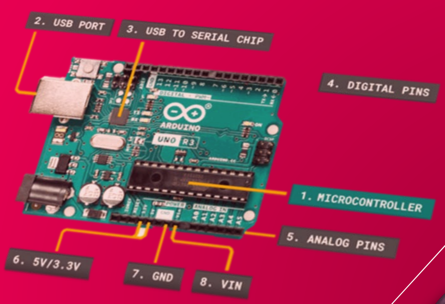
Politechnika
Wrocławska



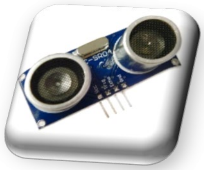
ROBOT LOCALIZATION AND MAPPING WITH LOW-COST SENSORS

PROJECT CHARTER

Project Information:

- **PROJECT NAME:** AUTONOMOUS ROBOT LOCALIZATION AND MAPPING PROJECT.

- **PROJECT MANAGERS:** ADRIANNA SENDYKA & ISRAEL OWOLABI.



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

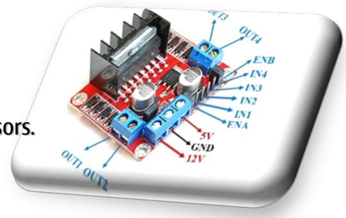
- **START DATE:** OCTOBER 4TH 2023.

- **Additional Project Description:**
This project aims to develop a cost-effective and accurate solution for robot localization and mapping in indoor environments using low-cost sensors.

Business Need, Problem, or Opportunity:

- The main driver for this project is to improve the efficiency and accuracy of indoor mapping while reducing costs. Traditional mapping methods are often time-consuming and expensive.

Project Objective, Benefits and Constraints:

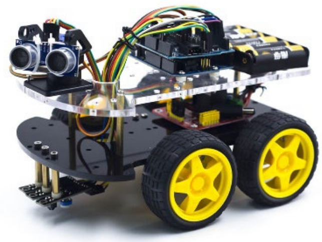


*** SMART Objectives:**

* Specific: Develop a prototype autonomous robot capable of mapping indoor environments using sensors.
* Measurable: Achieve a basic level of mapping accuracy.
* Achievable: Complete the project within the 15-week semester.
* Relevant: Demonstrate the robot's adaptability to various indoor settings.
* Time-bound: Present the robot and its capabilities by the end of the semester.

- **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).
* Compliance with university safety and ethical guidelines.
* Utilize accessible university hardware; if not accessible, purchase low-cost alternatives.

Hardware and Sensor Integration:

Ultrasonic Sensors: Ultrasonic sensors will be employed to measure distances to obstacles and walls within the indoor environment. The hardware selection process will include a comprehensive review of available ultrasonic sensor models, taking into consideration factors such as sensor range, accuracy, reliability, and compatibility with the robot's microcontroller or processor. A series of tests and evaluations will be conducted to ensure that the selected ultrasonic sensors meet the project's requirements.

Infrared Sensors: Infrared sensors will serve the critical role of detecting objects and obstacles in close proximity to the robot. The hardware selection process will involve the evaluation of infrared sensor options, with a focus on sensitivity, range, and precision. Compatibility with the robot's control system will also be a key consideration in the selection process.

Camera: The project will utilize a camera module to capture visual data for mapping. The camera selection process will entail the evaluation of camera modules based on factors such as image quality, resolution, field of view, and compatibility with the robot's microcontroller or processor. Extensive testing will be carried out to ensure that the chosen camera module is suitable for the project's mapping requirements.

Light-Dependent Resistor (LDR) Sensors: LDR sensors will be incorporated to monitor ambient lighting conditions. The selection process for LDR sensors will consider their 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, if necessary, trigger illumination to aid in navigation when darkness is detected.

Motor Driver (L298N): The L298N motor driver will be used to control the robot's motors. Its primary function is to prevent overuse of voltage and to regulate the motors' speed and direction. The L298N motor driver will be integrated into the robot's control system to ensure efficient and safe motor operation.

Arduino: The Arduino microcontroller will be a central component of the robot's control system. It will handle the execution of navigation algorithms, sensor data processing, and overall control of the robot's functions. The Arduino will collaborate with the L298N motor driver to coordinate motor actions, ensuring that the robot operates accurately and safely during mapping tasks.

Hardware Components: The selection of hardware components, including the robot's chassis, wheels, motors, and motor controllers, will follow a rigorous process. The team will identify components that provide stability, mobility, and precise control for the robot. Selection criteria will include durability, weight-bearing capacity, power efficiency, and compatibility with the chosen sensors and control system.

Power Supply: The choice of a power supply source, typically a rechargeable battery, will be made based on its ability to provide the required voltage and current for the robot and its components. The selection process will consider factors such as capacity, weight, and recharging capabilities.

The hardware selection process will be a collaborative effort involving the relevant team members and will be guided by the project's objectives for accurate localization and mapping, as well as safe navigation in varying lighting conditions. Compatibility between selected hardware components and sensors will be a primary focus during the selection and integration phase.

The project manager, led by Israel Owolabi, will work closely to ensure that the selected hardware components, including LDR sensors, meet the project's requirements and are seamlessly integrated into the robot's design. Effective communication, documentation, and testing will be integral to the success of this phase.

Project Organization:

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

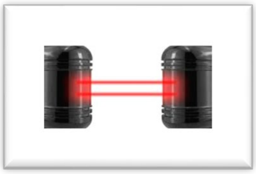
"Adrianna Sendyka"

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.



"Israel Owolabi"

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.

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.

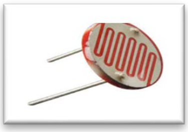
Sensor Selection and Procurement (Week 4): By this point, the project managers should have selected suitable low-cost sensors and initiated the procurement process.

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.

Risks Identified Early On:

Technical Risk: Sensor Compatibility

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

* **Risk Mitigation Plan**: Prioritize thorough testing and compatibility checks during the development phase.

Resource Constraints: Limited Time and Academic Resources

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

* **Risk Mitigation Plan**: 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.

* **Risk Mitigation Plan**: 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]