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Automotive Inventory Management using Robot

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***Abstract*— Automotive robot intended to improve inventory management across a variety of settings by decreasing labour costs and increasing efficiency. While the initial concept was inspired by challenges faced in a college library, the proposed solution is adaptable to various inventory management scenarios. Traditional inventory management systems encounter issues with accurately updating item availability, leading to inefficiencies. In response, this research presents an innovative inventory management robot capable of swiftly returning items to their designated locations. Unlike systems relying on complex Simultaneous Localization and Mapping (SLAM) techniques, our approach leverages a known environment, reducing system complexity and enhancing flexibility The robot navigates the inventory area and returns items to their appropriate shelves by using Radio Frequency Identification (RFID) tags to identify the location of each item on the shelf. This implementation is designed to be versatile, requiring minimal modifications to its operational environment while significantly improving inventory management processes.**

***Index Terms*— Internet of Things (IoT), automation robot, inventory management, path planning, automotive navigation.**

I. Introduction

When we consider inventory management, a number of issues come to mind, including automation, speedy product retrieval and storage, and availability monitoring. A college library is a kind of inventory, and they frequently resemble warehouses in their uniform design. Issues like not updating the library website right away after a book is returned or not being able to locate a book because it is still at the librarian's desk are comparable to what occurs at a warehouse when products are delivered or when someone requests that goods be placed inside a warehouse. Various methods have been suggested previously to address these issues. This problem can be solved most easily with a line-following robot. The automotive industry is one of the largest and most dynamic in the global economy, and it constantly needs precise and efficient inventory management. Having the right parts and components on hand is essential for automakers, dealerships, and suppliers to maintain flawless operations, reduce downtime, and satisfy customer needs. Traditional methods of inventory management, like data entry and manual counting, are often labour - intensive, slow, and prone to mistakes. However, as technology has developed, innovative solutions to these issues have become possible, and robotics has played a significant role in the revolution of automotive inventory management.

A cutting-edge technique to optimize the tracking, retrieval, and storage of parts and components in the automotive supply chain is robotic automotive inventory management.

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II. LITERATURE

Robotnik published "Autonomous Inventory Management Using Robots in Automotive Warehouses" [1]. This paper discusses the use of autonomous robots for inventory management in car warehouses. The authors propose a robot-equipped with RFID tags and barcode scanners system for tracking and monitoring inventory levels. The robots can also automatically update inventory data and optimize inventory placement, which increases cost savings, efficiency, and accuracy.

"Robotics and Automation in Automotive Warehousing" developed by RunBuggy [2] This study provides a thorough overview of the application of automation and robotics in automotive warehouse operations. The authors emphasize the benefits of using robots for a variety of tasks, such as inventory control, order fulfilment, and transportation. They emphasize how robotics may raise the efficiency, precision, and security of automotive warehousing.

The paper "Mobile Robotics for Autonomous Inventory Management" by Robotnik [3] This research focuses on the use of mobile robots for autonomous inventory management. The authors discuss the various types of mobile robots, such as inventory drones, autonomous forklifts, and mobile picking robots, that can be utilized for inventory management tasks. There is also discussion of the advantages of using mobile robots for picking, packaging, and moving around the warehouse.

"Inventory Management and Optimization with Robotics" by Robotic Systems [4] The use of robotics in inventory optimization and management is examined in this article. The authors detail how the use of robots can enhance inventory accuracy, reduce stockouts, and optimize inventory levels. They go over how inventory can be counted automatically by robots, how to keep goods from getting lost, and how to best arrange inventory based on demand patterns.

"Robotics and Automation in Automotive Manufacturing" [5] is stated by enVIsta. This article examines the use of robotics and automation in automotive production processes. The authors discuss the benefits of using robots for assembly, welding, and painting tasks. They stress how productivity, accuracy, and quality can all rise with robotic automation in the automotive sector.

Built In's "11 Car & Automotive Robotics Companies to Know" [6] This report highlights eleven companies that are leading the way in robotics innovation in the automotive industry. Companies including ABB, Bosch, and Rockwell Automation are involved. Robots are being developed and used for many purposes, such as inventory control, order fulfilment, and transportation.

J. Patton, T. Roppel, Y. Lyu, J. Zhang, and C. P. Senthilkumar [7] Because RFID technology enhances the functionality of automated checkout, inventory, and theft detection systems, its application in retail establishments is on the rise. We describe in this study an innovative implementation of a mobile robot capable of independent retail inventory management. Within the confines of a specified shop map, the robot may independently create a route that will cover every item, which it can then follow to complete the inventory. According to experimental findings, our robot can effectively conduct RFID-based inventory on a sales floor with a complicated layout and provide inventory accuracy that is competitive with human inventory.

Robotnik produces "Integrated inspection robots with warehouse management software" [8]. In order to increase inventory accuracy and reduce the likelihood of errors, this paper proposes integrating warehouse management software with inspection robots. The authors describe how inspection robots equipped with cameras and sensors can search inventory for defects, irregularities, or potential threats. Robotic data collection can be combined with warehouse management software to improve decision-making and offer real-time updates.

"Autonomous warehouse robots" from SICK [9] With a focus on the benefits and applications of autonomous warehouse robots, this paper provides a thorough analysis of the technology. The authors discuss the different types of autonomous warehouse robots, such as autonomous mobile robots (AMRs), autonomous guided vehicles, and autonomous forklifts. They emphasize how the automation of numerous tasks by autonomous robots, including order picking, inventory control, and transportation, will boost output and cut costs.

Logistics Management's article "Robotic warehouse automation: The future of logistics" [10] This essay examines the anticipated role that robotics will play in logistics in the future. The writers talk about how distribution, transportation, and warehousing are just a few of the logistics-related areas that robotics is changing. They stress how robotics can improve productivity, accuracy, and cost-effectiveness, resulting in a more efficient and effective logistics network.

J. Thirumurugan, G. Kartheeswaran, M. Vinoth, and M. Vishwanathan [11] The use of Line Following Robots (LFR) for the Library Inventory Management System (LIMS) is shown in this study. Using sensor-operated motors, a line-following robot is created to follow the predefined route for organizing library book shelves. The robot is equipped with a barcode scanner that reads barcodes from vertically stacked books and compares the decoded data with the search query. When the robot locates the book that needs to be discovered, it notifies the librarian or any patrons who are using the library, where the robot is used for searching. The robot stops and sounds an alert if it encounters any obstacles while doing its search. With the aid of the robot's preprogrammed data, misplaced books may be reorganized to help keep the volumes in order. This lessens the amount of physical labour that the library staff must do on a daily basis and helps to streamline the task of organizing the volumes.

N. Uzzaman, S. Hossain, M. R. Rashid, and N. K. Das Shuvra [12] The research under consideration presents a self-navigating library robot which follows no predetermined course or line and instead goes to the appropriate book shelf like a human would. An algorithm for self-navigating is created in order to accomplish this performance. A 2D array of book shelves is how many think of libraries. The robot measures the distances between things in its immediate environment using five ultrasonic sensors. These calculated lengths are a prerequisite for completing all required tasks, including determining the robot's present row-column location, assisting it in following a straight course, precisely turning, and so forth. The robot uses the developed algorithm flawlessly and produces satisfactory results, proving the algorithm's viability.

C. Floerkemeier I. Ehrenberg, and S. Sarma, [13] Since RFID is a key component of newly introduced automated self-checkout, return, and theft detection systems, its use in libraries has increased. In this work, we demonstrate LibBot, an RFID-equipped robot that detects misplaced books on its own and automates the normally laborious shelf-reading procedure. Our tests on a single library shelf demonstrate that our robot-assisted method of inventory management is able to precisely identify the arrangement of books on the shelves, locate individual volumes to within a few centimetres, and accurately identify misplaced items. Our research additionally illustrates the impact of RFID obstacles on location accuracy, such as thin books with RFID tags nearby and metal shelving.

A. Gade and Y. Angal [14] Robotic process mechanization is the integration of machine learning and artificial intelligence to programming to handle repetitive, high-volume tasks that formerly needed human intervention. A robot is a machine that is automated. Librarians are necessary in library administration for the proper handling of books. We have used robotization in libraries to expedite book transportation by means of robotic arms, in an effort to mitigate curator annoyance. A combination of hardware for managing book handling and software for managing the library database makes up a library management robotic system. This system aids in maintaining the documentation of all book transactions made available in a library. A robot is a modular system of sensor-driven motors that is used to operate a library. Robot retrieves book data from database that is stored. The robot collects barcode data from the books and associates the search input with the decoded barcode data. The robot carries a standard identification scanner that collects data from the book spine arranged vertically, compares the decoded data from the scanner tag, and obtains the information from the scanner tag information. The location of books is found via the global positioning system.

This facilitates and simplifies the custodian's job and reduces the amount of physical labour that the library staff must perform on a daily basis.

Yu, H., and others [15] An intelligent mobile robot for library management is presented with the goal of reducing the labour and material requirements of library administration and facilitating the development of unmanned libraries. A movable platform, a robotic arm with three degrees of freedom, and an information fusion system for many sources of image recognition make up the robot. The robot can do tasks such as book grip and shelving in order in addition to identifying data and the position of the book. An effective autonomous elevator button identification system based on neural networks is created, allowing the mobile robot to cross floors by elevator and expand its movement area while adapting to the current library environment. When paired with image identification technology, the mobile robot can navigate autonomously and avoid obstacles. In order to make the operating instructions simpler, a graphical user interface and data monitoring centre have also been built for the mobile robot. Calculations and experiments are used to assess the efficacy of the suggested study. The robot's novelty is in its ability to finish book shelving tasks while making the greatest possible adaptations to the current library.

III. Working Principle

An automobile inventory management system using robots consists of robots outfitted with sensors that navigate independently across a warehouse. They recognize and track goods using RFID or barcode technology, which updates a centralized database in real time. Robots are assigned duties, collaborate to ensure effective operations, and automate inventory replenishment. Integration with ERP systems assures consistent data flow, while selfmonitoring and security measures improve reliability and safeguard against unwanted access. This technology improves efficiency and accuracy in automotive inventory control.

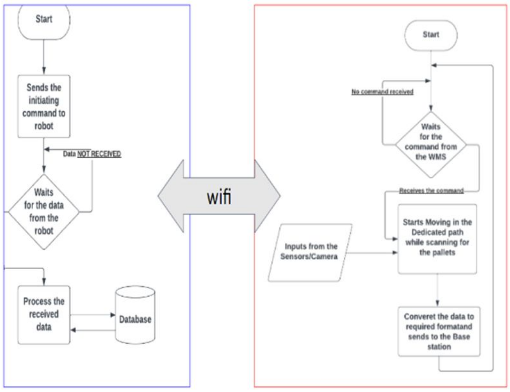

Figure 1. Flowchart

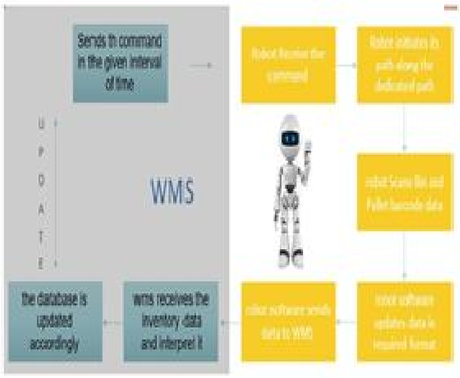

Figure 2. Block Diagram

IV. Results

The expected output of the automotive inventory management system utilizing a line follower robot with a camera involves real-time inventory data collection, accurate navigation through the inventory space, and precise image processing to extract vehicle information. This information is seamlessly transmitted to the base station or WMS for informed decision-making. Optionally, user interfaces and alerts may be incorporated for enhanced monitoring and notification. Overall, the system aims to improve inventory management efficiency and user satisfaction through its accuracy, reliability, and scalability.

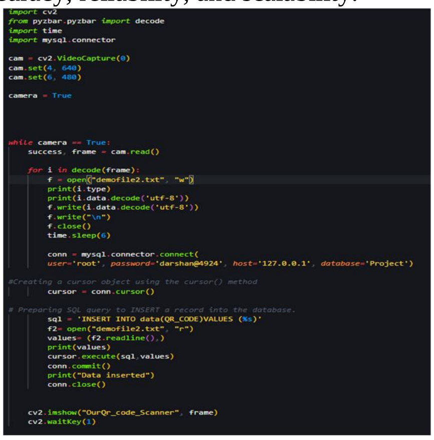

Figure 3. Snap Shot showing status python file which connects the database

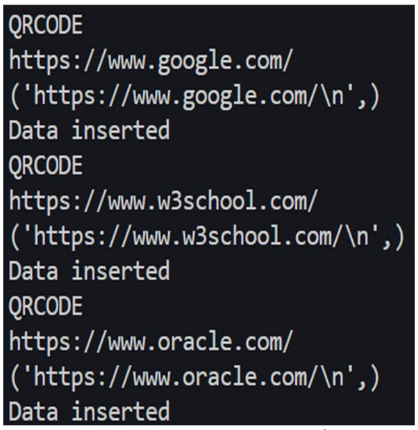

Figure 4. SnapShot showing status of Stored Database

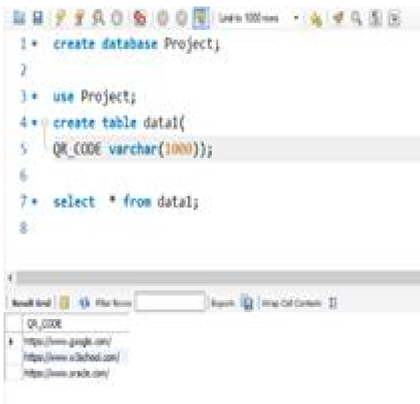

Figure 4. SnapShot showing status of Stored Database

V. CONCLUSIONS

In conclusion, the project's successful execution represents a major step toward an automated and robotically enhanced supply chain that is more responsive, accurate, and efficient in the future of automotive inventory management. The advantages could be felt outside of the automotive sector as well, paving the way for improvements in inventory management practices in other industries.

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