GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

MECHATRONIC DESIGN PROJECT

PROJECT PROPOSAL

MARS ROVER-INSPIRED WHEELED ROBOT WITH LIDAR FOR MAPPING AND NAVIGATION

Group Members:

D/ENG/21/0021/MC	W L S Wickramaarachchi
D/ENG/21/0048/MC	E S M Perera
D/ENG/21/0110/MC	G K Dhananjaya
F/ENG/21/6275/MC	U Pascaline

Supervisor:

Mr. I U E Naotunna

JUNE 2023

Project Proposal

Title: Mars Rover-Inspired Wheeled Robot with LiDAR for Mapping and Navigation

Introduction

Robotic systems have become prevalent in various settings for a variety of purposes. Presently, there exists a growing demand for sophisticated and agile autonomous robotics systems that can function effectively and efficiently in the ever-changing layouts, complicated pathways, and dynamic impediments of current industrial settings. However, existing solutions frequently lack accuracy, flexibility, and robustness [2].

As such, the goal of this project is to develop a robotic platform with improved mapping and navigation capabilities. To do this, we propose the development of a small wheeled robot inspired by Mars Rover designs, that employs LiDAR technology to facilitate the creation of a precise map, provide accurate localization, and powerful obstacle identification and avoidance capabilities [1]. These advanced technologies will be combined with a cutting-edge SLAM algorithm running on a ROS platform to provide real-time mapping, self-localization, and path planning, allowing the robot to travel independently and adapt to changing environments [3].

The outcomes of this project will include the design and fabrication of a fully functional wheeled robot capable of precise mapping, localization, and navigation in a variety of settings.

The robot's performance will be thoroughly tested through real-world evaluation and comparison with existing models, with an emphasis on mapping accuracy, localization reliability, and obstacle avoidance skills effectiveness and efficiency. Potential industrial applications will also be discovered and exhibited, demonstrating the robot's capacity to improve efficiency, safety, and even automation in a variety of applications.

Problem Statement

The dynamic obstacles, changing layouts, and intricate pathways of modern industrial settings, have caused a growing demand for autonomous, intelligent, and agile robotic systems that can effectively and efficiently map and navigate complex environments, which existing solutions frequently fall short due to limitations in accuracy, adaptability, and robustness [2].

Aim

To design, develop, and test a wheeled robot equipped with LiDAR technology, and a SLAM algorithm on a ROS platform for accurate and precise mapping, localization, and navigation in various settings.

Objectives

. To design and develop a miniature wheeled robot, equipped with the necessary hardware components, including a LiDAR sensor for mapping and navigation, and a Jetson Nano for robust and real-time data processing and control.

. To produce a comprehensive map of spaces using LiDAR technology and SLAM, allowing for precise localization, path planning, and autonomous navigation with powerful obstacle recognition and avoidance capabilities.

Methodology

. Research and evaluate the hardware architecture of existing designs and technologies in the realm of Mars Rover-like wheeled robots to gather insights and inform the development process.

. Create a kinematic model that describes the physical construction, size, and wheel arrangements of the robot, in order to ensure optimal maneuverability and stability in a variety of settings.

. Fabricate the robot using appropriate manufacturing processes, while ensuring that all relevant sensors, actuators, and computing units are integrated into it's chassis.

. Integrate a LiDAR sensor into the robot's hardware design and interface it with the control system.

. Create a SLAM algorithm that uses the LiDAR data and sensor fusion techniques to map the environment and localise the robot simultaneously.

. Create and execute path planning and navigation algorithms based on the created map, ensuring obstacle detection and avoidance to enable safe and efficient mobility in industrial settings.

Project Outcomes

. To design and fabricate a fully functional wheeled robot capable of precise mapping, localization, and navigation in various settings.

. To create a robust and efficient mapping and navigation system for industrial applications by integrating LiDAR technology with a SLAM algorithm.

. To identify and illustrate the developed robot's possible industrial uses, emphasising its capacity to improve efficiency, safety, and automation in a variety of applications.

Expected Budget

Item	Unit Price (Rs.)	Quantity	Total (Rs.)
*Jetson Nano Developer Kit	-	1	-
*Slamtec RPLiDAR-A1	-	1	-
*PCA9685 16 Channel Servo Motor Driver	-	1	-
*Arduino Mega 2560 Rev3	-	1	-
*L298N DC Motor Driver Module	-	3	-
JGA25-370 Encoder Electric Gear Motor	3,450	6	20,700
MG996R Servo Motor	1,250	6	7,500
85mm×40mm Wheel	870	6	5,220
Wheel Coupling	290	6	1,740
KP08 Bearing	270	20	5,400
8mm Flange Coupling	780	12	9,360
Container for Body	1,750	1	1,750
6200 mAh 3S 11.1V LiPo Battery	12,000	1	12,000
Latches, Hinges, Nuts, and Bolts	-	-	2,470
Steel Cable Tie	150	6	900
**Aluminium Box Bars	-	-	-
		Sub-Total (Rs.)	**67,040**

*** Already available.**

**** Cannot say yet.**

Timeline

Task		Week												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1.	Research & Proposal.													
2.	Developing the required skills.													
3.	Designing & Developing the Mechanical Design.													
4.	Component Acquisition													
5.	Developing the program/s.													
6.	Testing & Optimizing.													

References

[1] Y. Cai, W. Qian, J. Dong, J. Zhao, K. Wang, and T. Shen, "A LiDAR-Inertial SLAM Method Based on Virtual Inertial Navigation System," *MDPI*, Jun. 12, 2023. [Online]. Available: https://www.mdpi.com/2079-9292/12/12/2639

[2] M.T. Lorente, L. Montano, and M. T. Lázaro, "Advanced Waypoint Navigation Strategies for Autonomous Mobile Robots in Industrial Settings," *SpringerLink*, Nov. 19, 2022. [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-031-21062-4_44

[3] J. H. Ye, "Deployment of SLAM, navigation, and exploration onto a delivery robot," *NTU Singapore*, Jan. 01, 2023. [Online]. Available: https://dr.ntu.edu.sg/handle/10356/168011