IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 8, April 2025
Impact Factor: 7.67

Development of a Vertical Sorting Unit for Efficient Material Handling: Case Study

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Abstract: *In modern logistics and manufacturing industries, the need for efficient and space-saving material sorting systems is rapidly increasing. This report presents the design and development of a Vertical Sorting Unit (VSU), engineered by final-year students of the Department of Mechanical Engineering at [Your College Name]. The VSU aims to optimize material handling by enabling vertical sorting, thus minimizing floor space usage and increasing operational efficiency.*

Keywords: modern logistics

I. INTRODUCTION

Traditional sorting systems typically operate in a horizontal layout, consuming large amounts of space and requiring extensive conveyor mechanisms. The growing demand for compact and efficient systems in industries such as logistics, e-commerce, and warehousing motivated our team to design a vertically-oriented sorting unit. This project was initiated as part of the final-year capstone project with the objective of developing a scalable prototype that demonstrates the key features of vertical sorting while integrating basic automation principles.

II. OBJECTIVE

- To design a space-efficient vertical sorting unit suitable for small to medium-scale applications.
- To automate the sorting process using sensors and microcontrollers.
- To reduce human effort and error in the material handling process.
- To create a working prototype capable of sorting based on item weight, size, or barcodes

III. METHODOLOGY

The development of the VSU was carried out in several stages:

a. Design:

- CAD models were created using SolidWorks for the frame and sorting mechanism.
- A vertical frame was designed with multiple tray levels for sorting.
- Each tray corresponds to a predefined sorting category.

b. Components Used:

Arduino Uno (Microcontroller)

- IR Sensors and Load Sensors for object detection and classification
- Servo Motors and Stepper Motors for tray actuation
- Conveyor belt system for item input Mild Steel and Acrylic materials for structure

c. Fabrication:

- The frame was built using lightweight steel.
- Sensors and actuators were mounted with precision to align with trays.

DOI: 10.48175/568

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- Electrical components were soldered and integrated with the Arduino controller.

d. Programming:

- Arduino code was developed to control the sensors and motors.
- The program uses sensor input to determine the appropriate tray and activates the motor to guide the item.

IV. WORKING PRINCIPLE

- Item Detection: The object is placed on the input conveyor where it passes under a series of sensors.
- Classification: Based on parameters (such as weight or height), the item is categorized.
- Tray Selection: The control unit selects the corresponding tray.
- Actuation: A mechanical diverter or chute directs the item to the vertical tray assigned.
- Sorting Complete: The object is stored in the tray until manually or automatically collected.

V. CONCLUSION

The development of the Vertical Sorting Unit represents a significant step towards compact and efficient automation in material handling. The success of the project not only demonstrates the practical skills of students but also opens avenues for future research, optimization, and industrial collaboration. With continued support and enhancements, the VSU has the potential for real-world deployment in logistics and warehousing sectors.

VI. FUTURE SCOPE

- Integration with AI and Machine Learning for smart sorting.
- Addition of barcode and QR code scanning for dynamic classification.
- Expansion to multi-directional sorting with robotic arms.
- Use of IoT for real-time monitoring and data collection.

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