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Arduino Based Object Sorting System

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Abstract: *This paper presents an Arduino-Uno-based object sorting machine designed for efficient sorting of items, particularly suited for warehouses and industries dealing with large quantities of items like glass bottles. The machine offers time and cost savings by automating the sorting process, reducing reliance on manual labor. With an average sorting time of 6 seconds per object, it's a viable solution for industries employing Mechatronics systems.*

Keywords: Arduino-Uno, object sorting, Mechatronics, automation, efficiency

I. INTRODUCTION

1.1 Overview

In today's fiercely competitive manufacturing landscape, achieving optimal production efficiency is paramount for success. Efficiency encompasses various aspects such as the speed of production equipment, minimizing material and labor costs, enhancing product quality, reducing rejects, and minimizing downtime. As industries strive to excel in this modern era, the performance of manufacturing processes stands as a crucial determinant of their viability. Enhancing production speed, reducing labor costs, and minimizing equipment downtime are pivotal objectives to ensure competitiveness and sustainability.

Automation emerges as a pivotal solution in augmenting manufacturing efficiency by replacing manual efforts with sophisticated control systems. While the implementation of automated systems may initially incur higher costs due to complex algorithms, the long-term benefits outweigh the investment. Automation not only streamlines processes and reduces manual labor but also affords time for focusing on aspects like aesthetics and quality improvement. Furthermore, the utilization of automation mitigates risks associated with human involvement in hazardous environments, ensuring a safer working environment.

The advent of embedded technology has revolutionized various industries, including industrial automation, home appliances, automobiles, and aeronautics. Embedded systems, leveraging PCs or controllers, execute dedicated tasks efficiently, with programming executed using assembly language or Embedded C. With industrial automation and robotics witnessing high demand, the emphasis on product quality and flexibility becomes paramount. Automation, facilitated by industrial robots, promises a significant transition in the manufacturing landscape, offering superior speed, consistency, and accuracy.

Color-based sorting, a widely adopted technique across industries such as food processing, pharmaceuticals, automotive, and agriculture, exemplifies the efficacy of automation in enhancing manufacturing processes. By reducing human effort, labor costs, and operation time, color-based sorting optimizes efficiency while ensuring product quality meets desired standards. Automation's role in grading systems within agriculture and related industries underscores its potential to meet increasing demands for high-quality products promptly, fostering industry growth and development.

In this context, this paper delves into the realm of automation in sorting systems, with a focus on the utilization of color sensors for enhanced efficiency and precision. By elucidating the principles of sorting, the significance of automation, and the evolution of color sensing technologies, this paper aims to underscore the transformative potential of automated sorting systems in modern manufacturing environments.

1.2 Motivation

In the fiercely competitive landscape of modern manufacturing, the pursuit of enhanced production efficiency is imperative for staying ahead. Automation presents a compelling solution, offering the promise of reducing manual

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efforts, streamlining processes, and improving overall productivity. With the potential to lower labor costs, minimize downtime, and enhance product quality, the motivation behind embracing automation lies in its ability to drive competitiveness and sustainability in industrial operations.

1.3 Problem Definition and Objectives

In traditional manufacturing settings, manual sorting processes are time-consuming, labor-intensive, and prone to errors, hindering efficiency and product quality. The need for a more streamlined and accurate sorting solution is evident to meet the demands of modern industrial operations.

- Investigate the effectiveness of implementing automated sorting systems.
- Assess the impact of automation on reducing labor costs and increasing productivity.
- Evaluate the accuracy and efficiency of color-based sorting techniques.
- Analyze the potential benefits of automation in improving product quality and minimizing downtime.

1.4.Project Scopeand Limitations

This project aims to design, develop, and evaluate an automated object sorting system using Arduino-Uno, focusing on its application in industrial settings such as warehouses and manufacturing facilities. The scope includes the implementation of color-based sorting techniques to enhance efficiency and productivity, with a specific emphasis on reducing labor costs and improving product quality.

Limitations As follows:

- The scope of this project is limited to the sorting of objects based on color using a predefined algorithm.
- The hardware components and resources available may impose constraints on the complexity and scalability of the sorting system.
- External factors such as environmental conditions and variations in object characteristics may affect the accuracy and reliability of the sorting process.

II. LITERATURE REVIEW

1. Paper Title: "Automation in Object Sorting Systems: A Comprehensive Review"

This paper provides a thorough examination of automation techniques applied in object sorting systems across various industries. It explores the evolution of sorting technologies from manual to automated systems, highlighting the key advancements and challenges faced. The review encompasses a wide range of sorting methodologies, including color-based sorting, sensor-based sorting, and machine learning-based approaches. Additionally, the paper discusses the integration of emerging technologies such as Internet of Things (IoT) and artificial intelligence (AI) in modern sorting systems.

2. Paper Title: "Efficiency Improvement in Industrial Sorting Processes Through Automation"

Focusing on industrial applications, this paper investigates the role of automation in enhancing efficiency in sorting processes. It discusses the economic benefits of automation, including reduced labor costs, increased throughput, and improved product quality. Through case studies and empirical analysis, the paper illustrates how automation technologies, such as robotic arms and computer vision systems, streamline sorting operations in manufacturing facilities. Furthermore, it evaluates the impact of automation on overall production efficiency and competitiveness in the market.

3. Paper Title: "Color-Based Sorting Systems: A Review of Techniques and Applications"

This review paper provides an in-depth analysis of color-based sorting systems, emphasizing their significance in various industries such as food processing, recycling, and pharmaceuticals. It explores different techniques employed for color sensing and identification, including RGB color sensors, hyperspectral imaging, and machine learning algorithms. The paper evaluates the effectiveness of color-based sorting in improving product quality, reducing waste, and enhancing productivity. Furthermore, it discusses the challenges associated with color-based sorting, such as variability in lighting conditions and object characteristics.

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4. Paper Title: "Integration of Embedded Systems in Object Sorting Machinery: State-of-the-Art Review"
Focusing on embedded systems, this paper reviews the integration of embedded technology in object sorting machinery. It examines the design considerations and implementation challenges involved in developing embedded systems for sorting applications. The review encompasses a range of embedded platforms, including Arduino, Raspberry Pi, and FPGA-based systems, highlighting their suitability for different sorting tasks. Additionally, the paper discusses the role of embedded systems in enabling real-time data processing, communication, and control in sorting machinery, thereby enhancing automation and efficiency.

5. Paper Title: "Challenges and Opportunities in Implementing Automated Sorting Systems in Warehouse Logistics"
This paper addresses the challenges and opportunities associated with implementing automated sorting systems in warehouse logistics. It discusses the operational requirements, technical considerations, and cost implications of deploying automated sorting solutions in warehouse environments. Through case studies and industry examples, the paper highlights the benefits of automation in improving order fulfillment, inventory management, and overall warehouse efficiency. Furthermore, it examines emerging trends such as robotic picking systems, autonomous mobile robots, and AI-driven warehouse management systems, shaping the future of warehouse logistics.

III. REQUIREMENT AND ANALYSIS

a) Arduino UNO R3:
Description: Arduino Uno is a microcontroller board based on the ATmega328P, featuring digital and analog input/output pins, USB connectivity, and a 16 MHz clock.
Specifications: It operates at 5V, with input voltage ranging from 7-12V (6-20V limit). It has 14 digital I/O pins, 6 analog inputs, and a clock speed of 16 MHz.
Application: Used as the central control unit in the automation system, responsible for processing sensor data and controlling servo motors.

b) Servo Motors for Arduino:
Description: High-torque MG996R digital servo with metal gearing, capable of providing 9.4 kgf.cm stall torque at 4.8V and 11 kgf.cm at 6V.
Specifications: Weighs 55g, dimensions of 40.7 x 19.7 x 42.9 mm, operating speed of 0.17 s/60º at 4.8V.
Application: Used for actuating the sorting mechanism in the automation system based on signals from the Arduino.

c) TCS230 Color Sensor:
Description: Programmable color light-to-frequency converter, capable of detecting color and providing output frequency proportional to light intensity.
Specifications: Operates at voltages between 4.8V to 7.2V, with photodiodes for red, green, blue, and clear light detection.
Application: Used for color detection in the automation system, providing feedback to the Arduino for sorting objects based on color.

d) Infrared Object Detection Sensor:
Description: Medium-range infrared sensor for obstacle detection, utilizing modulated IR signal for non-contact detection.
Specifications: Sensing distance adjustable, immune to interference from ambient light sources.
Application: Used for detecting the presence of objects on the conveyor belt in the automation system, triggering the color sensing and sorting process.

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IV. SYSTEM DESIGN

4.1 System Architecture

The below figure specified the system architecture of our project.

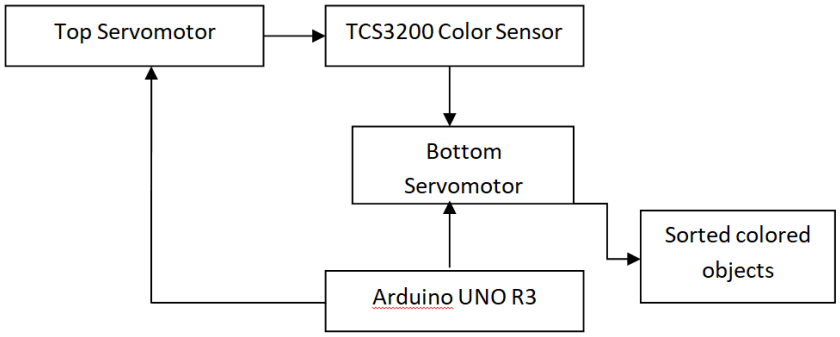

Figure 4.1: System Architecture Diagram

4.2 Working of the Proposed System

The proposed system is designed to automate the process of object sorting based on color detection using Arduino UNO R3, servo motors, and a TCS230 color sensor. The system operates in several stages to efficiently sort objects based on their colors. Initially, the object is placed on a conveyor belt, and an infrared object detection sensor detects its presence, signaling the system to start. As the object moves along the conveyor belt, it reaches a position where the TCS230 color sensor is stationed. The color sensor then identifies the color of the object by analyzing the light reflected from it.

Upon detecting the color of the object, the Arduino UNO R3 processes this information and sends instructions to the servo motors. The servo motors are responsible for actuating the sorting mechanism, which diverts the object to the appropriate sorting bin based on its color. For example, if the object is identified as yellow, the sorting mechanism directs it towards the designated bin for yellow objects. Similarly, if the object is red, it is sorted into the bin allocated for red objects. This process of color detection and sorting is repeated for each object placed on the conveyor belt.

The system ensures accurate and efficient sorting of objects, reducing the need for manual intervention and minimizing errors. By leveraging the capabilities of Arduino UNO R3 and servo motors, coupled with the precision of the TCS230 color sensor, the proposed system streamlines the sorting process in various industrial applications. With its modular design and customizable parameters, the system can be adapted to different sorting requirements, making it a versatile solution for warehouses, manufacturing facilities, and other industries requiring automated object sorting based on color.

The proposed system offers flexibility and scalability, allowing for easy integration into existing production lines or standalone operations. Its compact design and straightforward operation make it suitable for deployment in diverse environments with minimal setup and maintenance requirements. Additionally, by automating the sorting process, the system enhances overall productivity and throughput, leading to cost savings and improved efficiency. With its robust performance and user-friendly interface, the proposed system represents a significant advancement in automation technology, offering a reliable solution for optimizing object sorting tasks in modern industrial settings.

4.3 Circuit Layout

The below figure specified the Circuit Layoutof our project.

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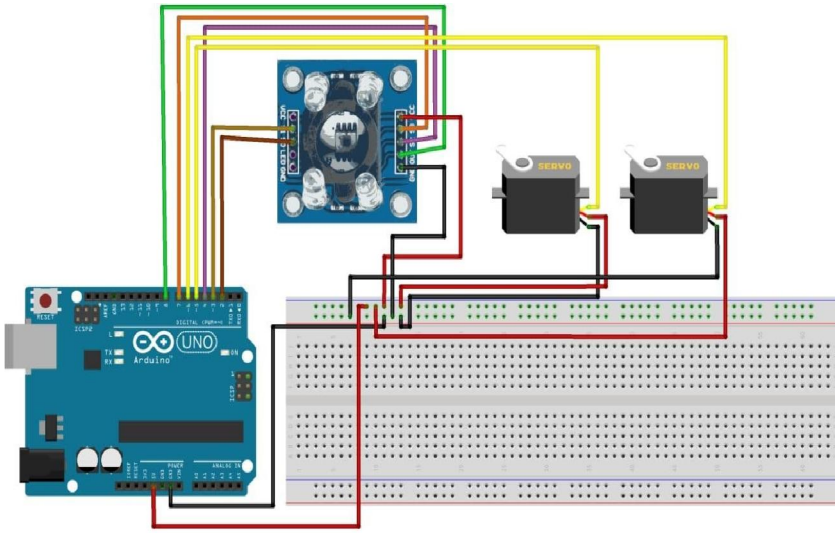

Figure 4.2: Circuit Layout

4.4 Result

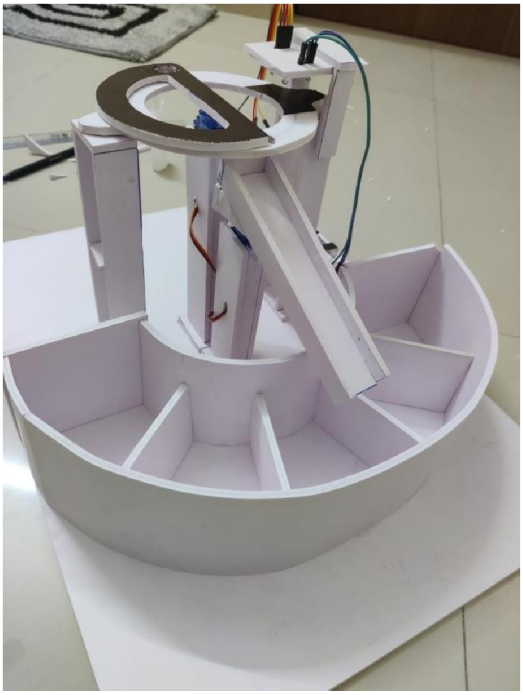

Figure 4.3: Sorting objects according to the color sensed by the TCS2300 color sensor

This system has been developed as a sorting machine using Arduino for automatic color sorting, taking into consideration two colors namely yellow and Red. So the results are shown as the following figures step by step involved in the process. To test the color detection and sorting of objects, lemon and tomato are considered in this project.

Firstly, the object will be sensed by the infrared detection object sensor as the object moves on the conveyor belt. At the second stage, it senses the object color by TCS2300 color sensor. In this stage, when the object (lemon or tomato) reached under the sensor, the sensor starts reading it. Upon sensing the color of object, the servo motor

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rotates to the specific positions for each color as programmed in the Arduino. Figure 5.1 shows the detailed result of sorting objects according to the color sensed by the TCS2300 color sensor.

V. CONCLUSION

Conclusion

In today's highly competitive industrial production environment, maintaining the integrity of a product's supply chain from raw material to finished product through quality manufacturing is critical. The bearing of high quality and dimensional precision is required for the declaration of a product. As a result, because of its working concept and vast use, this automatic color sorting project is a great one. An industry can quickly sort the required product based on its coloration by implementing the project's concept. This concept can be used in a variety of applications.

Future Work

It is very useful in wide varieties of industries along with the help of PLC and SCADA, especially in the packaging section. Automatic sorting machine enhances efficiency, practicality, and safety of operators. It ensures remarkable processing capacity as well as peerless performance including color detection. Of course we need to add high speed DC motors and sensors with appreciable response to speed up the system for industrial applications.

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