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Colour Based Item Sorting Using Robotic Arm

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Abstract*: Efficient sorting is essential for industries with high production rates, but traditional manual methods are often slow and labor-intensive. To address this challenge, we propose an automatic item sorting system that utilizes color-based technology for enhanced speed and precision. The system integrates a conveyor belt for smooth item movement, color sensors to identify and classify products, and a pick-and-place mechanism for accurate placement. An Arduino coordinates these components, ensuring seamless operation and adaptability to various sorting criteria. This automated system offers numerous advantages, including faster and more accurate sorting, reduced labor costs, and minimized errors. Its modular design allows easy scalability and customization, making it suitable for diverse industries like manufacturing, retail, pharmaceuticals, and food processing. By combining efficiency, flexibility, and cost savings, this solution is a significant step toward modernizing industrial operations.*

Keywords: sorting, controlling, robotic arm, conveyor belt, color sensor

I. INTRODUCTION

Automation has become a key driver of efficiency and precision in various industries. Sorting systems, in particular, play a vital role in manufacturing, packaging, and quality control, where items need to be categorized based on attributes such as color, size, or type. While many existing sorting systems are expensive and complex, this project focuses on developing a cost-effective and efficient alternative suitable for small-scale industries. The goal of this research is to design an automated color sorting system that integrates a conveyor belt, a robotic arm, and advanced sensors to streamline the sorting process.

The system uses a color sensor (TCS3200) to detect the color of items moving along the conveyor belt. A proximity sensor then detects the position of the item, triggering the robotic arm, which is controlled by an Arduino Uno. The robotic arm, equipped with a vacuum gripper, picks up the item and places it in the designated bin based on its color.

Unlike more expensive, complex systems, this design prioritizes affordability and simplicity without compromising efficiency or reliability. By using widely available components and minimizing unnecessary complexity, the system offers an accessible solution for small-scale industries that require an effective sorting system. The goal is to provide a system that is not only functional but also cost-effective, making it a practical choice for businesses seeking automation in their sorting processes.

This paper details the design, development, and testing of the system, offering insights into how automation can be leveraged to enhance sorting processes in industrial applications, with an emphasis on creating a solution that is both efficient and affordable.

II. LITERATURE REVIEW

The development of an automatic color sorting system has been the subject of numerous studies, each contributing to different technological advancements in sorting processes. This section presents a review of the research papers consulted, with a focus on key technologies such as sorting processes, sensor integration, vacuum gripping mechanisms, robotic arms, and actuators. These studies provide a comprehensive foundation for understanding the components and mechanisms required for designing an efficient and effective color sorting system.

A. Thike, Z. Z. Moe San, and D. Z. Min Oo, "Design and Development of an Automatic Color Sorting Machine on Belt Conveyor" (2015)

In this study, Thike et al. (2015) explore the design and development of an automatic color sorting system utilizing a belt conveyor. The research emphasizes the role of the conveyor belt as a transport mechanism for items that need to be sorted. As objects move along the conveyor, a detection point identifies their color, and the system sorts them accordingly. The study highlights the efficiency and reliability of conveyor belts in sorting systems, demonstrating how this simple yet effective mechanism enables fast, continuous operation. This research was instrumental in understanding how materials can be handled efficiently while being sorted by color in an automated setting.

C. K. Kunhimohammed, M. S. K. K, S. Sahna, M. S. Gokul, and S. U. Abdulla, "Automatic Color Sorting Machine Using TCS230 Color Sensor and PIC Microcontroller" (2018)
Kunhimohammed et al. (2018) investigate the integration of color sensors and microcontrollers for automatic color sorting. The authors utilized the TCS230 color sensor to detect the color of objects as they pass through the sorting system. The sensor's data is processed by a PLC microcontroller, which then determines the sorting action required for each object. This combination of color detection and processing is crucial for achieving accuracy and reliability in sorting operations. The study was significant in understanding the technical aspects of color sensor integration and the role of microcontrollers in processing sensor data to drive sorting decisions.

M. L. Dezaki, S. Hatami, A. Zolfagharian, and M. Bodaghi, "A Pneumatic Conveyor Robot for Color Detection and Sorting" (2017)
Dezaki et al. (2017) explore the use of pneumatic systems, specifically vacuum grippers, in automated color sorting systems. The study highlights the importance of vacuum grippers in handling items, offering a gentle yet efficient method for picking up objects without causing damage. By utilizing pneumatic actuators, the system offers flexibility in handling different types of objects, regardless of their shape or fragility. This paper was crucial in understanding how vacuum-based gripping mechanisms can be integrated into sorting systems, providing a reliable solution for picking and sorting items based on color without applying excessive force.

T. Jahan, Md. I. Ahmed, Md. A. Rahman, "Design and Fabrication of Color Sorting Machine for Industrial Conveyor Based Process" (2019)
Jahan et al. (2019) focus on the design and fabrication of a color sorting machine utilizing a robotic arm for sorting tasks. The robotic arm, controlled by a microcontroller, was employed to pick up objects based on their color and place them in designated bins. This study emphasized the precision and speed that robotic arms can bring to automated sorting systems, enhancing both flexibility and reliability. The paper offered valuable insights into how robotic arms can be used effectively in sorting processes to improve the accuracy and speed of item handling, thus contributing to the overall performance of the sorting system.

Tasnuva Jahan Nuva, Md. Imteaz Ahmed, and Sarker Safat Mahmud, "Design & Fabrication of Automatic Color & Weight-Based Sorting System on Conveyor Belt" (2021)
In their study, Jahan Nuva, Ahmed, and Mahmud (2021) proposed a cost-effective sorting system where the sorting bin changes its position based on the item being sorted. Instead of moving the items, the authors designed a system where the sorting bin adjusts its position according to the color and weight of the item. This innovation reduces the complexity and cost of the system while maintaining its effectiveness. The study contributed to the development of a more affordable sorting system that still offers high efficiency and accuracy, making it a relevant reference for developing practical and economical sorting solutions.

K. Ananthi, S. Priyadharshini, S. Sabarikannan, R. Dharshini, and K. Dharshini, "Design and Fabrication of Color based Automatic Yarn Carrier Sorting Machine," (2021)
The authors discussed the importance of actuators in their design, specifically how actuators create the necessary force to direct items from the conveyor to the sorting bin. Actuators play a pivotal role in ensuring that items are placed accurately and efficiently in the correct bin. The authors' work highlighted the functionality of actuators in the sorting process and demonstrated how they can be utilized to ensure smooth operation in automated systems. This research provided valuable insights into the design of actuator systems and their integration into sorting mechanisms for greater precision and control.

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III. METHODOLOGY

This section walks through the process of designing, building, and testing the automated sorting system. It covers everything from choosing the right components to putting them together and ensuring everything works smoothly.

Conveyor Belt Design and Assembly

The conveyor belt is the foundation of the system, responsible for moving the items from one place to another. We used a DC motor to power the belt, which made sure the items moved steadily and smoothly. The speed of the belt was carefully set to give enough time for the sensors to detect the items and for the robotic arm to do its job. It was important to keep the belt aligned properly to avoid any issues with movement. The materials chosen for the belt were durable, ensuring that it could handle constant use without breaking down, and would keep running smoothly throughout the sorting process.

Sensors and Detection Mechanisms

To accurately sort the items, we needed sensors that could detect both the color and position of each object. For color detection, the TCS3200 color sensor was used. This sensor is very sensitive and works perfectly with the Arduino, making it easy to integrate into the system. We mounted it above the conveyor so it could detect the color of each item as it passed underneath. The sensor was calibrated to handle different lighting conditions, ensuring that it would give us accurate readings no matter the environment. In addition to the color sensor, we used a proximity sensor to detect when an item was in place for sorting. This sensor worked in sync with the color sensor to make sure the system knew exactly when to start the sorting process.

Robotic Arm Design and Assembly

The robotic arm was designed to handle the picking and sorting of the items. We built the arm with a lightweight aluminum frame, which made it both strong and easy to move. Servo motors were used to give the arm precise control over its movement, both horizontally and vertically. At the end of the arm, we attached a vacuum gripper, powered by a small vacuum pump, which could gently lift and move the items without damaging them. The arm was programmed to place the items into specific bins depending on their color—blue items went to the particular bin, red item to its assigned bin, and green items to its bin. The assembly process focused on making sure the arm could move smoothly and place the items accurately every time.

Integration and Programming

Once the individual components were assembled, it was time to bring them all together into one functioning system. The Arduino Mega was the brain of the operation, processing inputs from the sensors and controlling the actions of the conveyor belt and robotic arm. We wrote a program that allowed the system to read the color of the items using the TCS3200 sensor, and then triggered the robotic arm to move based on signals from the proximity sensor. The programming also coordinated the arm's movements to ensure the items were placed in the right bins at the right distances. Integrating everything into one system was an exciting step, as it meant that all the parts were now working together as a single unit.

Testing and Calibration

With everything in place, we began the testing and calibration phase to make sure everything was functioning as expected. We adjusted the conveyor belt's speed to ensure the sensors had enough time to detect the items and the arm could react quickly. The TCS3200 sensor was recalibrated for different lighting conditions, so it would be accurate no matter where it was placed. The robotic arm's movements were also fine-tuned to ensure the items were placed precisely in their respective bins. Multiple tests were carried out using various items to verify the accuracy of the sorting system. Based on the test results, we made adjustments to improve the system's performance, ensuring that it was reliable and efficient for real-world use.

IV. WORKING

The working of the automatic color sorting system can be explained through the flow of operations as depicted in theblock diagram. The system comprises four key stages, starting from the item moving on the conveyor belt to the final sorting action performed by the robotic arm. Each stage of the process is interconnected, and the system operates in a seamless cycle to ensure efficient sorting based on color.

Item Travelling on Conveyor Belt

The process begins with items being placed on the conveyor belt. The conveyor belt serves as the primary transport mechanism, moving items from one point to another. As the items travel along the belt, they are directed towards the detection point where their color and position will be assessed. The conveyor system ensures continuous flow, allowing items to be processed in a timely manner without interruption.

Proximity Sensor and Color Sensor Detect the Item and Process Data

Once the item reaches the detection point, the system uses a combination of proximity and color sensors to gather crucial information. The proximity sensor detects the presence of the item on the conveyor belt and signals to the system that an item is ready to be sorted. Simultaneously, the color sensor (such as the TCS230) identifies the color of the item by analyzing the reflected light from the object. The data from both sensors is sent to the processing unit (microcontroller), which processes the information and determines which action needs to be taken based on the color of the item.

Robotic Arm Initiates the Action and Sorts the Item

After processing the data, the microcontroller sends a signal to the robotic arm to initiate the sorting action. The robotic arm, equipped with a vacuum gripper or similar end-effector, moves towards the item and picks it up. The arm's movement is controlled with high precision to ensure accurate placement of the item into the designated sorting bin according to its color. The robotic arm's flexibility and precision are crucial in ensuring that the sorting process is accurate and efficient, minimizing the chances of misplacement.

Robotic Arm Returns to Initial Position and System Resets

Once the item has been successfully sorted, the robotic arm returns to its initial position, ready to pick up the next item. This action signals the completion of one sorting cycle. The system then resets, and the process repeats for the next item traveling on the conveyor belt. The resetting ensures that the robotic arm is in the correct position and that all sensors are ready for the next sorting task. The system is designed to operate continuously, sorting items one after the other, without requiring manual intervention.Through this continuous cycle of detection, sorting, and resetting, the automatic color sorting system is able to efficiently handle and sort items based on color, ensuring smooth operation in industrial settings

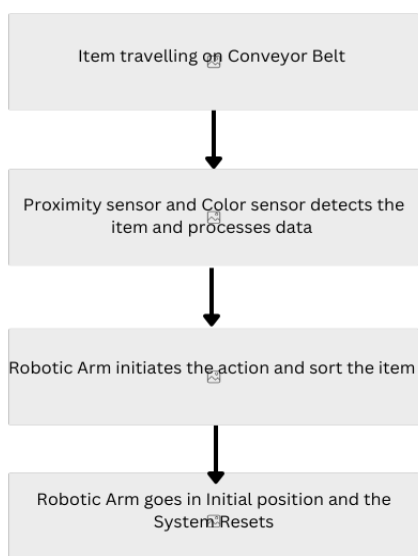

Fig 1- Block Diagram for the colour based item sorting system

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V. CONCLUSION

This research aimed to design and implement a color- based item sorting system integrated with a robotic arm and vacuum mechanism for efficient material handling. The system was developed using an Arduino Uno, color and proximity sensors, and a robotic arm equipped with a vacuum gripper. The conveyor belt and linear motion mechanism ensured precise transportation and sorting of items based on their color, while the robotic arm facilitated accurate pick-and-place operations.

The project successfully demonstrated the sorting of items into predefined categories with high precision and reliability. The integration of IoT and automation technologies underscores the potential for optimizing processes in industries requiring sorting tasks, such as packaging, quality control, and recycling.

This work serves as a foundation for further enhancements, such as improving system speed and accuracy, incorporating machine learning for advanced decision- making, and expanding the framework to support a broader range of object attributes. By combining cost-effective hardware and intelligent control, this project contributes to the growing field of industrial automation and material handling systems.

REFERENCES

[1] Thike, Z. Z. Moe San, and D. Z. Min Oo, “Design and Development of an Automatic Color Sorting Machine on Belt Conveyor,” International Journal of Scientific Engineering and Applied Science,” vol. 8, no. 7, pp. 176–179, Jul. 2019, doi: 10.7753/ijsea0807.1002

[2] K. Kunhimohammed, M. S. K. K, S. Sahna, M. S. Gokul, and S. U. Abdulla, “Automatic Color Sorting Machine Using TCS230 Color Sensor And PIC Microcontroller,” International Journal of Research and Innovations in Science and Technology, vol. 2, no. 2, pp. 33–38, 2015

[3] M. L. Dezaki, S. Hatami, A. Zolfagharian, and M. Bodaghi, “A pneumatic conveyor robot for color detection and sorting,” Cognitive Robotics, vol. 2, no. March, pp. 60–72, 2022, doi: 10.1016/j.cogr.2022.03.001

[4] T. Jahan, Md. I. Ahmed, Md. A. Rahman" Designed and Fabrication Of Color Sorting Machine For Industrial Conveyor Based Process" International Conference on Big Data, IOT and Machine Learning (BIM 2021), September, 2021, pp.98-105

[5] Design & Fabrication of Automatic Color & WeightBased Sorting System on Conveyor Belt Tasnuva Jahan Nuva1* , Md. Imteaz Ahmed2 , Sarker Safat Mahmud1 1Department of Mechatronics and Industrial Engineering, Chittagong University of Engineering and Technology, Bangladesh

[6] K. Ananthi, S. Priyadharshini, S. Sabarikannan, R. Dharshini, and K. Dharshini, “Design and Fabrication of Color based Automatic Yarn Carrier Sorting Machine,” 2021 7th Int. Conf. Adv. Comput. Commun. Syst. ICACCS 2021, pp. 677–682, 2021, doi: 10.1109/ICACCS51430.2021.9441995