Picomouse team project

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October 20, 2024

1 General overview

The objective of this project is to design an autonomous vehicle (the "mouse") that first explores a labyrinth to find a solution, and then uses that solution to navigate the maze as quickly as possible without crashing. The process involves two phases: exploration and optimized maze-solving.

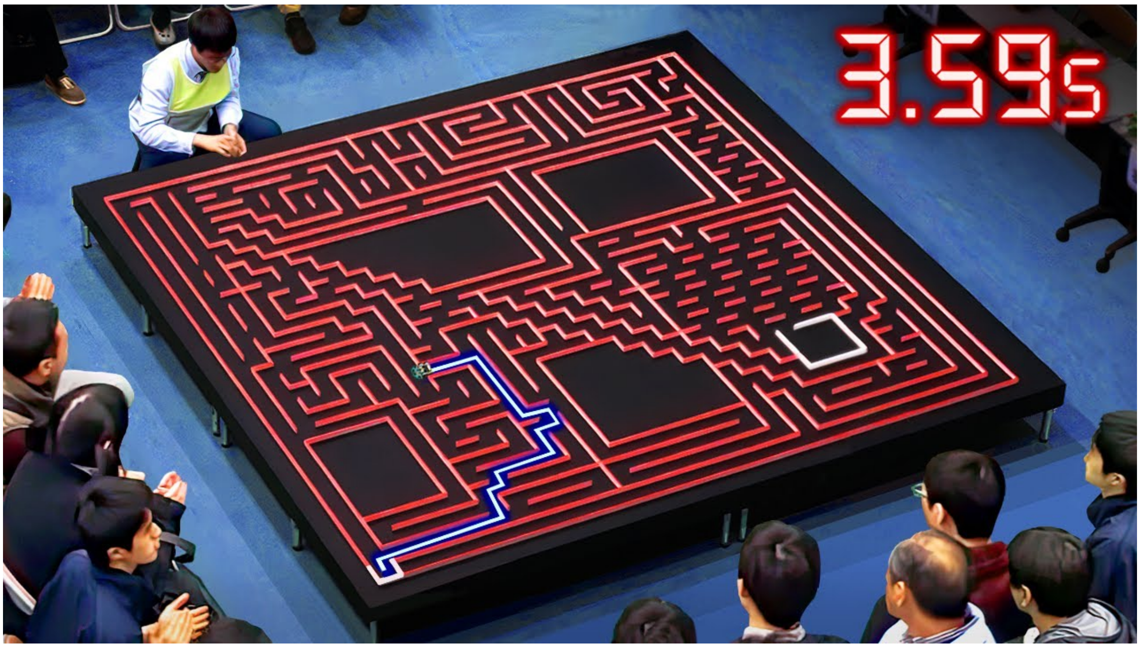


Figure 1: "Veritasium" Youtube miniature representing the japanese IEEE micromouse contest

2 Hardware side

The primary hardware challenges involve situating the mouse within the maze, given that the solution is always located at the center in competition settings. This can be achieved using time of flight sensors to determine the distance of the mouse from the walls. We plan to have 2 different TOF sensors. 1 for long-distance sensing (up to 2 meters) and 4 others for short distance sensing (down to 5mm) which will be used to ensure that the mouse is centered on the path and that it stops at the correct distance from the wall before turns. The 4 sensors would be placed to the side of the mouse to be able to assess it's surrounding and the long distance sensor would be placed straight ahead to help us with a general sense of position 2.

Another challenge is ensuring the mouse makes precise turns. we plan to use gyroscopes to achieve the highest possible degree of angular accuracy. To optimize the mouse's path, an advanced (optional) feature could be to allow turns other than the standard 90 degrees. This would improve efficiency, especially in more complex mazes, and is one of the key technological advancements in the official IEEE Micromouse competition.

Seeing how important the gyro is to our project, we looked for the best fitting gyroscope we could find, the one we chose has minimal drift issues (integrated filters) which will streamline the coding process for us reducing our workload. And it has a very good refresh rate which will insure precision in the mouse's movements especially if we want to make continuous turns without stopping the mouse at every corner.

Building the mouse is another challenge, fortunately we don't need to design it from scratch there exists numerous designs online which we used as inspiration.

2.1 Classic Micromouse (Maze-Solving)

- Maze Dimensions: 16x16 grid, each cell measuring 18 cm x 18 cm. (approx $9m^2$)
- Path Width: 16 cm between the walls.
- Wall Height: 5 cm.

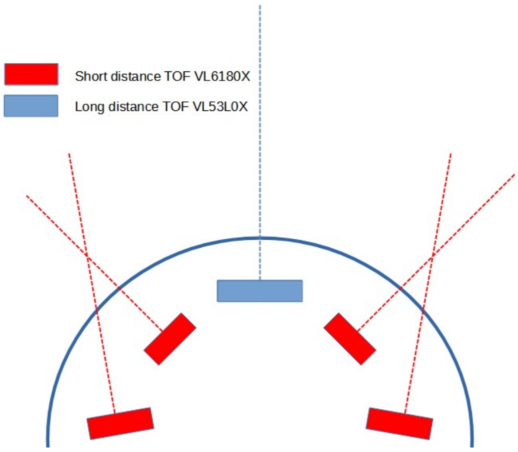


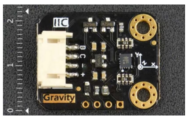
Figure 2: Captors layout

3 Software side

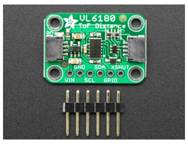
The primary software challenge is fitting everything into the microcontroller, as the mouse must operate autonomously. We plan to use established maze-solving algorithms, such as the Flood Fill algorithm, during the exploration phase. This algorithm allows the mouse to follow an optimistic path toward the center and updates the path as it encounters obstacles. Once the mouse reaches the center, it can refine its path and store it as the solution. Although this approach may not guarantee the shortest path, we can run the algorithm in reverse, from the center to the starting point, to increase the likelihood of finding an optimal path. Another software challenge lies in processing data from the TOF sensors and gyroscopes to ensure accurate turns and avoid frequent collisions. This aspect is less clear at the moment and will likely be the primary focus of troubleshooting during the project. We want to use the Bluetooth capacity of our ESP-32 to help us debug and log the mouse's actions. The idea would be to have the mouse send it current position in the maze, the sensor data and the algorithm state. Optionally we could make this data apparent in real time with a nice UI. We decided to take an ESP-32 with 2 threads, one that will operate the mouse and polling the captors and the other to send the data to the external computer over Bluetooth.

4 Components

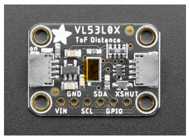
4.1 Sensors



(a) DFRobot Gravity I2C BMI160



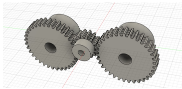
(b) VL6180X short distance TOF



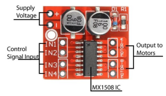
(c) VL53L0X long distance TOF

4.2 Motor

(a) 16DCT Athlonix Brush DC 6v



(b) Gears



(c) Motor controller MX1508

4.3 Mouse

(a) ESP32-E (N16R2)

(b) LIPO 2s 7.4V

(c) LIPO 2s 7.4V

See listed components with price: link

5 Risk assessment

- Can we design a mouse smaller than 10cm (11cm is the width of a diagonal)?
- Having enough energy density in the lithium batteries, small enough, light enough.
- Will the combination of the captors be reactive enough, to be precise in our mouvement (stopping at the right distance from walls, being accurate in our turns)?
- Will the maze build quality be good enough to not hinder the mouse's mouvement (floor leveling, parallel walls, grip)?
- Will we manage to calibrate the gyroscope (the goal is to make the mouse autonomous in keeping it's orientation)?
- Find a way to put the center of mass to maximize the adherence.
- Will the mouse be solid enough to sustain the many fails we will encounter in testing without irreversible damage?