Spring 2025

Yeditepe University
Mechanical Engineering Department

ME 456

Mechatronics

Workshop #4

Autonomous Navigation on Dohyo

FINAL REPORT

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Due Date: 15/05/2025   Group Number: 5

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1. Three Main Behaviours

This section explains the strategy and behaviors developed for the ME456 Mechatronics project. Three fundamental behavior modes were defined based on sensor feedback: **Search**, **Attack**, and **Evade**.

***Search**:* The robot activates this mode at startup, scanning for targets using distance sensors. It rotates around its axis following a predefined path, acting like a dynamic radar. To improve detection accuracy, multiple sensors can be used to measure distance data across XY coordinates. This behavior is similar to what was implemented in Workshop Assignment 2.

Attack: Once a target is detected, the robot moves toward it with full engine power, aiming to push it out of the dohyo. Since the target may also move, a dynamic orientation strategy is needed. For this, the triangulation method with two angled sensors—previously tested in Workshop 3—is used. These sensors calculate the real-time position of the target, guiding the motors accordingly.

Evade: To comply with competition rules, the robot must remain within the black dohyo and initiate an escape maneuver upon detecting a white line. This response is triggered both when approaching the line and when pushed by an opponent. The direction of the maneuver depends on which sensor detects the white area.

- **Front sensors (1–2):** Reverse and rotate 180°
- **Rear sensors (3–4):** Move forward to return inside
- **Side sensors (1–3 or 2–4):** Accelerate forward and steer away from the line.

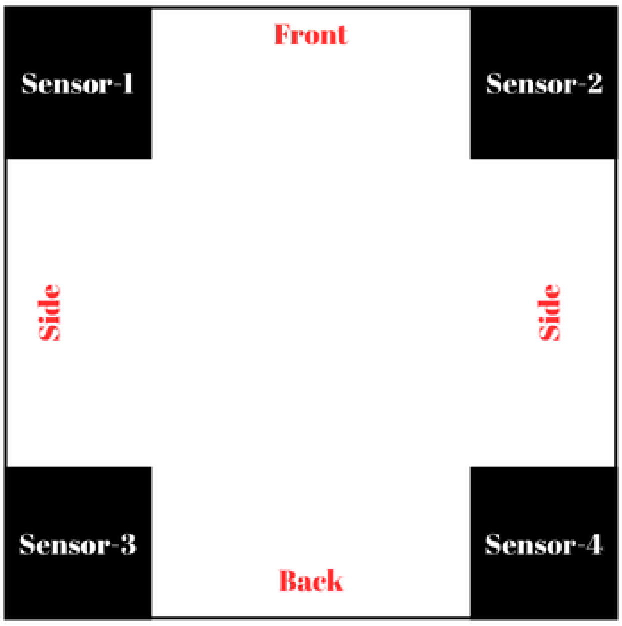

Figure 1: Sample sensor locations

2. Finite State Machine Approach

Under this heading, it is explained what kind of prioritizations and transitions the vehicle will provide in terms of different task behaviors. It has been determined that each behavior has a different importance in terms of the competition and that a priority order should be created considering this situation. It has been determined that the main purpose of the competition is to stay in the dohyo in the first stage and then to detect the target and perform an attack. The following task diagram has been prepared by taking this priority order as a reference.

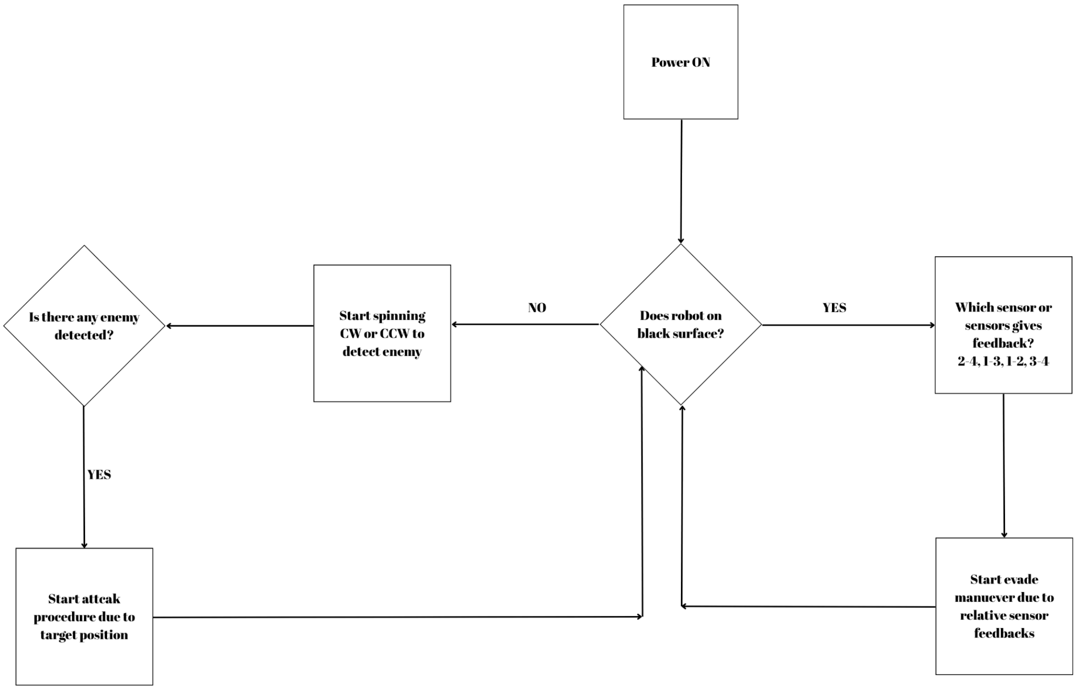

Figure 2: Diagram of behavioral strategy

3. Results

The robot's three main behaviors (search, attack, evade) were successfully implemented. Tests were conducted approximately 5-10 times under controlled conditions on the platform, and it was observed that the system operated consistently in each trial.

Figure 3: In these two photos, the mini-robot is performing the search task by rotating around its own axis to scan for a target.

Figure 4: In these two photos, the mini-robot is executing the **attack** task by pushing the object out of the platform.

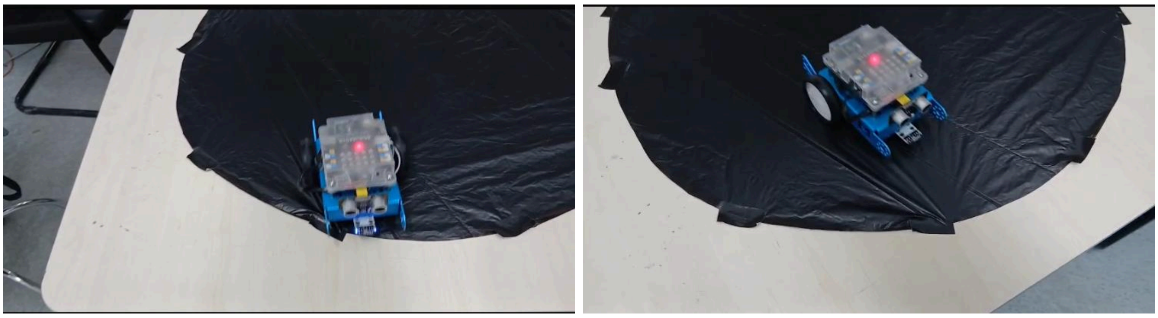

Figure 5: In these two photos, the mini-robot is performing the **evade** task by avoiding the edge of the platform.

4. Discussion

In this project, we used a finite state machine (FSM) to control the robot with three main behaviours: search, attack and evade. Each behaviour changes based on sensor feedback. At first, robot worked fine during basic tests, but we had some issues especially with edge detection and evasion.

The problem is mostly because not enough sensors are used. When robot goes close to the edge (white line), it doesn't know exactly which direction it's going out. Because of this, it sometimes makes the wrong escape or reacts too late. To solve this, we planned to add 4 sensors, one placed on each corner of the robot. So if a specific sensor detects the line, robot will understand from which side it's exiting and can do a different escape movement. Like, if front side sees the line, it goes back and turns. If the back sees it, it goes forward. We already prepared these 4 movements for each side.

Another issue is some needed parts are not available in Türkiye. That's why we're planning to change the control board to Arduino. Arduino is more flexible and easier to use with many sensors, and we can find more coding examples for FSM on Arduino IDE.

Right now, the FSM logic works and behaviour transitions are done correctly. We're still testing with the current setup. After the new sensors arrive and we complete the connections, we'll test the full behaviour set including direction-based evasion.