International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 10 | Oct - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

IOT – Based Automated Warehouse Picking and Sorting Robot

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Abstract - This paper summarizes the working, design, and potential benefits of an Automated Warehouse Picking and Sorting Robot. The system uses sensors, a microcontroller, motors, and a robotic mechanism to identify, pick, transport, and sort products into designated locations. The coordination of hardware and software enables the robot to perform warehouse tasks with reduced human intervention. The paper examines how automation can minimize manual effort, reduce sorting errors, save time, and improve the efficiency of warehouse operations. It also discusses important factors affecting system performance, including sensor accuracy, motor control, object detection, programming, and mechanical stability. The system is suitable for applications in e-commerce warehouses, manufacturing industries, logistics centers, and distribution facilities. However, implementation may involve challenges such as initial costs, maintenance, and handling products of different sizes and shapes. Overall, the paper highlights the potential of robotic automation to improve material handling, product organization, and resource utilization. Future improvements using artificial intelligence, machine vision, and intelligent navigation could further enhance the flexibility, accuracy, and reliability of automated warehouse operations.

Key Words: Warehouse Automation, Robotic System, Picking, Sorting, Sensors, Material Handling.

1. INTRODUCTION

Warehouse management plays an important role in industries, e-commerce businesses, and distribution centers. It involves storing, identifying, picking, moving, and sorting products before they are delivered to customers or transferred to other departments. Traditional warehouse operations mainly depend on manual labor, which can be time-consuming and may lead to human errors, delays, and difficulties in handling large quantities of products. With the development of automation technology, robotic systems are increasingly being used to improve warehouse productivity and operational efficiency.

An Automated Warehouse Picking and Sorting Robot is a robotic system designed to automate the process of selecting products and placing them in their assigned locations. The system combines hardware and software components, such as sensors, a microcontroller, motors, a robotic arm or picking mechanism, and a programmed control unit. These components work together to detect objects, control movement, and sort products according to predefined instructions.

The robot follows programmed commands to identify and handle products and transfer them to the appropriate sorting areas. Sensors provide information about the objects and their positions, while the controller processes the information and operates the motors. Depending on the system design, technologies such as barcode scanners, color sensors, or camera-based vision systems can also be used for product identification.

The main purpose of this project is to reduce manual work, improve sorting accuracy, save time, and support efficient warehouse operations. Automated picking and sorting systems can also help improve workplace safety by reducing repetitive material-handling tasks. Such systems are useful in e-commerce warehouses, manufacturing industries, logistics centers, and distribution facilities.

Overall, the Automated Warehouse Picking and Sorting Robot represents an important application of robotics and industrial automation. It provides a systematic approach to product handling and supports the development of faster, more reliable, and intelligent warehouse management systems.

2. Body of Paper

The body of this paper describes the design and development of the proposed PICKSORT AI SYSTEM, an automated warehouse picking and sorting robot designed to improve product handling and inventory management. The system integrates sensing devices, a microcontroller, a robotic arm, a conveyor belt, motor drivers, and an IoT-based monitoring platform. It identifies products, controls their movement, and sorts them into designated storage bins according to predefined categories. The system aims to reduce

manual effort, improve sorting efficiency, and provide better inventory tracking. This section explains the hardware components, system architecture, working principle, and software implementation of the proposed system.

2.1 PROPOSED SYSTEM

The proposed PICKSORT AI SYSTEM is designed to identify, pick, transport, and sort products automatically. It consists of an input sensing unit, a main control unit, a robotic picking mechanism, a conveyor belt, a sorting unit, and an IoT-based monitoring system. Sensors collect product information and send it to the controller, which processes the data and controls the actuators according to the programmed sorting logic.

2.2 SYSTEM ARCHITECTURE / BLOCK DIAGRAM

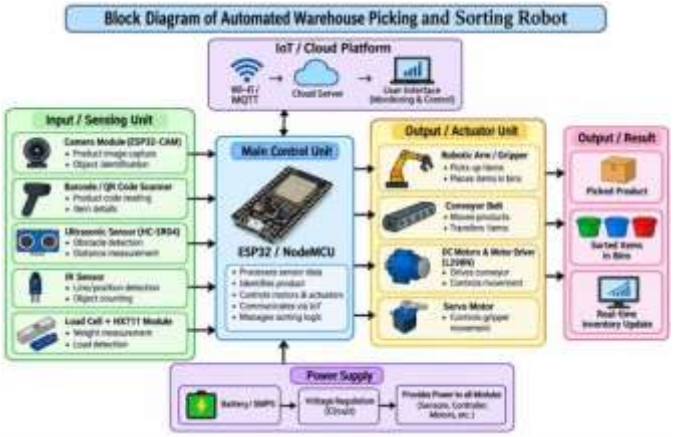


Fig 2.1: Block Diagram of Proposed System

The block diagram shows the working of the Automated Warehouse Picking and Sorting Robot. Sensors identify products and send data to the ESP32/NodeMCU controller. The controller operates the robotic arm, conveyor belt, and motors to pick and sort products into designated bins. The IoT platform enables remote monitoring and inventory updates. The power supply provides the required power to all components.

2.3 SOFTWARE ARCHITECTURE

The software architecture of the proposed Automated Warehouse Picking and Sorting Robot consists of sensor data acquisition, data processing, decision-making, actuator control, and IoT communication. The ESP32/NodeMCU controller processes sensor inputs and executes the programmed logic to identify, pick, and sort products. The software controls the robotic arm, conveyor belt, and motors. Wi-Fi and MQTT enable communication with the cloud platform for remote monitoring and inventory updates.

3. HARDWARE – BASED SYSTEM

A. ESP32 Controller



Fig-3.1: ESP32 Controller

The ESP32 is a powerful microcontroller board with built-in Wi-Fi and Bluetooth capabilities. It is used to process data received from sensors and control various electronic components. In the Automated Warehouse Picking and Sorting Robot, the ESP32 acts as the main control unit of the system. It receives sensor inputs, processes the information, and sends control signals to the motors and robotic arm. It helps coordinate product detection, robot movement, and sorting operations. Its compact size, processing capability, and wireless communication features make it suitable for warehouse automation applications.

B. Ultrasonic Sensor



Fig-3.2 : Ultrasonic Senseor

The ultrasonic sensor is an electronic device used to measure the distance between the robot and nearby objects. It works by transmitting ultrasonic sound waves and calculating the time taken for the reflected waves to return to the sensor. The measured distance is then used by the controller to detect obstacles. In the Automated Warehouse Picking and Sorting Robot, the ultrasonic sensor helps the robot identify obstacles and avoid collisions during movement. It can also assist in maintaining a safe distance from objects in the working area. This improves the safety, reliability, and efficiency of the robotic system.

C. L298N Motor Driver



Fig 3.3: L298N Motor Driver

The L298N Motor Driver is an electronic module used to control the speed and direction of DC motors. It acts as an interface between the microcontroller and the motors because the controller cannot directly supply sufficient current to drive them. The module receives control signals from the ESP32 and provides the required power to operate the motors. In the Automated Warehouse Picking and Sorting Robot, it helps control the movement of the robotic vehicle, allowing it to move forward, backward, and turn in different directions. It supports smooth movement and improves the overall control of the robotic system.

D. Servo Motor



Fig 3.4: Servo Motor

A servo motor is an electromechanical device that provides accurate angular movement according to the control signals received from the microcontroller. It can rotate to specific angles, making it suitable for precise positioning tasks. In this project, the servo motor is used to control the movement of the robotic arm or gripper. It helps the robot pick up products and place them at the desired location during the sorting process.

E. Robotics Arm and Conveyor



Fig 3.5: Robotics Arm and Conveyor

The robotic arm and conveyor system are important components of the warehouse automation process. The robotic arm is designed to pick up products and place them at the required locations. The conveyor belt transports products from one section to another, making the sorting process easier and more efficient. Together, these components reduce manual handling, save time, and improve the overall performance of the warehouse picking and sorting system.

F. IR Sensor



Fig 3.6: IR Sensor

An Infrared (IR) sensor is an electronic device that detects objects using infrared light. It senses the presence of an object within its detection range and sends a signal to the microcontroller. In this project, the IR sensor can be used to detect products moving on the conveyor belt or identify obstacles, depending on its position and programming. It helps the robot perform object detection and supports the automation of the sorting process.

G. Power Supply



Fig 3.7: Power Supply

The power supply is responsible for providing electrical energy to the different components of the robotic system. It supplies the required voltage to the microcontroller, sensors, motor driver, and motors. A suitable power supply is necessary for the smooth and continuous operation of the robot. Proper power management helps maintain stable performance and prevents interruptions during the picking and sorting process.

H. Camera Module



Fig 3.8: Camera Module

The camera module is used to capture images of products placed in the warehouse system. These images can be processed using suitable image-processing software to identify products based on their shape, colour, or other visual features. In this project, the camera module can support product recognition and automatic sorting when integrated with an appropriate program. It helps improve the identification process and reduces the need for manual inspection.

I. Barcode Scanner



Fig 3.9: Barcode Scanner

A barcode scanner is an electronic device used to read the barcode printed on products. It converts the barcode into identification data that can be processed by a controller or computer. In this project, the barcode scanner helps identify products and determine their correct sorting destination according to predefined instructions. It improves the accuracy of product identification, reduces human errors, and supports efficient warehouse inventory management.

3. CONCLUSIONS

The Automated Warehouse Picking and Sorting Robot improves warehouse efficiency by automating product identification, picking, transportation, and sorting. It reduces manual effort, saves time, and minimizes sorting errors. With future improvements in artificial intelligence and machine vision, the system can provide smarter, faster, and more reliable warehouse operations.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my project guide and teachers for their valuable guidance, support, and encouragement throughout the completion of this project on “Automated Warehouse Picking and Sorting Robot.”

I am also thankful to my college for providing the necessary facilities and learning opportunities. Finally, I thank my family and friends for their continuous support and motivation in completing this project successfully.

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