Automated Ferrous and NonFerrous Sorting using Inductive Proximity Sensor with Conveyor Belt and Live Monitoring

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Abstract –

The proper separation of ferrous and non-ferrous metals plays a critical role in recycling and manufacturing processes. This research proposes an automatic metal sorting system that involves the use of an inductive proximity sensor with a conveyor belt system. The system operates based on object detection laid on the conveyor belt by the inductive proximity sensor, which determines whether the object is ferrous or non-ferrous. A motorized sorting system, consisting of a vertically mounted motor with a mounted thin sheet, facilitates efficient sorting. The motor runs in its natural mode to sort non-ferrous metals and reverses its mode when ferrous metals are detected, ensuring accurate separation. An ESP32-CAM module, used for real-time monitoring and live streaming, is part of the system, which facilitates remote monitoring of the sorting processes. An ESP8266 microcontroller, integrated with an L298N motor driver, controls the operational processes of the system. An AI-based counter, which tracks the count of ferrous and non-ferrous objects sorted, is also part of the system. This project proposes a cost-effective and automated solution towards metal sorting, with high applicability in waste management, recycling, and industrial automation.

1.INTRODUCTION

Metal segregation is an important operation in recycling, waste treatment, and manufacturing industries. Effective differentiation between ferrous and non-ferrous metals enhances the efficacy of resources and minimizes environmental degradation. The conventional sorting procedure is based on manual intervention, which is error-prone and time-consuming. To overcome such limitations, automated metal sorting equipment with sensors and real-time monitoring has become indispensable.

1.1 Metal Sorting using Inductive Proximity Sensor

This research project involves the creation of an automatic sorting system for metals, utilizing an inductive proximity sensor to detect ferrous and non-ferrous material. The items are placed on a conveyor belt, where the sensor detects the material type. A motorized sorting system separates the items based on the type of classification determined by the sensor. The system is controlled by an ESP8266 microcontroller, which guarantees proper and efficient operation.

1.2 Real Time Monitoring

To further improve monitoring and data acquisition, the system incorporates an ESP32-CAM module for real-time streaming of the sorting process. Moreover, the system includes an AI-driven counter that monitors the volume of ferrous and non-ferrous objects sorted, showing real-time figures. The integration of automation, sensor technology, and AI enhances the accuracy of sorting and facilitates remote monitoring, thus being a cost-efficient solution for industrial and recycling processes.

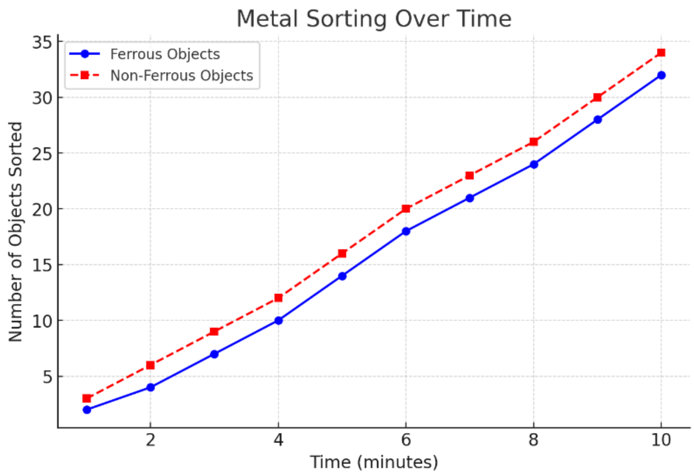


Chart -1: Metal Sorting Over Time

The graph displays the count of ferrous and non-ferrous items separated over time by the automatic metal sorting system. With time passing, the count of both ferrous and non-ferrous metals increases, reflecting the steady operation of the system. The non-ferrous items are separated at a slightly increased rate than ferrous items because of their greater prevalence or quicker default separation process. This visualization assists in examining the efficiency and regularity of the sorting process throughout a specified period of time.

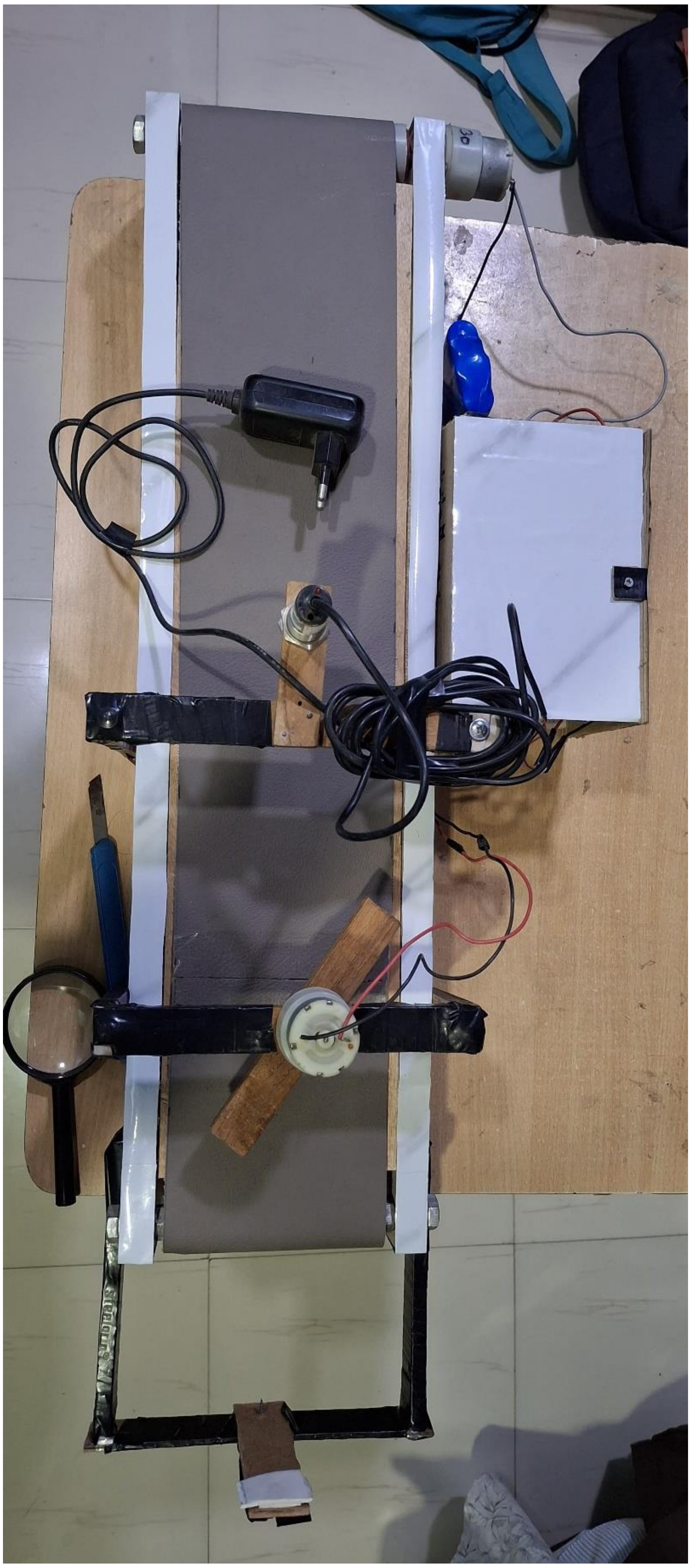


Fig -1: Project Model

METHODOLOGY

The methodology of the automated metal sorting system is a systematic process of detecting, classifying, and sorting ferrous and non-ferrous metals with real-time monitoring and AI-based counting. The steps are as follows:

1. Placement of Object on Conveyor Belt

The metal object is placed on a conveyor belt driven by a 12V DC motor. The conveyor belt is moved at a controlled speed to facilitate proper detection and sorting.

2. Metal Detection Via Inductive Proximity Sensor

As the object travels on the conveyor belt, it goes through an inductive proximity sensor. The sensor identifies if the object is ferrous or not ferrous based on its electromagnetic reaction.

3. Signal Processing and Categorization

The inductive proximity sensor sends the signal to the ESP8266 microcontroller. The microcontroller processes the sensor information and decides the category of the object:

Ferrous Metal: Picked up by the sensor because of its magnetic nature.

Non-Ferrous Metal: Not picked up by the sensor, since it is not magnetic.

4. Activation of Sorting Mechanism

A 12V DC motor, with a thin deflector sheet attached, is employed to sort objects.

The motor works as follows:

Default Rotation: Non-ferrous objects are allowed to move further along the conveyor belt.

Reverse Rotation: When the object is ferrous, the motor turns around, moving the deflector sheet to deflect the object into an alternate collection area.

5. Live Monitoring through ESP32-CAM

An ESP32-CAM module records and streams the sorting activity in real time. The real-time feed is accessible remotely for monitoring.

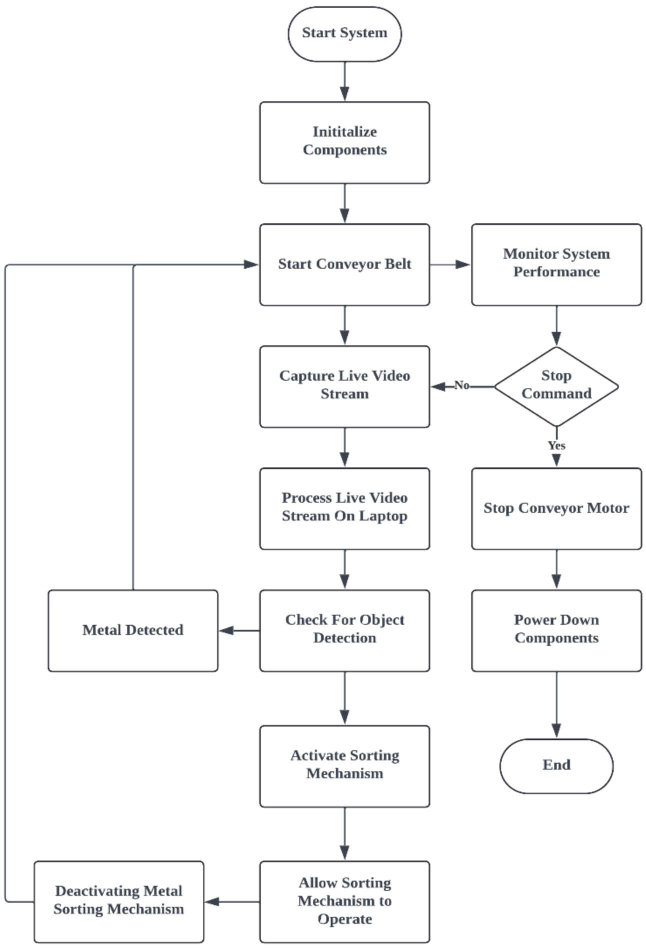
6. AI-Based Counting and Display

Data is processed using an AI-based system to determine the number of ferrous and non-ferrous items. The count is displayed on an attached screen for real-time monitoring.

7. Data Analysis and Optimization

Data is accumulated on sorting over a period of time, which is used to enhance efficiency. Possible enhancements involve modifying conveyor speed, sensor positioning optimization, and cloud-based monitoring integration.

FLOW CHART



Benefits of the Automated Metal Sorting System

1. Improved Efficiency – Automates sorting, minimizing the use of manual labor.
2. High Accuracy – Employs an inductive proximity sensor to accurately sort ferrous and non-ferrous metals.
3. Real-Time Monitoring – ESP32-CAM facilitates live streaming and remote monitoring.
4. AI-Based Counting – Monitors and shows the number of sorted objects for analysis.

Shortcomings of the Automated Metal Sorting System

1. Restricted to Metal Detection – Ineffective for sorting materials apart from metals.
2. Initial Cost – Needs to be invested in parts such as sensors, motors, and microcontrollers.
3. Sensor Accuracy Dependence – Dependent on the sensitivity of the inductive proximity sensor.
4. Potential Maintenance Problems – Maintenance is needed for motors and conveyor belts.

Need for This Project

1. Enhancing Recycling Efficiency – Helps manage wastes by accurately separating recyclable metals.
2. Industrial Automation – Reduces reliance on human labor, boosting productivity in metal processing plants.
3. Cost Savings – Minimizes operational costs by restricting human intervention.
4. Monitoring-Driven By Data – Provides real-time data for analysis and optimization.
5. Improved Workplace Safety – Eliminates human touch in risky sorting plants.
6. Scalable For Mass Implementation – Can be scaled to handle large loads in enterprises.
7. Integrability in Smart Manufacturing – Can be integrated with IoT devices for remote monitoring and control.

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REFERENCES

[1] Paul J. LaNasa: "Automated Continuous Process Control"

[2] John J. Craig: "Introduction to Robotics: Mechanics and Control"

[3] W. Zhang et al: "Intelligent Sorting of Materials Based on Image Processing and Machine Learning Techniques,"

[4] S. Smith, A. Jones: "Metal Detection Techniques in Recycling,"

[5] Automation.com: "How Inductive Proximity Sensors Work"

[6] ResearchGate: "Understanding Image Processing Techniques"