DMT Final Report

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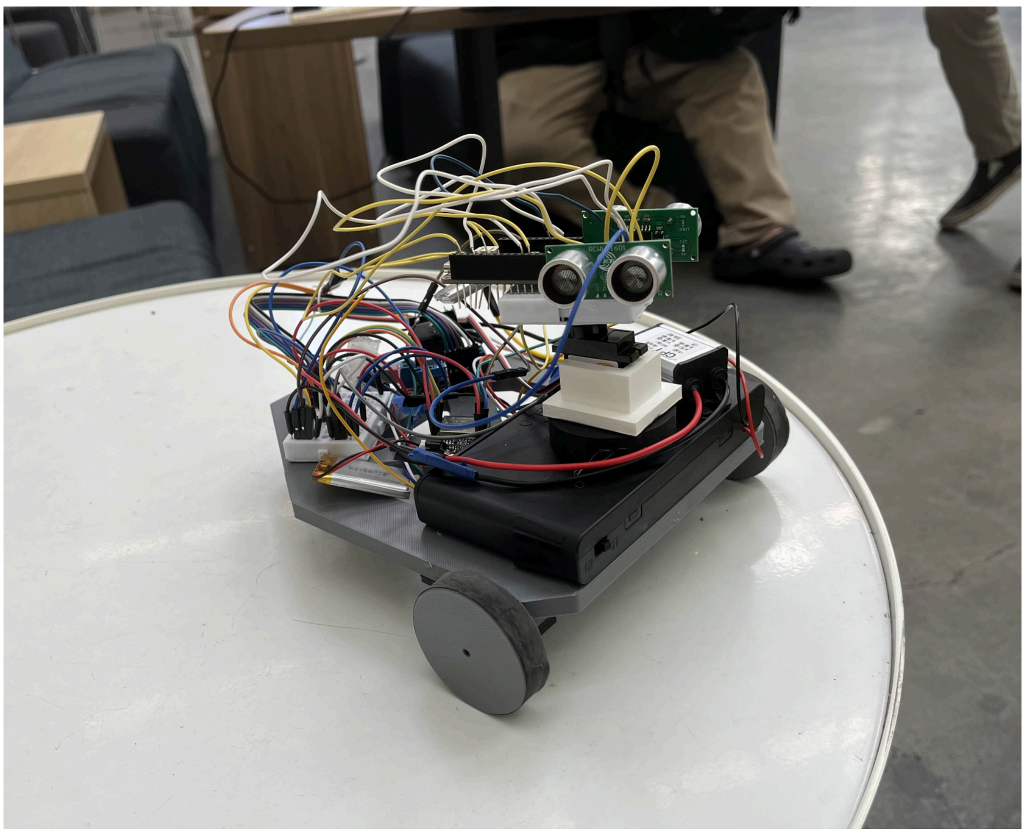

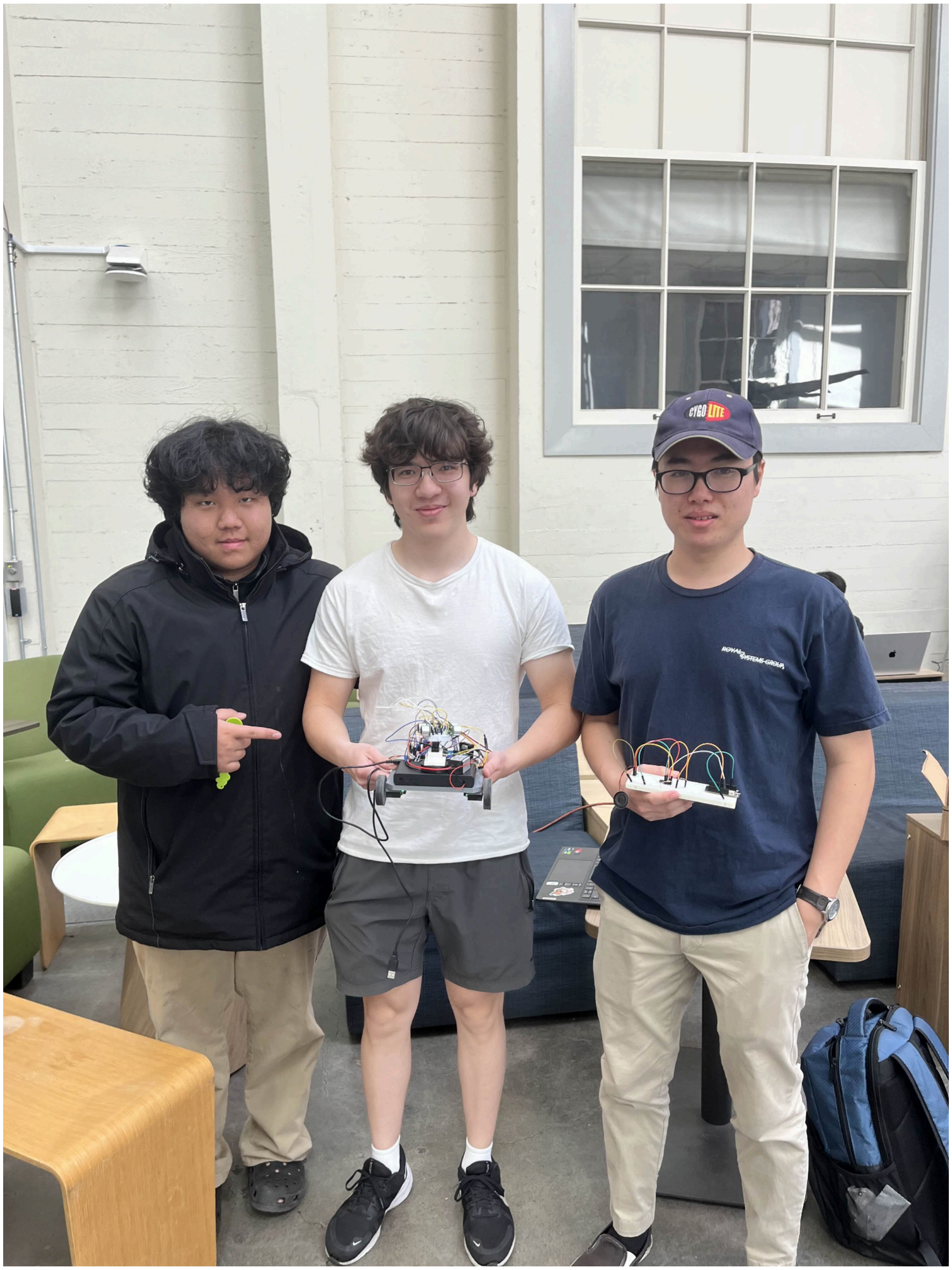

Project Video Link:

https://youtu.be/oUCaXZgvTps

I. Introduction

The compromise of a stationary camera is that one needs a network of them to effectively survey a space with walls and obstructions. This can be costly and retain blind spots. Our proposed solution was the use of a scanning rover to traverse a path which would eliminate the need for a network, while retaining the ability to detect environmental disturbances.

II. Objectives

The proposed function of the rover was to begin by taking a primary scan along a set path, recording physical environmental features. On subsequent passes, new scans are compared to previously stored scans to check for differences. If a difference were to be detected, this would alert the owner via buzzer. This functionality would be supported with three ESP's: The first would be the Home ESP, which accepts the desired path from the user, interprets it, and sequentially sends these movement and scan commands to the rover. The second and third ESP's are on the rover. The second ESP is responsible for receiving movement commands and interpreting those to move the rover forward, backward, left, and right. The third ESP takes the scan commands from the Home ESP, and when prompted, performs a scan. Information gleaned from this is sent back to the Home ESP for analysis.

The functionality of the programmed path was invoked by interpreting a string inputted by the user. This string would include the lengths of straights, and necessary orthogonal turns. These straights and turns would be transmitted to the rover for interpretation and execution; accurate distance and movement was facilitated with use of encoders and PID correction.

A scan is invoked between each step of the path. If there were particularly long straight distances, they would be broken down into shorter segments automatically, and scans inserted into those breaks.

The scanning system makes use of two ultrasonic sensors mounted on a servo motor. At each of the repeatable, stationary scan points in the path, 62 total measurements are taken at different angles, and the floats are transmitted off the rover. Due to the finicky nature of ultrasonics with angled surfaces, only measurements under 60cm were taken as true measurements. If the number of scanned points under 60cm at a given position differed from the number of scanned points at the same position on the previous run, this was interpreted as an environmental change. A buzzer then sounded, representing an alert to the operator.

The looping and possible alerting would then continue until the operator stops it.

III. Conclusions

The chosen motors and encoders, while sufficient for shorter paths, would not be sufficiently consistent over longer distances. Without active correction, following a path, we learned, is quite a fickle thing.

The use of a buzzer activated by ESP-NOW also limits the range at which the alert can be sounded. This is a problem because the point of the rover is such that it can be left to patrol an area, without active supervision. The lack of alert range requires the operator to be near the system, which limits the purpose.

The performance of the rover was significantly affected by the quality of the floor upon which it operated. Bad flooring would cause parts of the rover to catch while turning, and cause it to turn less than the encoder suggested it did. Certain calibrations regarding turns and traveling straightness would need to be redone on different surfaces. This is inconvenient and inconsistent.

The density of the ultrasonic scan was lacking due to the 250 byte limitation of ESP-NOW. Since only a maximum of 62 floats could be sent back, the lack of scan density meant that a few missed measurements would make up a significant percentage of the perceived total scans, and cause false positive “change detected” cases.

IV. Recommendations

To account for the smaller inconsistencies in path execution, at the start of each loop, a “re-zeroing” function could be invoked, where the rover physically uses a dock to re-align itself to a known zero position. An example of this functioning would be that the back of the rover would have a cone, while the dock would be the inverse of this shape. The rover could back into the dock, and the cone would self - center in the dock, effectively setting the rover off from a known start point.

The range limitations of ESP-NOW could be remedied by use of Wi-Fi and the Internet. By connecting the system to the Internet, an email could be sent to the operator when a change is detected, and this has no range limitation. In addition, while the rover is able to detect environmental changes, there is no way to visually confirm what causes the alert. A simple method is adding a camera module that would take a photo when change is detected and alert the user via email.

The current rover setup is also limited by the type of terrain it is traversing. Bigger wheels would be affected less by the terrain. However, grip issues and bigger imperfections in the ground will likely still cause consistency problems. A system may need to be put in place to actively correct the rover’s position on long, low-quality routes. An example of such a system could be that if the ultrasonic measurements were within a certain tolerance, then the rover would perform maneuvers to “zero” its position by moving so that the previous and current measurements match more closely. Another way this could be remedied is by adding checkpoints at certain points in the path that the rover could use as reference; the ultrasonic sensors would be used to center the rover in the checkpoint using the aforementioned maneuvers.

The issue of lack of information being sent from the rover can be resolved by simply not calculating the distances of the ultrasonic sensors before sending the values. The raw number of ticks can simply be sent, each of which takes half as much space than a float. These ints are just two bytes, so 125 values can be sent, double that of floats. This would improve the density situation, and use ESP-NOW bandwidth much more efficiently.

As a final note, our use of a very small servo resulted in some servo hunting due to the significant rotational inertia mounted to the servo shaft. This was remedied by use of a mass damper, but a stepper motor may be a better choice for this application to ensure accurate, small steps without great stress to the motor.