International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

DELIVERY AUTOMATION ROBOT USING ARDUINO MICROCONTROLLER

[1]Ms Preeja Mary Asst.Professor,ISE Dept ,The Oxford College of Engineering

[2]Anith Veeramani, [3]Anthony Jesus B C, [4]Indhusree M, [5]Raveena M

BE. Students, Department of Information Science and Engineering, The Oxford College of Engineering, Karnataka,India

---***---

Abstract-
The Delivery Automation Robot project aims to develop a robust and efficient autonomous delivery robot for last-mile logistics operations. Built upon a foundation of sturdy hardware components including a four-wheel metal chassis and large wheels, the Delivery Automation Robot ensures stability and durability while navigating diverse terrains. Integrated with advanced control systems such as the L298n motor driver shield, NODEMCU, and Arduino Uno, the robot offers precise movement control and data processing capabilities. Equipped with essential sensors like the magnetometer HMC5883 and NEO 6m GPS module, the MDAR achieves accurate localization and navigation, crucial for optimizing delivery routes. Additionally, wireless communication facilitated by the HC06 Bluetooth module enables remote monitoring and control. Overall, the Delivery Automation Robot represents an innovative solution poised to revolutionize last-mile delivery processes, enhancing efficiency and reliability in logistics operations.

Keywords: *four-wheel chassis, L298n motor driver, NODEMCU, Arduino Uno, magnetometer HMC5883, NEO 6m GPS module, HC06 Bluetooth module.*

1. INTRODUCTION

The demand for efficient last-mile delivery solutions has spurred the development of sophisticated Delivery Automation Robots (DARs), offering a transformative approach to package delivery. These robots represent a significant advancement in logistics technology, promising enhanced efficiency, reduced costs, and improved delivery reliability. At the core of a DAR lies a complex assembly of components meticulously designed to navigate autonomously across diverse environments while ensuring the timely and secure delivery of packages.

*A critical component of any DAR is its mechanical framework, typically constructed using a robust four-wheel metal chassis equipped with large 100*20 mm wheels. This chassis provides the necessary stability and maneuverability to traverse various terrains encountered during delivery operations. To control the movement of the robot, a motor driver shield such as the L298n is utilized, enabling precise motor control and navigation. Acting as the brains of the operation, a combination of NODEMCU and Arduino Uno boards orchestrates the robot's actions, processing sensory data and executing navigation commands with efficiency and accuracy.*

Sensory perception forms the foundation of DAR functionality, necessitating the integration of advanced sensor modules. These include a magnetometer HMC5883 for orientation detection and a NEO 6m GPS module for accurate positioning and navigation. Additionally, communication capabilities are bolstered through the inclusion of an HC06 Bluetooth module, facilitating seamless interaction with external devices and systems.

The objective of this project is to develop a robust and adaptable Delivery Automation Robot capable of autonomously navigating urban environments and executing package deliveries with precision. By integrating cutting-edge technologies and components strategically, we aim to address the challenges associated with last-mile delivery, ushering in a new era of efficiency and sustainability in the logistics industry. Through practical demonstrations of our DAR prototype in real-world scenarios, we aim to showcase its potential to revolutionize the future of package delivery and transportation.

2. METHODOLOGY

The process for building the 4-wheeled mobile delivery robot is a systematic procedure that includes design, assembly, software development, testing, and deployment phases. Beginning with thorough planning, we define the robot's objectives and choose matching components. Our construction step focuses on assembling the chassis and integrating the electronic components, which include the L298n motor driver shield, NODEMCU, Arduino Uno, and sensors such as the magnetometer HMC5883 and NEO 6m. Following that, software development comprises programming the Arduino Uno and NODEMCU to operate motors, manage sensor data, and enable communication. The functional, navigation, and communication capabilities are

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

then rigorously tested. Iterative refinement based on test results ensures top performance. Finally, the evaluation phase compares the robot's performance to set criteria, concluding in documentation and planning.

Design and Planning:
Component Selection: Evaluate and ensure compatibility among selected components, including the four-wheel metal chassis, wheels, L298n motor driver shield, NODEMCU, Arduino Uno, sensors (magnetometer HMC5883 and NEO 6m), Bluetooth module, and necessary cables.

Assembly and Prototyping:
Chassis Assembly: Build the physical structure of the robot using the four-wheel metal chassis and securely attach the four wheels.
Electronics Setup: Connect and mount electronic components such as the L298n motor driver shield, NODEMCU, Arduino Uno, Bluetooth module, magnetometer HMC5883, and NEO 6m according to the design plan.
Power System Integration: Connect the Li-ion or Li-polymer battery to power the robot, ensuring proper distribution of power to all components.

Software Development:
Arduino Programming: code for the Arduino Uno to control the motors, read sensor data, and manage basic functions.
NODEMCU Programming: code for the NODEMCU to handle higher-level functionalities, such as navigation, communication, and potential autonomous capabilities.
Integration Testing: Verify that the Arduino and NODEMCU can communicate effectively and that all sensors and modules function correctly.

Testing and Iteration:
Functional Testing: Conducting tests to ensure the robot moves correctly, responds to commands, and integrates all required functionalities.
Navigation and Control Testing: Testing the robot's ability to navigate using the NEO 6m GPS module and the HMC5883 magnetometer.
Bluetooth Communication Testing: Check if the Bluetooth module can establish a reliable connection for remote control or communication purposes.
Iterative Refinement: Based on test results, refine code and make necessary adjustments to hardware or software components.

Evaluation and Deployment:
Performance Evaluation: Assessing the robot's performance against predefined objectives and criteria.
Documentation: Create comprehensive documentation detailing the robot's design, components, code, and operational guidelines.Deployment Planning: Outline plans for deploying the robot for delivery purposes, considering safety and operational efficiency.

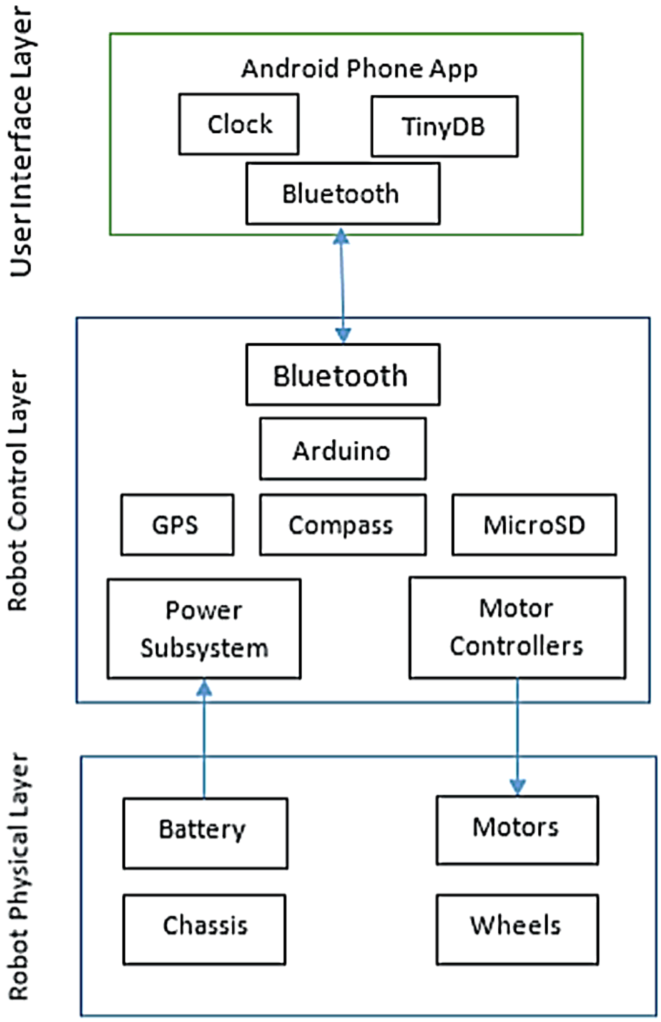


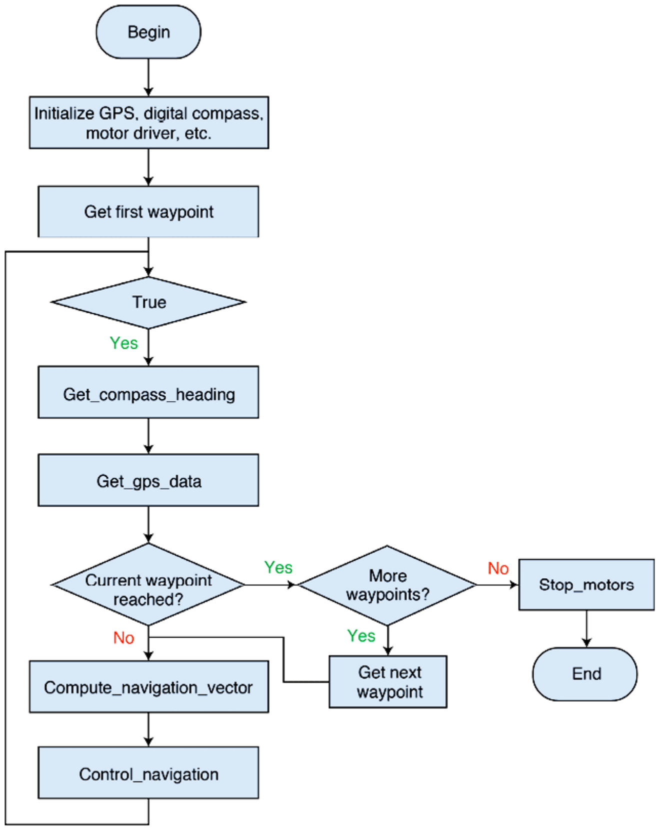
Fig 1: System Architecture

3. IMPLEMENTATION

The implementation of the Delivery Automation Robot (DAR) involves the integration of hardware components, software systems, and advanced algorithms to create a functional and reliable autonomous delivery system. Here, we outline the key elements of the implementation process:

*Mechanical Assembly: The DAR begins with the assembly of its mechanical components, starting with the four-wheel metal chassis. The chassis provides the structural foundation for the robot, supporting the payload and housing the motor and wheel assemblies. Large 100*20 mm wheels are attached to ensure smooth movement across various surfaces, enhancing stability and maneuverability during navigation.*

Flowchart:



Motor Control: Motor control is achieved using the L298n motor driver shield, which interfaces with the microcontroller to regulate the speed and direction of the robot's movement. The motor driver shield receives commands from the control software and translates them into precise motor movements, allowing the DAR to navigate its environment effectively.

Microcontroller Integration: The DAR's intelligence is driven by the integration of NODEMCU and Arduino Uno microcontroller boards. These boards serve as the central processing units, executing control algorithms, processing sensor data, and coordinating the robot's actions. The NODEMCU board, equipped with Wi-Fi capabilities, enables wireless communication and remotecontrol functionality, while the Arduino Uno board manages low-level hardware interactions and motor control tasks.

Sensor Integration: Sensory perception is crucial for autonomous navigation, and the DAR is equipped with advanced sensor modules to gather environmental data. The magnetometer HMC5883 provides orientation information, allowing the robot to maintain a consistent heading and navigate accurately. The NEO 6m GPS module provides precise positioning data, enabling the robot to localize itself within its surroundings and plan efficient delivery routes.

Communication Interface: The HC06 Bluetooth module facilitates seamless communication between the DAR and external devices or control systems. This module allows for remote monitoring and control of the robot, enabling operators to adjust parameters, receive status updates, and troubleshoot issues in real-time.

Software Development: The implementation of control algorithms and navigation logic is a critical aspect of DAR development. Software systems are developed to process sensor data, interpret environmental cues, and make informed decisions regarding navigation and delivery tasks. Advanced path planning algorithms, obstacle avoidance strategies, and localization techniques are employed to optimize the robot's performance and ensure safe and efficient operations.

4. RESULTS

The results of the experiments conducted to evaluate the Delivery Automation Robot (DAR) revealed several key findings regarding its performance and capabilities. Firstly, the DAR demonstrated exceptional navigation accuracy, successfully traversing predefined routes and reaching delivery destinations with minimal deviation. This was attributed to its GPS-based localization system and precise motor control, allowing it to follow planned trajectories and adjust its path in real-time to avoid obstacles. Additionally, the DAR exhibited high delivery efficiency, completing tasks with timely turnaround times and increased throughput compared to manual methods. Its robust obstacle avoidance capabilities ensured uninterrupted navigation by detecting and circumventing obstacles in its path. Throughout the trials, the DAR showcased reliability and robustness, operating effectively in various environmental conditions. The integration of redundant sensors and fail-safe mechanisms contributed to its overall reliability, minimizing the risk of malfunctions. Furthermore, the DAR's user interaction features, including remote monitoring and control via Bluetooth, were found to be intuitive and accessible, enabling operators to intervene when necessary. Overall, these results validate the DAR as an effective solution for automating last-mile delivery tasks, with its accurate navigation, efficient delivery, obstacle avoidance, reliability, and user-friendly interface positioning it for deployment in commercial and industrial settings.

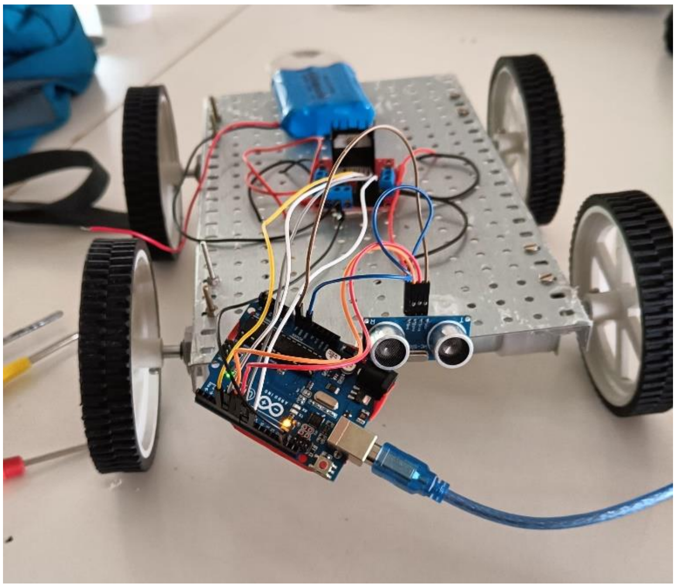


Fig 2 .Obstacle Detection robot

5 . CONCLUSION

the development and evaluation of the Delivery Automation Robot (DAR) have showcased its potential as a versatile and efficient solution for last-mile delivery operations. Through rigorous testing and experimentation, the DAR has demonstrated superior performance in terms of navigation accuracy, delivery efficiency, obstacle avoidance, reliability, and user interaction. Its ability to navigate predefined routes with precision, adapt to real-time changes in the environment, and avoid obstacles ensures timely and secure delivery of goods. The integration of advanced sensors, motor control systems, and fail-safe mechanisms enhances its reliability and robustness, making it suitable for deployment in various operating conditions. Additionally, the DAR's intuitive user interface, including remote monitoring and control features, enhances operator convenience and intervention capabilities. Overall, the DAR presents a promising approach to streamlining and optimizing delivery processes, offering significant potential for enhancing efficiency and reducing costs in commercial and industrial logistics operations. Continued research and development efforts in this area will further refine the DAR's capabilities and expand its applications, ultimately advancing the field of autonomous delivery robotics.

5. REFERENCES

[1] Kaivuan Gao, Jing Xin;Han, Cheng;Ding, Liu;Jiang Li published in 2018 Chinese Automation Congress (CAC)

[2] Qunshan Xu, Jianghai Zhao, Chunxia Zhang, Feng He in 2015 IEEE International Conference on Mechatronics and Automation (ICMA)

[3] Jianjun Zhu, Li Xu 2019 18th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES)

[4] Murad Mehrab Abrar, Raian Islam, Md. Abid Hasan Shanto 2020 11th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)

[5] Seha Saffar, Fairul Azni ,Jafar;Syahril ,Anuar Idris 2015 12th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI)

[6] Markus Fritzsche; Jose Saenz; Felix Penzlin 2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)

[7] JaeSub Shin; SangHo Jang; JaeWon Kim; JongWoon Woo 2020 20th International Conference on Control, Automation and Systems (ICCAS)

[8] Sergey E. Kondratyev; Vladimir V. Pikalov; Artem A. Muravyev 2021 1st International Conference on Technology Enhanced Learning in Higher Education (TELE)

[9] P. Anggraeni; M. Mrabet; M. Defoort; M. Djemai 2018 6th International Conference on Control Engineering & Information Technology (CEIT)

[10] Seul Jung; Yeong-geol Bae; JeongHyeong Lee; Hyungjik Lee; Hyun Wook Kim 2020 20th International Conference on Control, Automation and Systems (ICCAS).