Project Deliverable F: **Prototype I and Customer Feedback**

GNG 1103 – Engineering Design

Group 5

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Introduction

Our group is developing a navigation assistant using the RoboMaster S1, where the robot will recognize gestures assigned to specific locations in a building. The objective we aim to achieve through this deliverable is to analyze the client feedback we received during the previous client meeting, and how it has impacted our project.

1.0 - Client Feedback and Design Adjustments

Based on the feedback we received from the second client meeting; we were able to modify our project scope entirely. Our initial idea was too advanced and ambitious for a first-year project and therefore, far too difficult to implement. The client liked the concept of our second idea and wanted to hear more about the idea of having the RoboMaster S1 stationed in a building, ready to be used as an indoor navigation assistant.

1.1 - Client Feedback

The following sections will be a breakdown of key points/insights the client made during the meeting:

1.1.1 - Indoor navigation is preferred

Since the first concept we proposed heavily revolved around outdoor environments, the client proposed we pivoted towards our second concept which negated this issue and solely worked indoors to operate.

1.1.2 - Gestures for user interaction

The client shared concerns when we proposed using voice commands or a simple user interface to interact with the RoboMaster S1, as they pointed out it may prove difficult for the RoboMaster to pick up audible cues in a busier environment. Fortunately, we can still use simple gestures as a way for the users to communicate to the RoboMaster.

1.1.3 - Easier execution

The initial concept mentioned above proved to be too complicated and the client encouraged us to simplify our design to ensure practicality.

1.2 - Planned Adjustments Based on Feedback

According to the client's feedback, we will work on the second concept and revise the sections outlined as follows. By keeping our concept and goals simple, we aim to create a functional and effective navigation assistant.

1.2.1 - Simplified gestures

We will perform experiments using easily understandable and replicated hand gestures to reinforce accurate recognition and enable intuitive interaction.

1.2.2 - Simple pathing for travel

Instead of complex route calculations, we will use a more minimalistic approach to programming the path to the destinations. We have discussed two concepts, both being much simpler to program than what we had in mind for the outdoor navigation concept.

1.2.3 - Chassis light indications

To enhance the user interaction part of our project, we will be using the color of the chassis feature as a way to indicate upcoming turns or braking. We can modify the frequency of the blinking, and the colour.

1.3 - Next Steps

These revisions make our project more practical, achievable and in line with the expectations of the client. The future of our project is outlined through the adaptation of our second concept and the absorption of our client's suggestions, establishing the first prototype's focus being simple path navigation, and gesture recognition.

2.0 - Prototype Development

Incorporating the client feedback, we will advance the development of our prototype. Our objective is to design functional navigation assistance that integrates gesture recognition, a straightforward pathing system, and effective user feedback mechanism.

2.1 - Gesture Recognition Implementation

To facilitate user interaction with the RoboMaster S1, we will implement a gesture recognition system that enables users to issue navigation commands through predefined hand movements.

- A camera-based system will be employed to detect and interpret gestures.
- Simple, universally recognizable gestures will be used (e.g., pointing left, right, stop, or forward).
- Testing will be conducted under varying lighting conditions and from multiple angles to ensure accurate recognition.

2.2 - Path Navigation System

Rather than implementing a complex navigation algorithm, we will adopt a simplified approach to path planning.

- The RoboMaster S1 will follow a predefined route marked with tape on the floor, eliminating the need for complicated dynamic route calculations.
- Tape colors or patterns will differentiate various paths and destinations for RoboMaster S1 recognition. Black tape will define the primary route, with colored tape branching off to indicate different destinations/rooms.
- Distance sensors will continuously scan nearby objects, allowing the RoboMaster S1 to adjust its speed accordingly.

2.3 - LED Light Feedback

To enhance user interaction and provide clear visual indicators, we will utilize the RoboMaster S1's LED lighting system.

- LED light colors will change according to specific actions (e.g., red for stopping, blue for turning, and green for moving forward).
- Blinking light patterns may be implemented to indicate upcoming turns or braking.
- The lighting system will be tested under diverse ambient lighting conditions to ensure optimal visibility and effectiveness in different environments.

2.4 - User Testing & Optimization

To validate the effectiveness, we will perform usability testing and refine the system based on feedback.

- Testing will take place in an indoor environment within the university STEM building.
- Users will simulate different navigation scenarios and interact with the RoboMaster S1 to evaluate gesture recognition functionality and path accuracy.
- Feedback will be collected, analyzed, and implemented to enhance system performance for the future modifications.

3.0 - Prototyping Test Plan and Analysis

To ensure the effectiveness and reliability of our RoboMaster S1 navigation assistant prototype, we have devised a comprehensive testing plan. This section outlines the specific tests we will conduct to evaluate key functionalities, assess performance, and refine our prototype based on findings.

3.1 - Testing Objectives

Our testing objectives focus on validating the three core aspects of our prototype:

1. **Gesture Recognition Accuracy** – Ensuring the system correctly identifies and responds to predefined hand gestures.
2. **Path Navigation Reliability** – Confirming that the RoboMaster S1 follows the designated paths with minimal errors.
3. **LED Feedback System Effectiveness** – Evaluating the visibility and clarity of light signals under various conditions.

3.2 - Test Methodology

We will conduct a series of controlled experiments to measure the effectiveness of our system under different conditions. Each test will involve multiple trials to ensure consistency and reliability.

3.2.1 - Gesture Recognition Testing

- **Objective:** Determine the recognition accuracy of different hand gestures.
- **Procedure:**
    - A set of 10 users will perform predefined gestures (pointing left, right, forward, stop) in different lighting conditions and from multiple angles.
    - The system's recognition accuracy will be recorded based on the number of correct detections out of the total attempts.
- **Success Criteria:** The system must correctly identify at least 90% of gestures under normal lighting and 80% under varied conditions.

3.2.2 - Path Navigation Testing

- **Objective:** Assess the RoboMaster S1's ability to follow predefined paths accurately.
- **Procedure:**
    - The RoboMaster S1 will be placed at a starting point and directed to follow a designated path marked with black tape.
    - Variations in floor texture, lighting, and minor obstacles will be introduced to evaluate adaptability.
    - The number of successful path completions (without deviation) will be recorded.

- **Success Criteria:** The robot should complete at least 90% of trials without deviation from the marked path.

3.2.3 - LED Feedback Testing

- **Objective:** Ensure that users can clearly interpret the LED signals under different conditions.
- **Procedure:**
    - The LED system will be tested under different ambient lighting levels (bright, dim, and dark environments).
    - A group of participants will observe and identify the meaning of the LED indications (e.g., red for stop, blue for turn, green for go).
    - The percentage of correct interpretations will be recorded.
- **Success Criteria:** At least 95% of participants should correctly interpret the LED signals in normal lighting conditions and 85% in varied lighting.

3.3 - Data Collection and Performance Analysis

- All test results will be documented in a structured format, including success rates, common failure points, and observations.
- Statistical analysis will be conducted to identify patterns and areas for improvement.
- Feedback from test users will be incorporated to refine the prototype before the next iteration.

3.4 - Expected Challenges and Mitigation Strategies

Potential Challenges	Mitigation Strategies
Low gesture recognition accuracy in poor lighting	Improve camera sensitivity and refine gesture dataset
Difficulty in following paths on certain surfaces	Adjust sensor calibration and experiment with alternative markers
LED visibility issues in high brightness	Increase LED intensity or introduce contrasting indicators

3.5 - Conclusion and Next Steps

Through rigorous testing, we will refine our prototype to improve gesture recognition, path navigation accuracy, and user interaction via LED feedback. The findings from these tests will inform us of our next phase of development, leading to a more robust and user-friendly navigation assistant.

The next steps will include analyzing collected feedback, making necessary modifications, and preparing for additional client demonstrations to ensure our prototype aligns with user expectations and practical implementation.

4.0 - Feedback Collection and Results Documentation

Feedback is to be recorded within writings in a notebook as it is given, before being processed and discussed through the group as a whole. Feedback is to be categorized to individual features and components of the prototype. Discussion of issues presented by the clients and tests is to be done via the presentation of different potential remedies from each group member, before a full discussion of each idea is carried out. This allows for quicker narrowing of solutions to any issues brought to light.

Issues brought to our attention currently include the general complexity and extreme ambition of the group's initial idea, which was rectified by the simplification of the robotic guide. This necessitated that it be relegated from street guidance to indoor navigation for the impaired, to present something more specific and readily useful.

This serves as a proper template for the group to follow in the development of the project.

Further issues recorded include the blandness of the robot's appearance, with proper eye-catching colors and symbols being missing.