Project Deliverable G: **Prototype II and Customer Feedback**

GNG 1103 – Engineering Design

Group 5

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Introduction

With the development of the second prototype for our A.N.A. project, we have refined our design process by adapting to the feedback and results we have received from our first prototype. The second prototype focuses on the navigation with following pre-determined paths using tape / lines on the floor. Users will find a selection of cards, each with a designated symbol prompting the robot to guide them to their desired location. This report will establish the importance of some results over others and analyze what lessons we learned from it as it will strengthen the development for our third prototype. Furthermore, it will emphasize design, functionality and usability to deliver a more refined product. Through strict analysis of client and peer feedback along with cross-referencing our previous report of the first prototype, we look forward to correcting the previous flaws by implementing prototype two.

1.0 - Feedback Analysis and Documentation

During the initial stages of the project, we gathered and reviewed feedback from the client through a series of meetings. In the second meeting, the client suggested pivoting from our original concept, which led to the development of the current navigation system utilizing the RoboMaster S1 and color-coded tape paths. In the third meeting, the client recommended revising the RoboMaster S1's specifications and programming as there are more restrictions for the sensors than we anticipated.

1.1 - Identifying Key Issues and Trends

From this feedback, we identified several key issues and trends. Firstly, the current concept may not fully leverage the robot's capabilities for gesture recognition. We plan on resolving this issue by switching to symbols as previously mentioned in the document. Secondly, the programming limitations for our consistent path following and error avoidance. We initially believed our implementation handling both following capabilities and object avoidance, though this has proven to challenge our programming abilities. Finally, the lack of structured user testing really underscores the need for a more comprehensive and realistic evaluation of our implementations in general.

1.2 - Impact of Feedback on Future Design

To address these concerns at a further level, we plan on conducting experiments with different tape colors and widths to optimize the path-following performance. We will also implement a selection of cards granted along with the RoboMaster S1, each with a designated symbol prompting the robot to guide them to their desired location.

For clarity and completeness, we will conduct an internal team review to verify that all client feedback has been thoroughly addressed. Moving forward, team collaboration will be very important to discuss the proposed improvements. The documented feedback analysis will be aligned with the team's revised development goals and the upcoming test plan.

1.3 - Review

By addressing the client's feedback and refining the prototype, we are laying the groundwork for a more functional yet simple design. The insights gained during this phase will directly inform the next iteration of the prototype, assuring an effective navigation experience for all users.

2.0 - Prototyping Development and Modeling

Based on the test results from the first prototype and client feedback, we have developed the second prototype with the aim of optimizing the user experience. The primary objective of this prototype is to enhance RoboMaster S1's navigation by utilizing color-coded tape paths on the floor. Additionally, we have introduced a set of symbol-based cards that allow users to instruct the robot to guide them to specific locations.

2.1 - Optimizing Navigation and Path Following

In the previous prototype, we identified challenges in the accuracy of path following and obstacle avoidance. To address these issues, we are conducting experiments with different tape colours to determine the optimal navigation configuration.

2.2 - Enhancing User Interaction with Symbols

Due to the high level of uncertainty associated with gesture recognition, switching to fixed symbol-based cards reduces malfunctions and errors. This modification simplifies user operation while ensuring clear and precise communication between the user and the robot. Each card contains a symbol corresponding to a specific location, allowing users to select their destination with ease.

2.3 - Testing and Iterative Optimization

Our product is not designed for a single type of disabled person. We aim to help all individuals with physical impairments to navigate more easily. Therefore, we need to consider different user's situations during testing. To simulate the real experience of disabled users, we will use props to mimic their conditions. For example, if we are assisting a visioned impaired user, we can wear blindfolds to replicate their perspective and adjust our product accordingly. If we are serving users with leg disabilities, we can conduct tests using wheelchairs or crutches to better simulate their perspective and identify their challenges.

2.4 - Future Developments

We will continuously refine the program, adjusting navigation algorithms strategies to enhance RoboMaster S1's stability and intelligence.

3.0 - Test Planning and Execution

To ensure the effectiveness and reliability of Prototype II, a structured test plan will be implemented. This section outlines the approach for testing the navigation system, user interaction, and overall performance of RoboMaster S1.

3.1 - Test Objectives

- Validate the robot's ability to follow pre-determined tape paths accurately.
- Assess the reliability of symbol-based card navigation.
- Test usability and ease of interaction for users.
- Gather feedback and comments from potential clients and users on the prototype and its ideas.

3.2 - Test Methods

- **Navigation Path Test:** Place various color-coded tape paths and evaluate the robot's consistency in following these paths under different lighting and surface conditions.
- **Symbol Card Test:** Provide users with symbol-based cards and observe the robot's response in guiding users to designated locations.
- **User Interaction Test:** Simulated user scenarios will be conducted to assess the ease of interaction, focusing on how intuitive and user-friendly the navigation system is.
- **Feedback Collection:** After each test, feedback from participants will be systematically gathered through surveys and discussions.

3.3 - Test Metrics

- **Navigation Accuracy:** Percentage of successful path-following attempts without deviation.
- **Card Recognition Rate:** Rate of correct responses to symbol cards.
- **User Satisfaction:** Qualitative feedback on usability, ease of use, and clarity in robot guidance.

3.4 - Test Schedule

- **Week 1:** Preparation of the test environment, including setting up tape paths and creating symbol cards.
- **Week 2:** Conduct initial navigation and user interaction tests, gathering feedback after each session.
- **Week 3:** Analyze feedback, refine programming as needed, update target specifications, detailed design, and the bill of materials (BOM) based on test analyses and results.

3.5 - Data Collection and Analysis Strategy

Data Collection and Analysis Strategy Data will be systematically collected for each test type, including video recordings, observation notes, and user feedback surveys. This data will be analyzed to identify common issues, success rates, and potential areas for improvement. The outcomes will directly inform refinements in navigation accuracy, symbol recognition, and overall usability.

3.6 Risk Management

- **Navigation Limitations:** Pre-test simulations will be conducted to identify and address potential navigation errors.
- **Environmental Variables:** Tests will be conducted under different conditions, such as varying lighting levels, floor textures, and potential obstacles, to assess consistency and reliability.
- **User Errors:** Clear instructions and demonstrations will be provided to all participants to minimize inconsistencies in testing outcomes.

3.7 - Summary and Next Steps

The structured testing phase will ensure that the robot's navigation system is refined and optimized based on user feedback and performance analysis. Key insights and outcomes from the tests will be used to update target specifications, enhance the detailed design, and revise the bill of materials (BOM). The lessons learned will guide the development of the next prototype iteration, ensuring alignment with client expectations and design objectives.

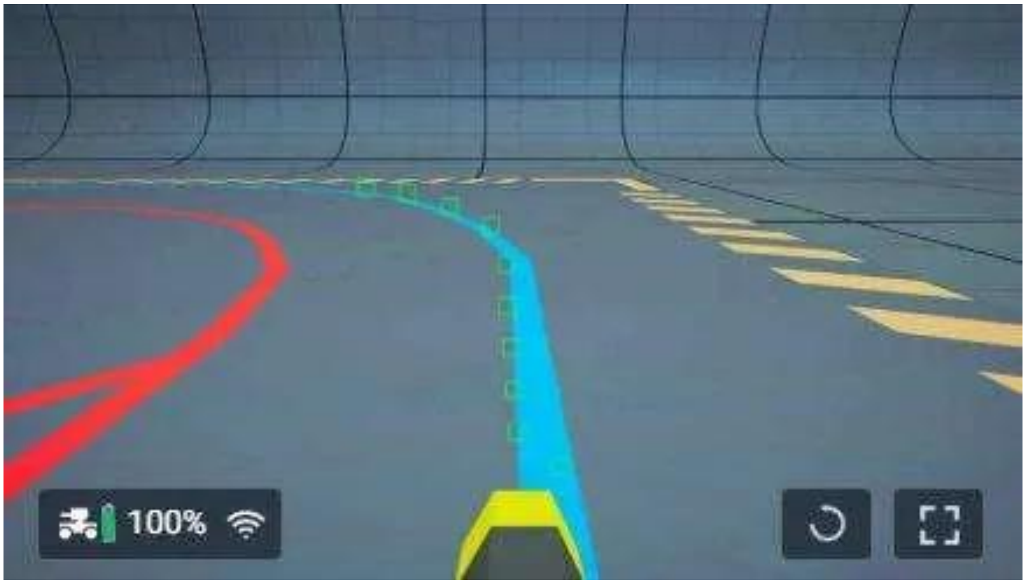
4.0 - Future Planning

Based on acquired data and results, prototype planning will be modified to better provide specific measurements of the product’s capabilities and whatever may impede it.

One such modification is the complexity of designated paths for the robot to follow.

Several screenshots to follow.

4.1 - Figures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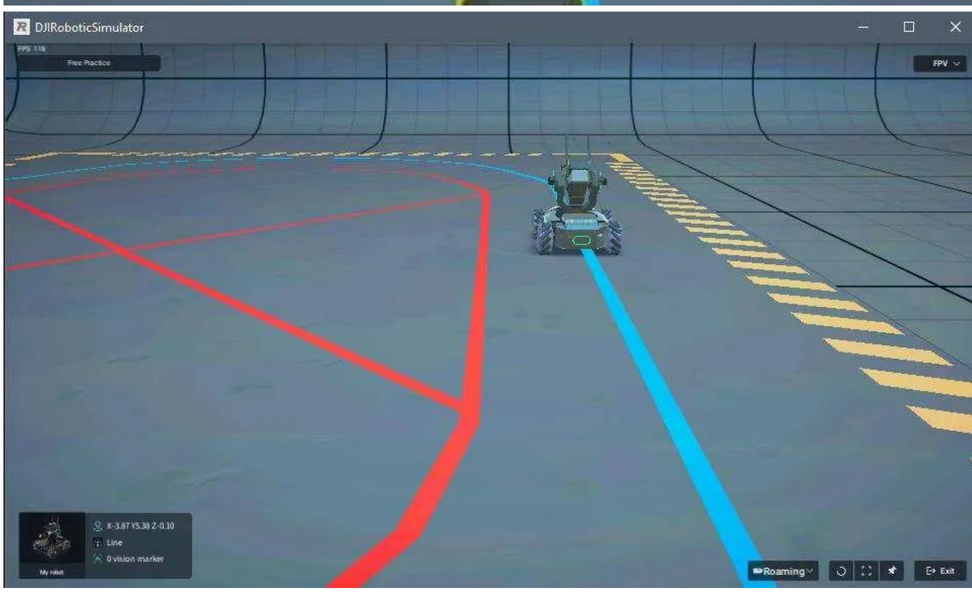
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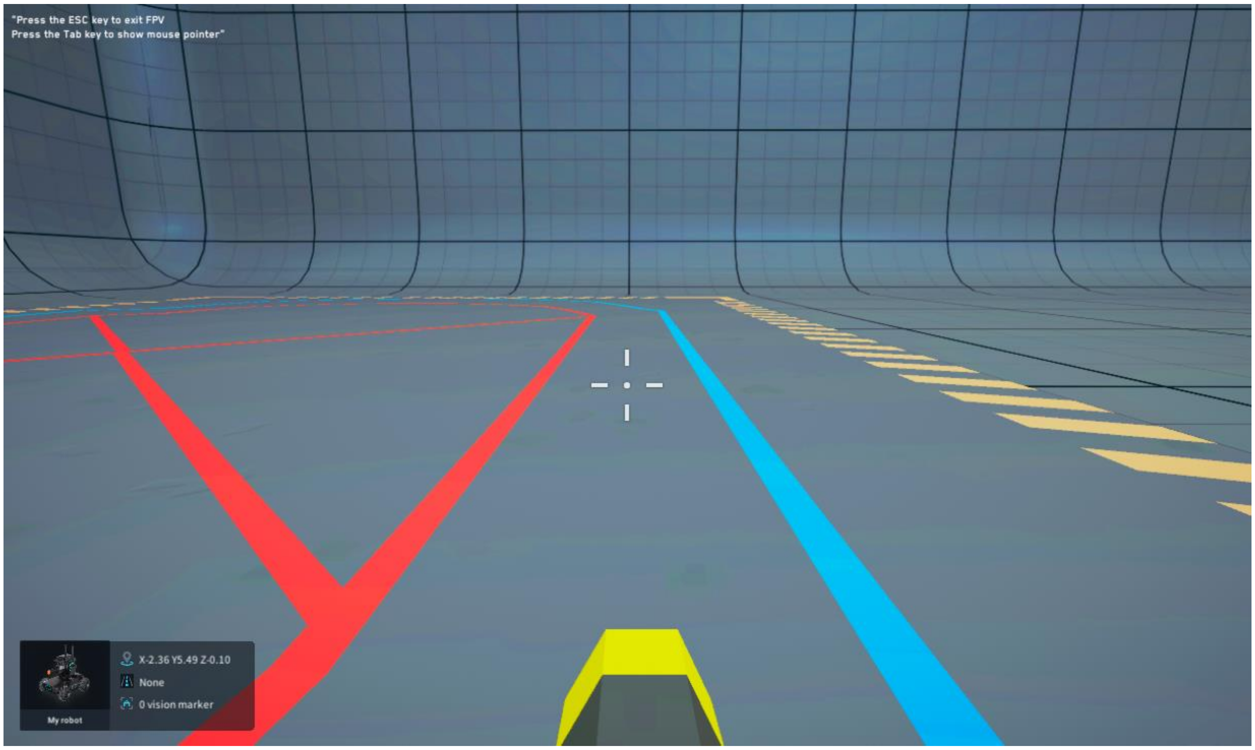
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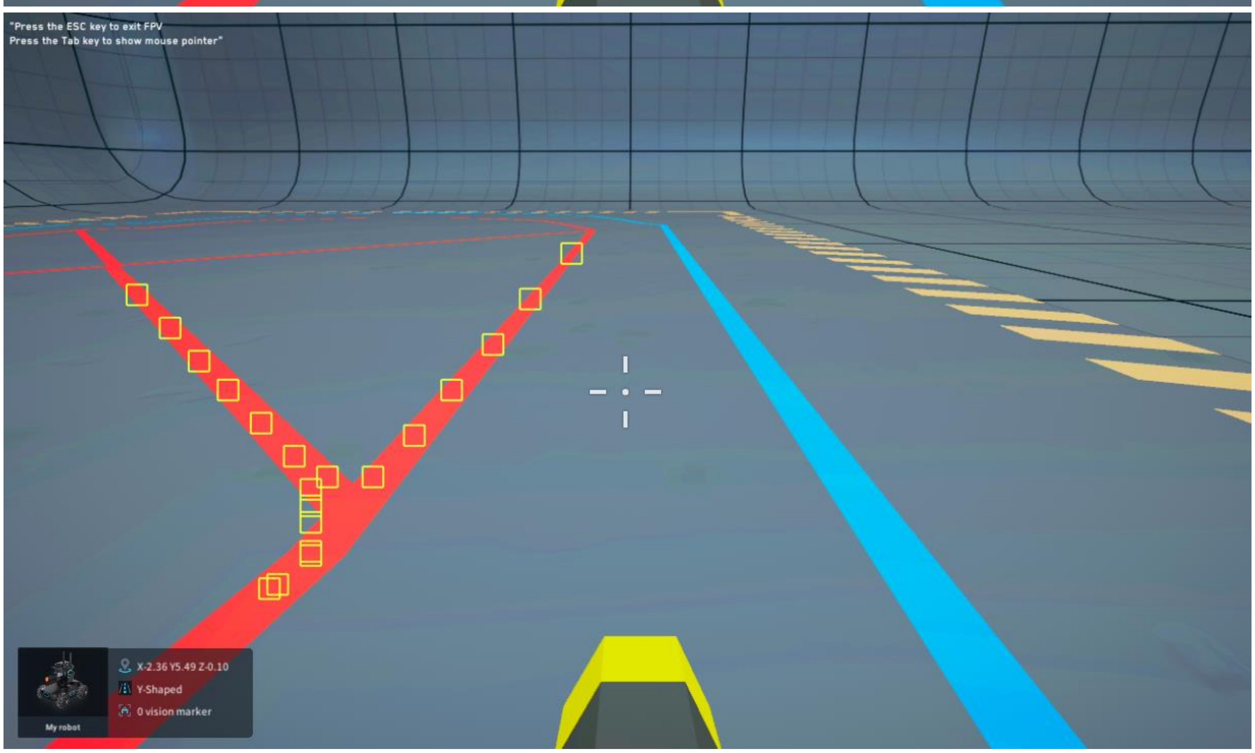
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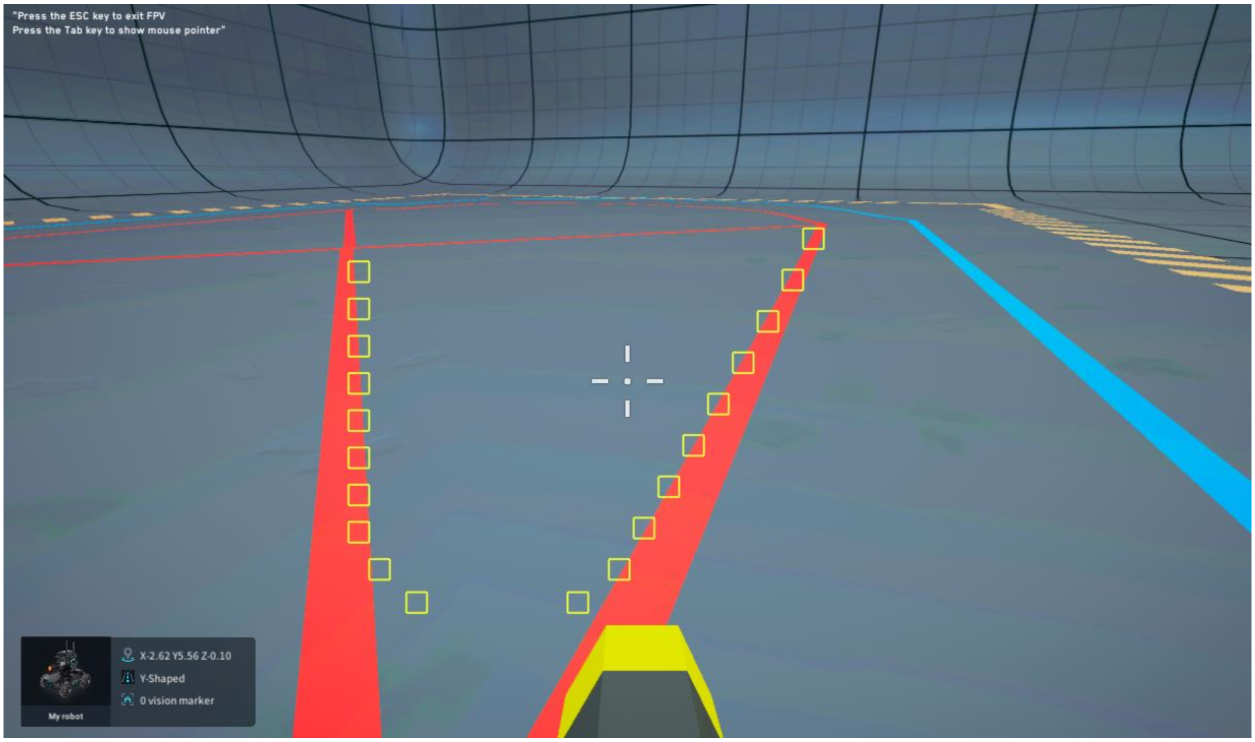
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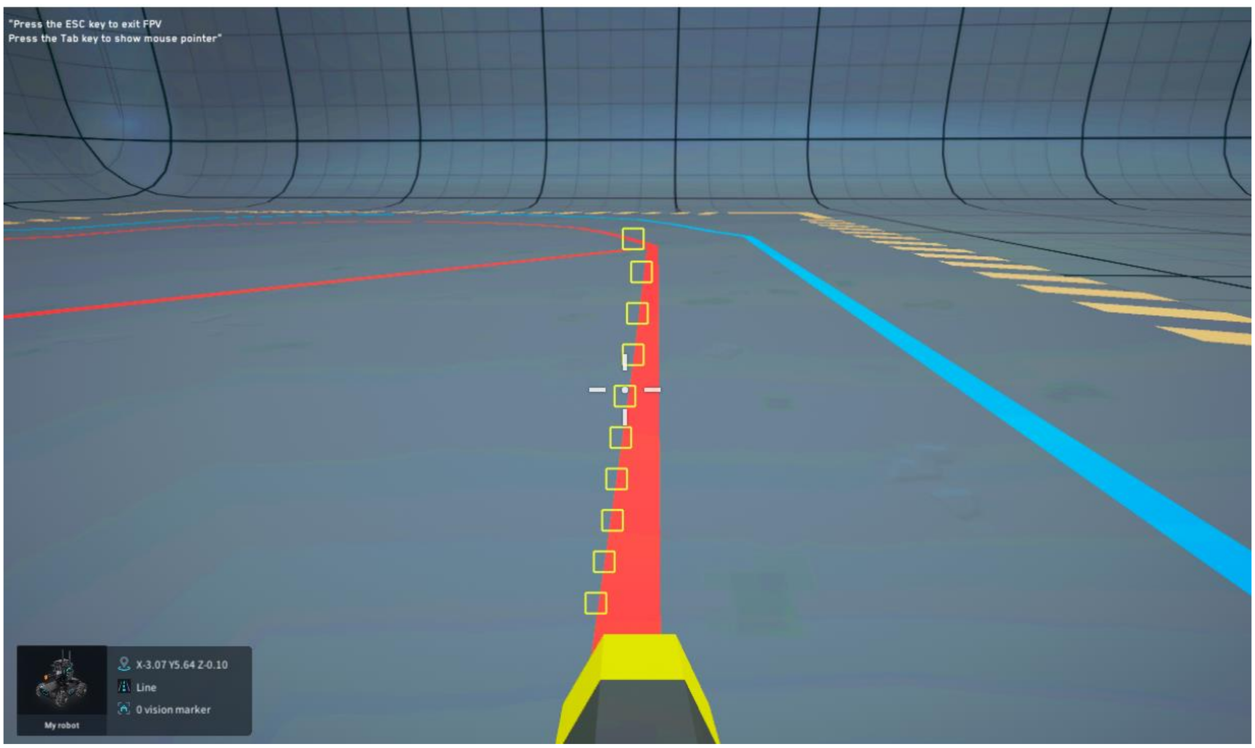
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My robot

As pictured above, the robot's programming allows it to successfully navigate paths of different colors, which it can sense and recognize. However, indoor pathways may necessitate more complex movements, such as turns (either cornered or curved) of varying frequency and distance from each other. Slopes are also to be considered, with this and the previous considerations necessitating implementation in further tests. Once navigation functions reliably, obstacle avoidance will then be implemented and tested in tandem.

Areas of differing brightness must also be used for testing to properly gauge the degree of light exposure that may cause the robotic guide's sensors to misinterpret symbols, miss obstacles, and even lead the guide from the designated path.

The guide must also be tested to determine the most comfortable speed for users of all kinds to be led at, avoiding potential problems with the robot being too quick or slow.