ROBOT LOCALIZATION AND MAPPING WITH SMARTLY PRICED SENSORS

PROJECT CHARTER

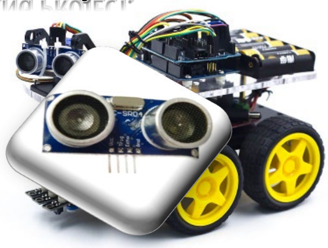
Project Information:

PROJECT NAME: AUTONOMOUS ROBOT LOCALIZATION AND MAPPING PROJECT.

PROJECT MANAGERS: ADRIANNA SENDYKA & ISRAEL OWOLABI.

**PROJECT ID: ** ARMP-2023-001.

**START DATE: ** OCTOBER 4TH 2023.



Project Organization:

**Project Team: ** The project team includes:

"Israel Owolabi"

Project Manager: Responsible for overseeing the project's overall progress, coordinating tasks, and ensuring that the project stays on track. This includes project planning, scheduling, and communication.

Software Developer: In charge of coding and programming the robot's software, ensuring it can process sensor data, navigate the environment, and create maps accurately.

Quality Assurance (QA) Tester: Responsible for testing the robot's functionality, identifying and reporting issues, and ensuring it meets the project's success criteria.

Documentation & Procurement Specialist: Tasked with keeping track of project documentation, including design documents, user manuals, and any reports that need to be submitted. Also responsible for acquiring any hardware or materials needed for the project.

"Adrianna Sendyka"

Technical Lead: Overseeing the technical aspects of the project, including robot hardware and low-cost sensor selection and integration.

Hardware Engineer: Focusing on the robot's hardware components, such as sensors, actuators, and power systems, ensuring they are functioning correctly and are well integrated.

Communication and Liaison: Ensuring clear and effective communication among team members, with the project manager, and potentially with external stakeholders.

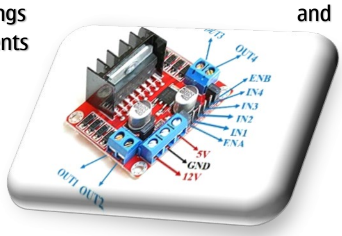
Risk Manager: Identifying and mitigating risks, including incompatibility issues between sensors and hardware/software, and ensuring the project stays on course.

Presentation and Demonstration Lead: Collaboratively responsible for preparing and delivering the presentation and demonstration of the robot's capabilities at the end of the semester, showcasing its mapping functionality.

EXPLORATORY PHASE

** Project Description: **

The objective of this project is to enhance the performance of low-range sensors to achieve cost savings and empower robots with increased capabilities. The focus is on optimizing the results of these components and exploring the manipulation of machine code to develop a more advanced solution. The ultimate goal is to create an efficient and economical system for robot localization and mapping in suitable or various environments.



Business Need, Problem, or Opportunity:

- As an ongoing initiative leading up to the final submission, we are actively engaged in enhancing the core functionalities of a line-following robot. The primary focus remains on elevating mapping capabilities through the optimization of the robot's configuration. Our efforts extend to refining control mechanisms, aiming to impart greater agility and smoother movement, thereby enhancing balance and rigidity, especially in challenging environments. This iterative process aims not only to improve the efficiency and precision of 1mm indoor mapping but also to concurrently reduce costs.

Furthermore, our exploration extends to complex differential solutions, delving into new technological developments. Specifically, we are investigating the potential of utilizing underutilized sensors that have not been extensively employed in contemporary technology. This multifaceted approach underscores our commitment to innovation and the pursuit of advanced solutions in line following robotics.

Project Objective, Benefits and Constraints:

*** SMART Objectives:**

* Specific: Develop a prototype autonomous robot capable of mapping indoor environments using sensors.
* Measurable: Achieve a basic level of mapping and improved accuracy.
* Achievable: Complete the project within the 15-week semester.
* Relevant: Demonstrate the robot's adaptability to various indoor settings.
* Time-bound: Conclude the semester by showcasing the robot and its expanded capabilities, achieved through comprehensive testing, intricate functions, and the exploration of diverse environmental challenges.

****Objectives: ****
The project aims to develop a prototype autonomous robot that can accurately localize itself and map indoor environments using low-cost sensors. The objectives follow the SMART criteria: Specific, Measurable, Attainable, Realistic, and Time-bound.

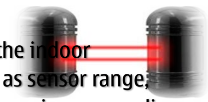
****Benefits: **** The project will showcase the potential for cost-effective and precise indoor mapping, which can be valuable in various applications, including building management, navigation, and research.

*** Constraints:**

* Limited project duration of one academic semester (15 weeks).
* Adherence to stringent university safety and ethical guidelines.
* Leveraging accessible university hardware, or in the absence of availability, opting for cost-effective alternatives to drive efficiency and cost-cutting strategies.
* Our budget is capped at 300zl, requiring careful allocation and smart financial planning.

BLUEPRINTING INNOVATION: EMBARKING ON THE DESIGN PHASE

Hardware and Sensor Integration:



Ultrasonic Sensors: Ultrasonic sensors will be strategically chosen to measure distances to obstacles and walls within the indoor environment. The selection process will involve a comprehensive review of available models, considering factors such as sensor range, accuracy, reliability, and compatibility with the robot's microcontroller. Initial testing will ensure that the selected ultrasonic sensors align with the project's requirements.

Infrared Sensors: Playing a crucial role in detecting objects in close proximity, infrared sensors will be meticulously evaluated for sensitivity, range, and precision. Compatibility with the robot's control system will be a key consideration in the selection process. Rigorous testing will be conducted to confirm that the chosen infrared sensors meet the project's specifications.

Camera (Optional for Now): The project will potentially incorporate a camera module to capture visual data for mapping purposes. The selection process will assess factors such as image quality, resolution, and field of view. However, the integration of the camera will be deferred until the robot achieves a rigid body, focusing initially on essential functionalities.

Light-Dependent Resistor (LDR) Sensors: LDR sensors will be integrated to monitor ambient lighting conditions. Selection criteria will include sensitivity to light levels, response time, and compatibility with the robot's control system. These sensors will enable the robot to assess the lighting environment and trigger illumination if needed.

Motor Driver (L298N): The L298N motor driver will regulate the robot's motors, preventing overuse of voltage and ensuring efficient motor operation. Integration into the control system will be a priority, enhancing motor control for accurate and safe navigation.

Arduino Microcontroller: Serving as the central component of the control system, the Arduino microcontroller will execute navigation algorithms, process sensor data, and oversee overall robot functions. Collaboration with the L298N motor driver will be established to ensure precise motor control during mapping tasks.

Hardware Components: A meticulous selection process for chassis, wheels, motors, and motor controllers will prioritize stability, mobility, and precise control. Criteria will include durability, weight-bearing capacity, power efficiency, and compatibility with chosen sensors and the control system.

Power Supply: The power supply source, typically a rechargeable battery, will be chosen based on its capacity, weight, and recharging capabilities. The objective is to ensure a stable power source that meets the voltage and current requirements of the robot and its components.

The hardware selection process will be collaborative and guided by the project's objectives. Compatibility and seamless integration between hardware components and sensors will be a primary focus. The project manager, Israel Owolabi, will lead this phase, emphasizing effective communication, documentation, and testing to ensure successful implementation.

High-Level Project Scope:

- The project will focus on developing a prototype autonomous robot capable of precise indoor localization and mapping using low-cost sensors. The scope includes defining key deliverables and identifying what is out of scope.

High-Level Project Timescale:

- The project is scheduled to be completed within a 15-week semester and will consist of the following key stages and milestones:

**Stage 1 (Weeks 1-4): ** Project planning and sensor selection.

**Stage 2 (Weeks 5-8): ** Robot hardware assembly and sensor integration.

**Stage 3 (Weeks 9-12): ** Software development, localization algorithms, and initial mapping functionality.

**Stage 4 (Weeks 13-15): ** Testing, refinement, and project presentation.

Project Kick-off (Week 1): This milestone marks the official start of the project, including team formation, project introduction, and initial planning.

Sensor Selection and Procurement (Week 4): By this point, the project managers should have selected suitable low-cost sensors and initiated the procurement process.

Hardware Assembly and Sensor Integration (Week 8): Israel's team effort should have completed the assembly of the robot's hardware and integrated the selected sensors.

Software Development and Initial Mapping Functionality (Week 12): Adrianna's team should have developed the initial version of the robot's software with basic mapping functionality.

Testing and Refinement (Week 15): This final milestone includes testing the robot's capabilities, identifying and addressing any issues, and ensuring that it meets the project's success criteria.

Project Presentation (End of Week 15): This milestone signifies the completion of the project, with a presentation and demonstration of the robot's mapping capabilities.

High-Level Project Budget:

- The project budget is estimated at 300zł, covering capital and revenue expenditure forecasts for hardware, software, and other project-related expenses.

Key Assumptions:

- The project team assumes that the selected low-cost sensors are compatible with the robot's hardware and software.

- The team assumes that the project schedule and budget estimates are accurate for the planned scope.

Key Project Risks:

- Main risks identified include sensor incompatibility, potential scope changes, and resource limitations. The project team acknowledges these risks and is prepared to mitigate them.

Early-Identified Risks:

Technical Risk: Sensor Incompatibility

* **Risk**: Incompatibility issues may arise between the selected sensors and the robot's hardware or software.

*** Mitigation Approach:** Proactively integrating the robot, applying algorithms to enhance scanning scope, and promptly addressing any arising compatibility challenges and implementing other advanced features.

Resource Constraints: Limited Time and Academic Resources

* **Risk**: The academic project has a fixed timeframe and resources, which may limit the depth of development.

*** Mitigation Approach:** Carefully plan the project scope within the given 15-week timeframe and optimize the use of available academic resources.

Scope Clarification and Changes

* **Risk**: As the project progresses, there may be changes in scope or additional requirements.

*** Mitigation Approach:** Maintain clear communication with the professor, and any changes or adjustments to the project scope should be documented and discussed for approval.

Success Criteria:

The success of the project will be determined based on the following key metrics:

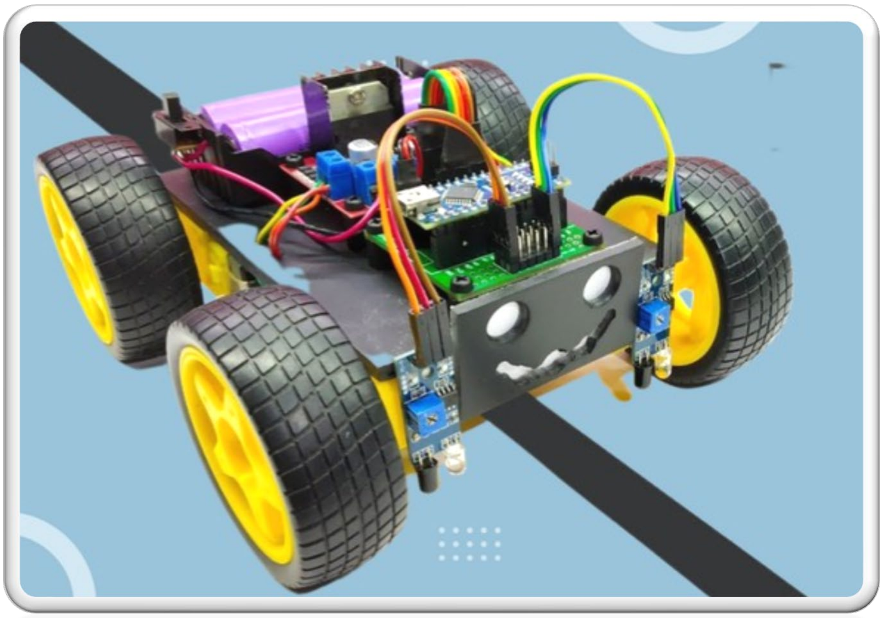
- Localization accuracy achieved by the robot.
- Mapping functionality's accuracy and completeness.
- Adherence to safety and quality standards.
- Meeting project milestones and budget constraints, within the 15-week semester.

This project charter serves as an agreement and reference for all project stakeholders. It is presented for review and approval by the project sponsor(s) and project manager.

PROJECT APPROVER: DR INŻ. JANUSZ JAKUBIAK

ADRIANNA SENDYKA: [SIGNATURE] [DATE]

ISRAEL OWOLABI: [SIGNATURE] [DATE]



Procurement and Assembly Process:

1. Parts Acquisition: Commencing with the meticulous selection of components and ordering, ensuring compatibility and adherence to project specifications.
2. Assembly Initiation: Launching the assembly process, team members meticulously connect the acquired parts according to the design blueprint.
3. Challenges Encountered: Facing manufacturing tolerance errors leading to some loose fittings, the team adeptly navigates these challenges with proactive solutions.
4. Adaptation and Adjustment: Implementing modifications and adjustments where necessary to address the encountered challenges and ensure a cohesive assembly.

Testing Preparation:

5. Coupling Success: Despite challenges, the team achieves success in coupling the robot, setting the stage for the upcoming testing phase.
6. Initial Testing Phase Kick-off: Transitioning seamlessly into the initial testing phase to evaluate the assembled prototype's performance.
7. Outcome Anticipation: With the coupled robot ready for testing, the team eagerly awaits the results of their diligent efforts and anticipates insights for further refinement.

Iterative Enhancement:

8. Feedback Integration: Leveraging insights from the initial testing phase, the team iteratively refines the prototype, addressing any identified issues.
9. Continuous Improvement: Implementing a continuous improvement cycle, the team refines the assembly and addresses any unforeseen challenges, ensuring an optimized prototype.

Documentation and Reporting:

10. Detailed Documentation: Comprehensive documentation of the entire assembly process, challenges faced, adaptations made, and lessons learned.

11. Reporting Progress: Regular reporting on the phase's progress to stakeholders, highlighting achievements, adaptations, and the readiness for the subsequent testing and refinement stages.

Future Steps:

12. Test Phase Initiation: Moving forward with the detailed testing phase, gathering crucial data to inform further enhancements and optimizations.
13. Refinement Planning: Concurrently planning for iterative refinements based on testing outcomes, ensuring a robust and high-performance prototype.