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Automated Barcode -Based Warehouse Sorting System

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Abstract: In recent years, cctv cameras are used in various locations. The data captured by these cameras can be used for event prediction, real-time monitoring, and goal-oriented analysis, including anomaly and intrusion detection. With advancements in Artificial Intelligence, several methods are applied for anomaly detection, in which convolutional neural networks (CNNs) powered by deep-learning have improved detection accuracy. This article aims to introduce a novel deep learning- based approach for crime detection in video surveillance footage. this method has been tested on the UCSD dataset and has demonstrated improved accuracy in detecting criminal activities.

IndexTerms-BarcodeScanning,WarehouseAutomation,SortingSystem,EmbeddedSystems,Arduino,Stepper Motor,ServoMotor

I. INTRODUCTION

The Automated Barcode-Based Warehouse Sorting System streamlines the process of organizing and moving items within a warehouse, making it faster and more accurate. By leveraging barcodes to identify and categorize products, the system significantly enhances efficiency, accuracy, and processing speed. Each item is assigned a unique barcode that specifies its delivery location. Using this information, the system automatically sorts and routes packages to their designated areas in the warehouse for further processing and shipment, reducing errors and optimizing overall warehouse operations.

In the rapidly evolving landscape of supply chain and logistics, warehouse automation has become a cornerstone for improving operational efficiency, reducing manual labor, and enhancing accuracy. Among the various automation techniques, barcode-based sorting systems have emerged as a reliable and cost-effective solution for managing large volumes of inventory in warehouses and distribution centers..The traditional method of manual sorting is not only time-consuming but also prone to human errors, which can lead to misplaced items, inventory discrepancies, and delays in order fulfillment. To address these challenges, automated systems that leverage barcode scanning and electromechanical components—such as stepper motors and servo motors—have been developed. These systems are capable of identifying, categorizing, and directing products to designated storage locations or dispatch zones with minimal human intervention

I. LITERATURE SURVEY

[1]"SmartLogistics WarehouseManagement System Based on RFID and Internet of Things Technology"(2024)This paper explores the integration of RFID and IoT technologies to enhance logistics operations in warehouses. It discusses the implementation of real-time tracking, adaptive inventory management, and efficient sorting systems that optimize space utilization and improve processing accuracy, addressing challenges such as scalability and system responsiveness【20】.

[2]"Integration of RFID Technology in Automated Storage and Retrieval Systems" (2015) This study highlights how RFID is utilized in automated storage and retrieval systems (AS/RS) to improve warehouse efficiency. The paper discusses the use of programmable logic controllers (PLCs) and real-time inventory tracking systems to reduce human errors and accelerate sorting processes【19】.

[3]"RFID-Based Inventory Management System for Dynamic Warehousing"(2015) This research delves into RFID-enabled inventory systems capable of adjusting dynamically to real- time conditions in warehouses. It emphasizes accurate inventory tracking, reduced sorting errors, and better utilization of resources【19】.

[4]"Smart Warehouse Automation Using IoT and RFID for Real-Time Tracking"(2024) Examines the application of IoT and RFID for automating warehouse operations. The paper presents methods for integrating tracking and sorting functionalities with real-time monitoring to enhance efficiency and reduce operational overhead
【20】.

[5]Automated Sorting Systems Using Barcode TechnologySeveral researchers have proposed systems that combine barcode scanning with mechanical sorting units. For example, a study by Singh et al. (2019) developed an automated system using Arduino and IR sensors to detect packages and sort them based on barcode inputs. The system demonstrated increased speed and accuracy compared to manual sorting.

[6]Barcode Scanning Techniques and Their Reliability Research by Khan and Verma (2021) focused on the effectiveness of different barcode scanning technologies—laser, CCD, and camera-based scanners. The study concluded that CCD scanners provided a good balance of speed, cost, and reliability for warehouse environments, especially when integrated with embedded systems like Raspberry Pi or Arduino.

[7]Smart Warehousing and IoT Integration Recent trends in literature suggest a shift toward IoT-enabled smart warehouses. According to Guptaetal. (2022), integrating barcode-based systems with wireless communication modules and cloud databases allows real-time inventory updates and remote monitoring. Although these systems are more complex, they significantly enhance operational efficiency

[8]Role of Stepper and Servo Motors in Sorting ApplicationsMechanical motion in sorting systems is commonly driven by stepper motors for conveyor control and servo motors for actuation. In the work of Liu et al. (2018), a conveyor-based sorting system used stepper motors for precise package movement, while servo arms directed items to designated bins. The system achieved high reliability and repeatability in industrial simulations

[9]Enhancing Warehouse EfficiencyImplementing barcode systems has been shown to streamline warehouse processes. Kubáňová et al. (2022) focused on expanding the use of barcodes in logistics activities, emphasizing their role in error reduction and time-saving during the COVID-19 pandemic

[10]Barcode Implementation in Warehouse Efficiency Implementing barcodes has been shown to improve warehouse efficiency. Istiqomah et al. (2020) conducted a qualitative study on barcode implementation in warehouse management systems, highlighting its role in minimizing human error and providing accurate real-time data.

[11]Design of Sorting Machines Using Arduino Designing sorting machines with Arduino has been explored for automation. Kadole et al. (2020) developed a sorting machine using Arduino and IR sensors to sort products based on height, demonstrating its effectiveness in reducing manual sorting time

[12]Integration of Barcode in Warehouse Management SystemsIntegrating barcode technology into warehouse management systems enhances operational efficiency. Deepali et al. (2024) provided a framework for designing barcode-based WMS, offering practical guidance for organizations seeking to leverage this technology.

.[13]Barcode in Smart WarehousingSmart warehouses leverage barcode technology for automation. Gupta et al. (2022) discussed integrating barcode systems with wireless communication modules and cloud databases for real-time inventory updates.

[14]Barcode in Logistics and Warehouse ManagementApplying barcode technology in logistics and warehouse management has become essential for modernization. A study presented at the 2009 International Workshop on Education Technology and Computer Science emphasized the benefits of barcode technology in goods receiving, storage, and dispatch

[15]Enhancing Warehouse Efficiency Implementing barcode systems has been shown to streamline warehouse processes. Kubáňová et al. (2022) focused on expanding the use of barcodes in logistics activities, emphasizing their role in error reduction and time-saving during the COVID-19 pandemic

[16]Advanced Sorting SystemsAdvanced sorting systems utilizing barcode technology have been developed to improve accuracy and speed. Li et al. (2019) designed an inventory system based on barcode scanning technology, incorporating digital image processing to enhance scanning speed and recognition accuracy.

[17] Barcode Implementation in Warehouse EfficiencyImplementing barcodes has been shown to improve warehouse efficiency. Istiqomah et al. (2020) conducted a qualitative study on barcode implementation in warehouse management systems, highlighting its role in minimizing human error and providing accurate real-time data.

[18]“Optimization of Conveyor-Based Barcode Sorting Systems inWarehousing"(2019) Investigates the design and optimization of barcode sorting systems integrated with conveyors. The study evaluates the performance benefits of combining barcode scanning with automated routing systems to streamline warehouse operations and minimize delays【18】

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II. Methodology

A. Block diagram

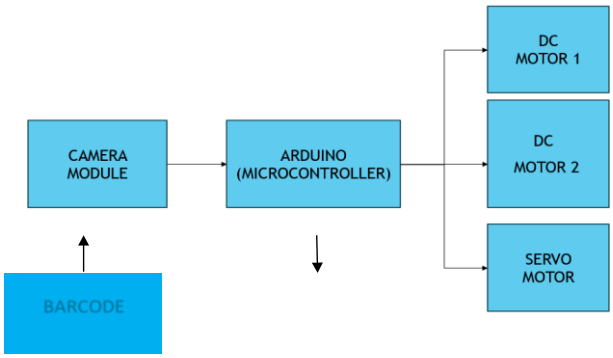


Figure 1 : Block Diagram of literature survey on automated barcode -based warehouse sorting system

In this system, everything is controlled by the Arduino microcontroller. The camera module is connected to the Arduino to scan barcodes and send the data for processing. Based on this barcode data, the Arduino manages the operations of the conveyor belts.

The first DC motor is used to rotate the first conveyor belt, moving products along the system. The second DC motor is responsible for controlling the second conveyor belt, ensuring smooth movement for further sorting or transportation of items. Additionally, the servo motor is also controlled by the Arduino. It changes the direction of the second conveyor belt to route products to different areas based on the scanned barcode information.

In essence, the Arduino microcontroller coordinates all actions within the system, from reading the barcode to controlling both DC motors and the servo motor for efficient sorting and movement of products within the warehouse or processing system.

B. WORKING

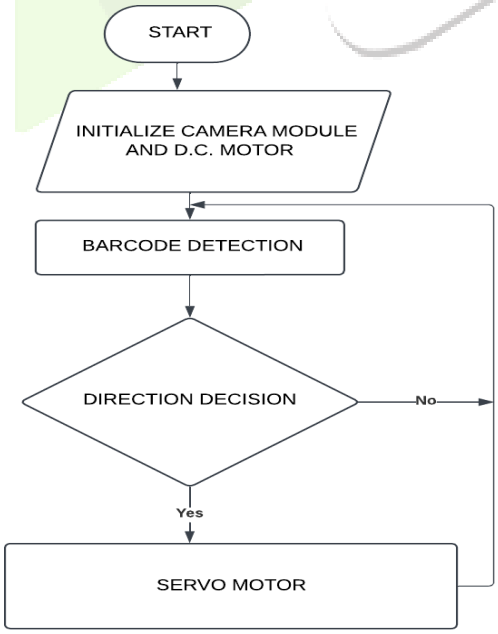
The system consists of two conveyor belts. A barcode scanner is positioned at the beginning of the first conveyor belt. As a product is placed on the belt, the barcode scanner reads the barcode attached to the product. The scanner sends the data to an Arduino microcontroller for processing.

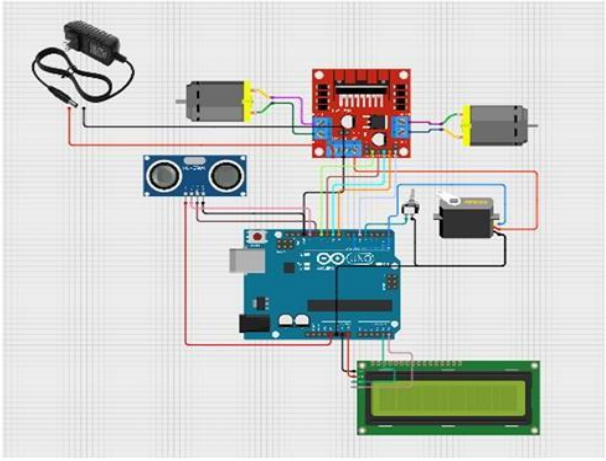
The Arduino analyzes the received barcode data to determine the product's designated direction—North, East, West, or South. Each direction is pre-configured with a unique angle corresponding to the servo motor's position.

The second conveyor belt is equipped with a servo motor controlled by the Arduino. Based on the analysis, the Arduino instructs the servo motor to adjust its angle to align with the appropriate direction. Once aligned, the p roduct moves from the first conveyor belt to the second, which then redirects the product to its specified path.

This setup ensures that products are sorted and sent to their designated directions automatically, improving efficiency and accuracy in the sorting process

c. Flowchart of literature survey on automated barcode -based warehouse sorting system





D.Circuit diagramliterature survey on automated barcode -based warehouse sorting system

Figure 3.1:Circuit diagramliterature survey on automated barcode -based warehouse sorting system

This is a circuit diagram representing an automated sorting system using an Arduino microcontroller. The system consists of motors, an ultrasonic sensor, an LCD display, a motor driver module, and a servo motor.

DC Motors: Two DC motors are used to drive the conveyor belt. Controlled using an L298N motor driver module. L298N Motor Driver Module (Red Board) :Controls the speed and direction of the DC motors. Acts as an interface between the Arduino and the motors. Servo Motor: Used for sorting by pushing or diverting objects to different locations. Receives signals from the Arduino to adjust position accordingly. LCD Display : Displays system status, barcode readings, or sorting information. Connected to the Arduino for real-time data display. Power Supply: Provides power to the entire system, including motors and sensors.Object Detection: The ultrasonic sensor detects an approaching object on the conveyor belt. Data Processing: The Arduino processes the information and determines if sorting is required. Motor Control: The L298N motor driver controls the DC motors to move the conveyor belt. The Servo motor is activated if an item needs to be sorted. Sorting Action : The Servo motor moves to guide the object to its correct bin or location. Display Updates: The LCD screen updates with relevant sorting information, such as the item ID

III. Results of Integrated crime detection and alert system .

Figure 4.1: Initial Display

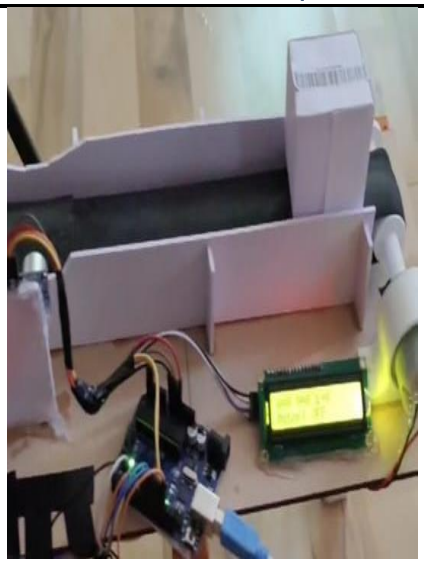


Figure 4.2:Product at first conveyor belt

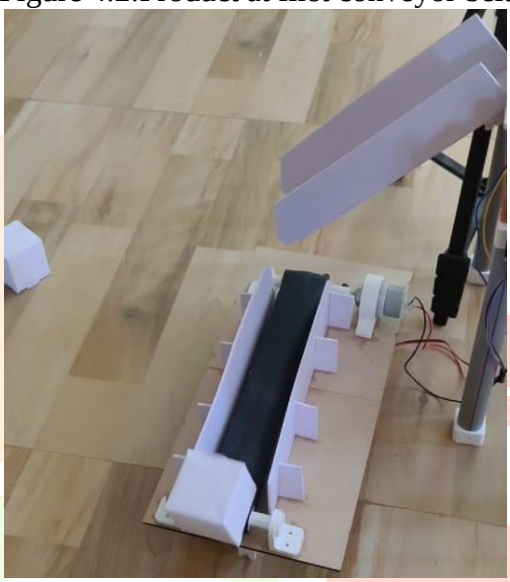


Figure 4.2:Product at end of 2nd conveyor belt

Figure 4.3:Final display

IV. Applications

1. E-commerce and Retail Order Fulfillment: Quickly and accurately sorts products to fulfill online orders. Inventory Management: Tracks product movement and ensures real-time inventory updates. Shipping and Dispatch: Automates the sorting of packages for delivery to specific locations.

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2. Logistics and Supply Chain Parcel Sorting: Sorts parcels based on destination codes to streamline transportation. Cross-Docking: Ensures items are sorted and moved to outbound trucks without intermediate storage. Route Optimization: Groups products or packages based on delivery routes.

3. Manufacturing Raw Material Sorting: Manages incoming materials, directing them to the correct production lines. Finished Goods Handling: Automates the sorting of finished goods for packaging and shipping.

4. Healthcare and Pharmaceuticals Medicine Sorting: Organizes medications for storage and dispatch to hospitals, clinics, or pharmacies. Order Accuracy: Reduces errors in sorting and dispatching critical medical supplies.

5. Food and Beverage Perishable Goods Sorting: Prioritizes sorting based on expiration dates or cooling requirements. Batch Tracking: Assists in sorting food items based on production batches for traceability

6. Automotive Industry Spare Parts Sorting: Automates the handling of automotive parts for assembly or shipment. Warehouse Management: Ensures real-time tracking and sorting of parts inventory.

7. Apparel and Fashion Product Categorization: Sorts clothing and accessories by size, color, or design for efficient distribution. Returns Management: Streamlines the sorting process for returned items

8. Third-Party Logistics (3PL) Custom Sorting Solutions: Adapts to the unique sorting needs of clients in various industries. Scalability: Handles large volumes of parcels during peak seasons.

9. Postal and Courier Services Mail Sorting: Automates the sorting of letters and parcels by destination. Delivery Efficiency: Speeds up the process of dispatching packages for last-mile delivery.

10. Electronics and Technology Component Sorting: Manages the sorting of small electronic components for assembly lines. Reverse Logistics: Facilitates the sorting of returned or defective items for reprocessing

V. Conclusion and Future scope

The system's real-time tracking capabilities ensure better inventory management, reducing delays and optimizing warehouse space utilization. Additionally, its scalability allows seamless expansion for growing businesses, making it adaptable to various warehouse sizes and industry needs. By leveraging AI, IoT, and robotic automation, it enables predictive maintenance, demand forecasting, and seamless warehouse-towarehouse coordination, transforming traditional supply chains into smart, data-driven ecosystem AI and Machine Learning Integration Predictive analytics for demand forecasting. AI-driven route optimization for faster deliveries. Automated anomaly detection for quality control. 2. IoT-Based Real-Time Monitoring Smart sensors for tracking product movement. Cloud-based dashboards for live inventory management. Automated alerts for temperature-sensitive shipments. 3. Expansion to Multi-Warehouse Networks AI-driven inter-warehouse coordination. Blockchain for secure and transparent supply chain tracking. Automated warehouse-to-warehouse inventory balancing. 4. Automated Guided Vehicles (AGVs) Self-navigating robots for material handling. Reduced human intervention in warehouse logistics. 5. Augmented Reality (AR) for Warehouse Operations AR-assisted picking and sorting for workers. Hands-free inventory management using smart glasses. 6. Energy-Efficient Sorting Systems Green logistics with low-power automation. AI-driven power optimization for conveyor belts and motors. 7. Energy-Efficient Sorting Systems Green logistics with low-power automation. AI-driven power optimization for conveyor belts and motors

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