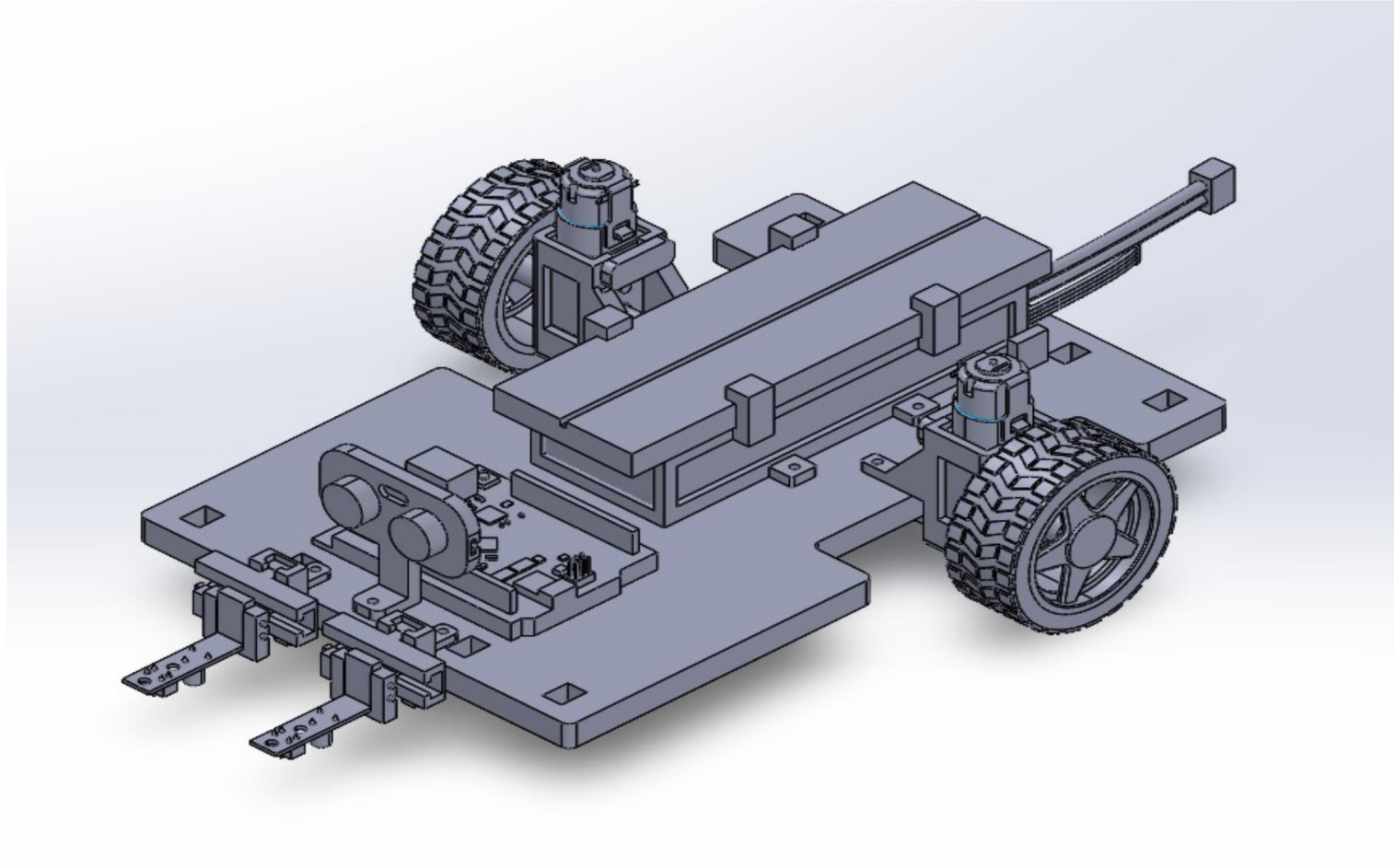
To understand the behaviour:





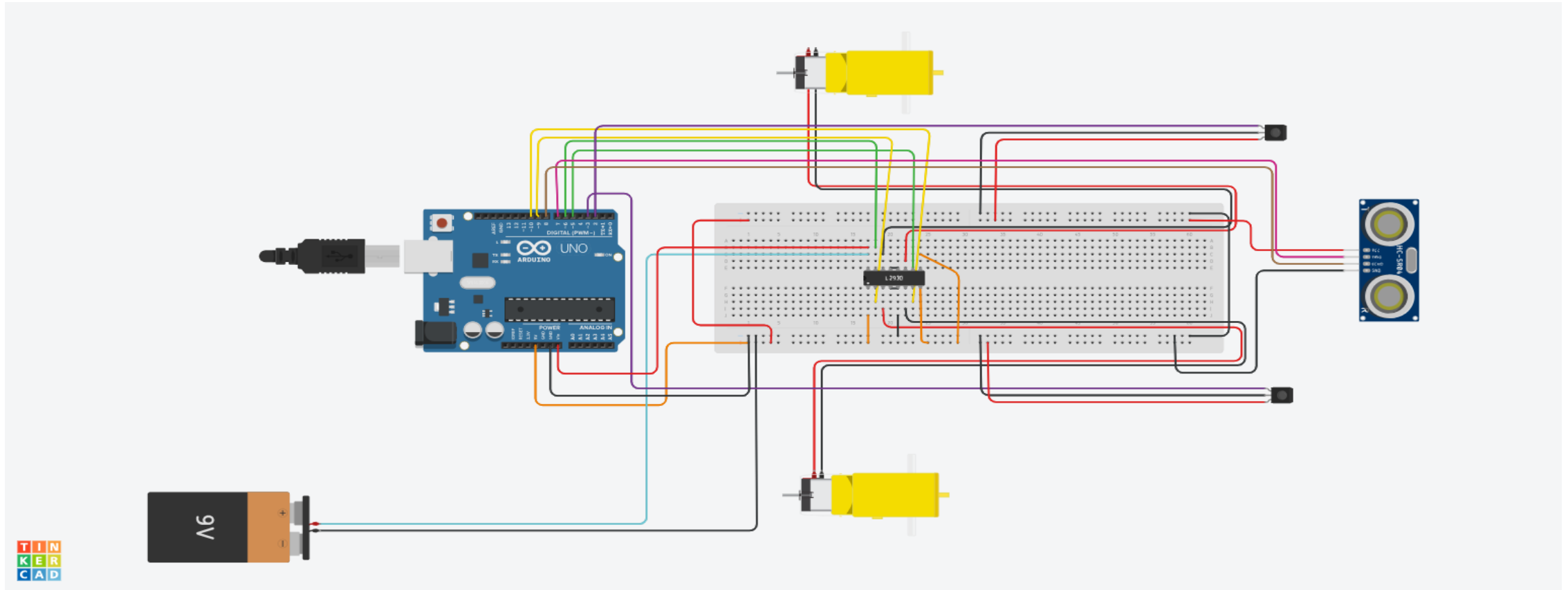
# PROTOTYPING & DESIGN

## ➤ Physical Design (SolidWorks)



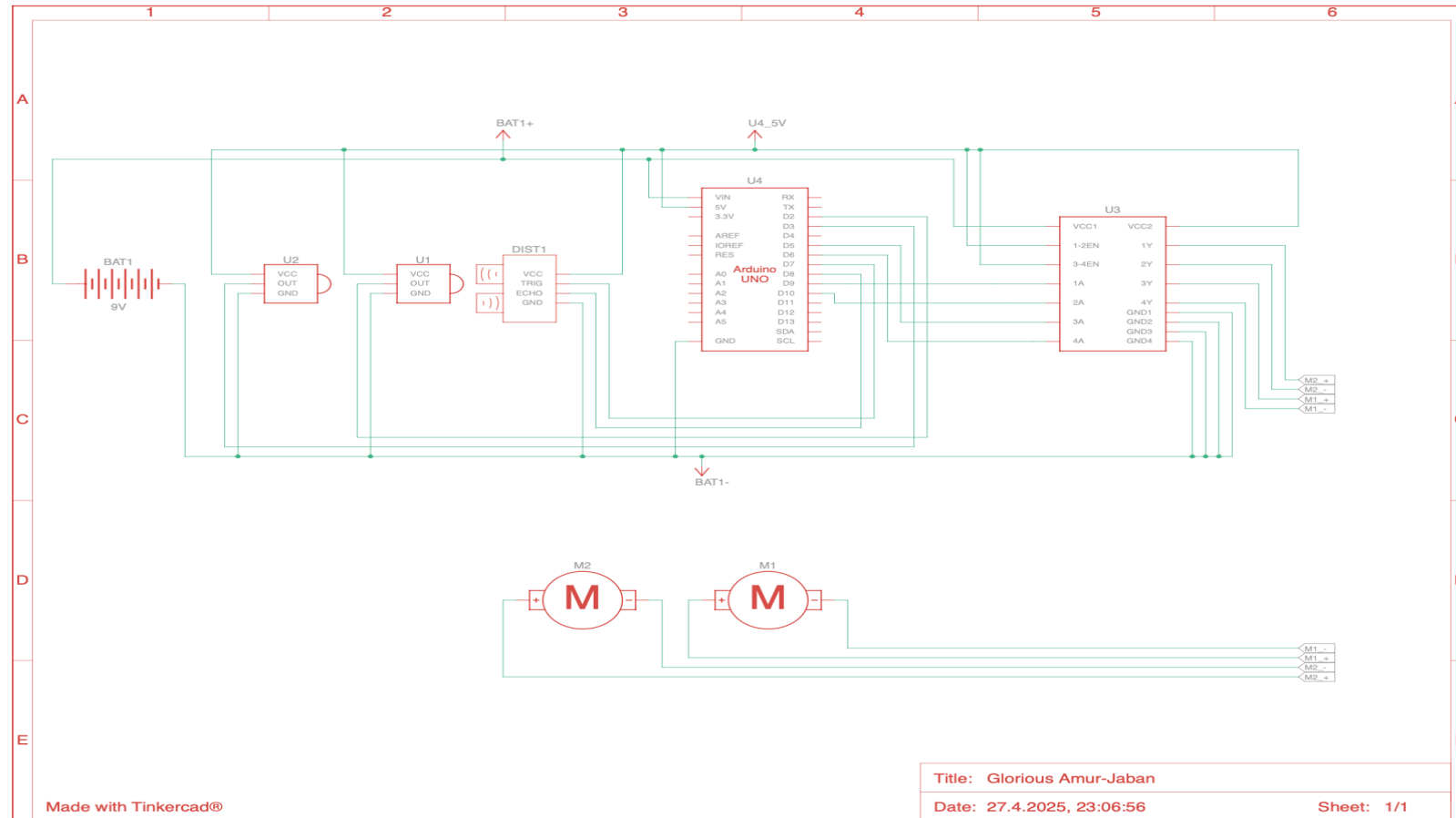
# PROTOTYPING & DESIGN

## ➤ Virtual Prototypes (TinkerCad)



# CIRCUIT DESIGN

## ➤ Sensor & Motor Wiring and Complete Circuit Layout



## Sensors:

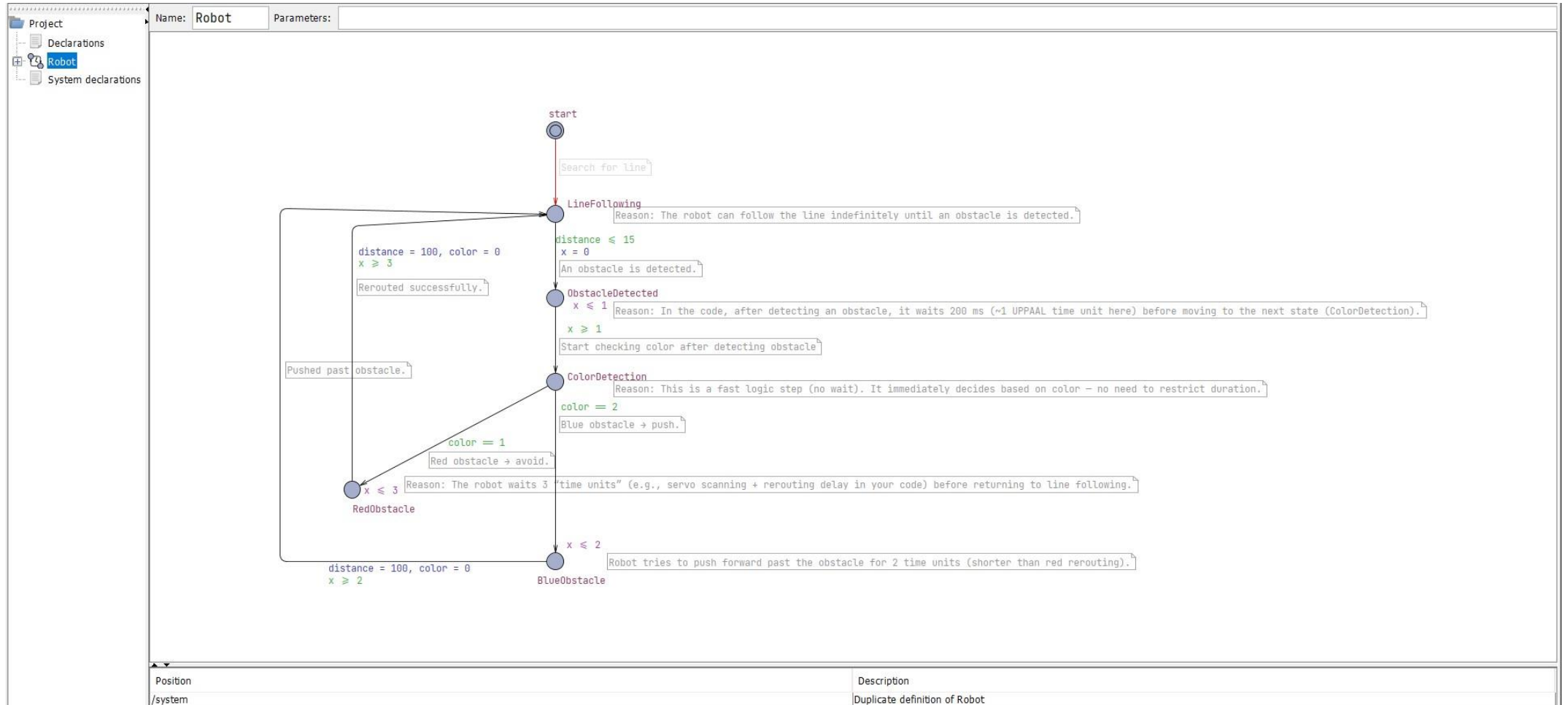
1. Line Tracking IR Sensor
2. Ultrasonic Sensor
3. Color Sensor

## Circuit Layout



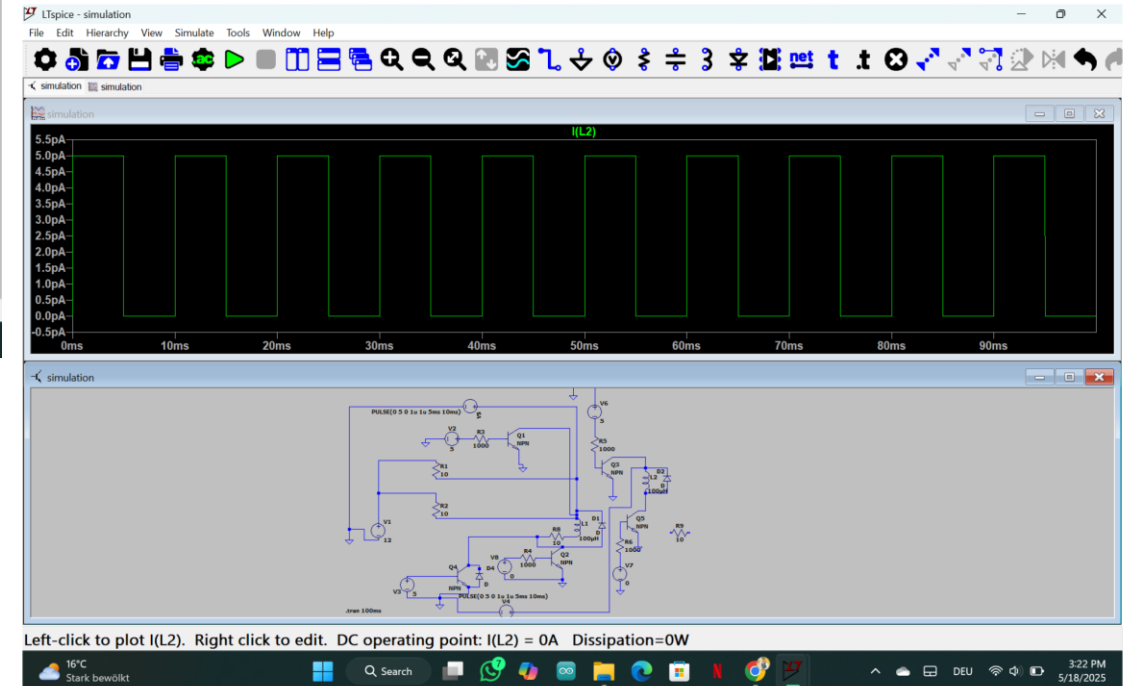
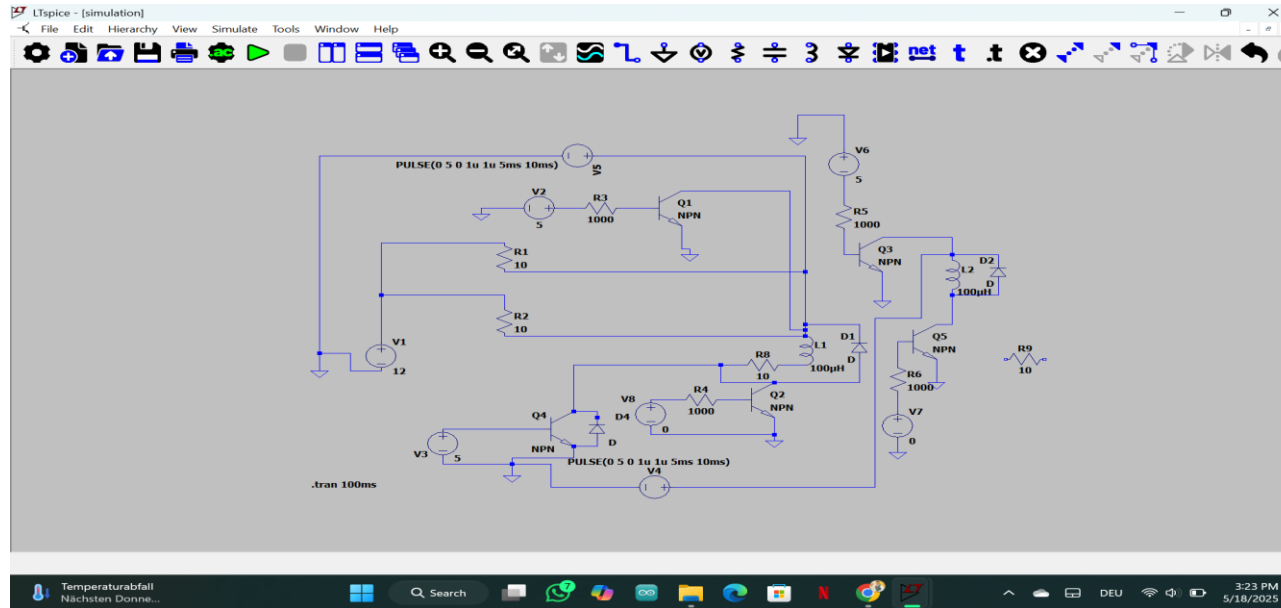
# SOFTWARE IMPLEMENTATION

## ➤ UPPAAL Timed Automata



# SOFTWARE IMPLEMENTATION

## ➤ LTspice Circuit Simulation



# PROOF OF CONCEPT: VIDEO

- <https://youtu.be/kWiVvY1VcH8?si=XqXR6bjObIauFDW2>



# KEY ACHIEVEMENTS AND CONCLUSION

## Collaborative Outcomes:

Integrated Multi-Sensor System

Autonomous Navigation

Robust Embedded Design

Applied SysML & UML Thinking

Design Principles Used

This project showcases an autonomous embedded system combining line tracking, obstacle avoidance, and color-based decisions forming a foundation for future intelligent robotics.

