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COLOR SORTING AND LINE FOLLOWING ROBOT

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Abstract: Sorting and navigation are critical tasks in various industries, such as manufacturing, logistics, and recycling. Traditional methods of manual sorting and navigation are often inefficient, time-consuming, and prone to human error. Our prototype integrates two essential functionalities—color sorting and line-following—into a single robotic system, offering an automated and efficient solution. The color sorting system uses advanced sensors to accurately identify and categorize objects based on their color, while the line-following system ensures precise navigation along predefined paths. This combination delivers high accuracy, reduced manual intervention, and improved operational efficiency, making it a reliable and cost-effective solution for industrial and educational applications.

Keywords: color sorting, line following, automation, efficient, accurate, cost-effective, robotic system.

INTRODUCTION

The Integrated Color Sorting and Line Following Robot featuring the Adafruit TCS34725 sensor represents a cutting-edge solution for automating sorting and navigation tasks in industries, educational settings, and research applications. This system seamlessly combines two key functionalities: color sorting and line following. The Adafruit TCS34725 sensor, known for its high accuracy and sensitivity in color detection, forms the core of the color sorting mechanism, while infrared sensors enable precise path tracking for the line-following functionality.

The robot operates by detecting and categorizing objects based on their color using the TCS34725 sensor, which offers superior performance under varying lighting conditions. Simultaneously, the line-following system guides the robot along predefined paths, ensuring accurate and autonomous navigation. This integration enhances the robot's versatility, enabling it to perform tasks such as sorting materials in industrial settings or navigating complex routes in automated environments.

By leveraging advanced sensors and microcontroller technology, the Integrated Color Sorting and Line Following Robot delivers high efficiency, accuracy, and reliability. Its ability to reduce manual intervention, improve operational workflows, and adapt to diverse applications makes it an invaluable tool for automation. Furthermore, the system is designed to be user-friendly and cost-effective, making it accessible to industries and educational institutions alike.

I. LITERATURE PAPER

[1] Sharma, R., & Kumar, A. (2023) proposed a color sorting robot using an Arduino microcontroller and a TCS3200 color sensor. Their approach demonstrated a simple and low-cost design, where objects are sorted into bins based on their color. However, the system lacked precision when sorting objects with varying lighting conditions, leading to inconsistencies in the detection process.

[2] Gupta, P., & Verma, S. (2022) introduced a line-following robot using an infrared sensor array for navigation. This robot effectively followed predefined paths and avoided deviations. The system was reliable and robust for flat, even

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surfaces. However, the robot faced difficulties when navigating uneven terrains or paths with sharp turns, limiting its application in real-world scenarios.

[3] Singh, M., & Patel, T. (2024) developed a dual-function robot integrating both color sorting and line-following capabilities. The system used a TCS34725 sensor for color detection and IR sensors for navigation. While the integration was innovative, the robot faced challenges in synchronizing both functionalities simultaneously, often prioritizing one task over the other, which affected performance efficiency.

[4] Reddy, S., & Priya, D. (2023) proposed an advanced color sorting robot with an image processing-based color detection system. This system used a camera module and a Raspberry Pi for detecting object colors more accurately than traditional sensors. Although highly accurate, the system was expensive and required significant computational power, making it less feasible for low-budget applications.

[5] Thomas, J., & Daniel, K. (2023) implemented a line-following robot with obstacle detection. The robot utilized ultrasonic sensors in addition to IR sensors for dynamic environments. This system was efficient in avoiding obstacles and continuing its path. However, the integration of obstacle detection increased the system's complexity and cost, and the robot struggled in environments with multiple closely spaced obstacles.

[6] Ananya, S., & Deepak, G. (2023) designed a color sorting robot optimized for industrial applications using the TCS3200 sensor. The robot effectively sorted objects in a controlled environment but failed to maintain high accuracy under changing light conditions. The authors suggested implementing adaptive lighting for improved performance but acknowledged the additional cost and complexity it would entail.

II. METHODOLOGY

A. BLOCK DIAGRAM

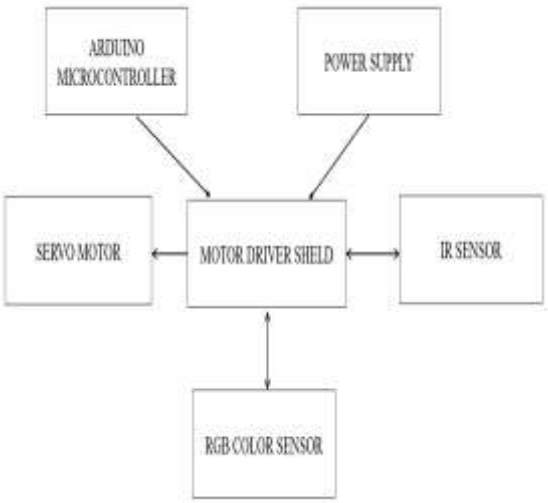

Figure 1 represents a color sorting and line-following robot. An Arduino microcontroller processes inputs from the RGB color sensor (for color detection) and the IR sensor (for line following). These signals control the motor driver shield, which operates the servo motor for sorting and navigation. A power supply powers the entire system.

B. WORKING

The color sorting and line-following robot operates by using the Adafruit TCS34725 RGB sensor for color detection and IR sensors for path tracking. The process begins as the robot follows a predefined path using the IR sensor signals,

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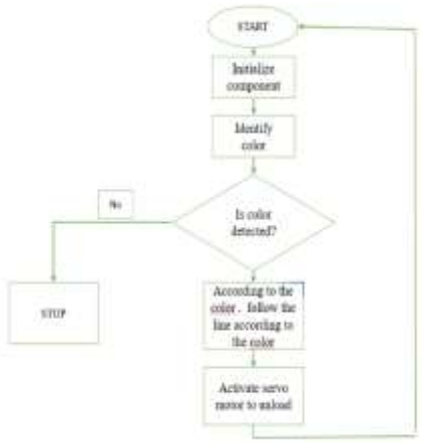
controlled by the Arduino microcontroller. When an object is detected, the TCS34725 sensor analyzes its color, sending the data to the Arduino for classification.

If the object matches a predefined color, the servo motor is activated via the motor driver shield to place the object into the correct category. A green LED blinks, indicating successful sorting. If the color is unidentified, the object remains unsorted, and a red LED blinks.

The robot continues to follow the line and repeat the process for subsequent objects. The system is powered by a constant power supply and runs efficiently, ensuring accurate sorting and navigation. After completing the task, the system pauses for operator input or a new batch of objects.

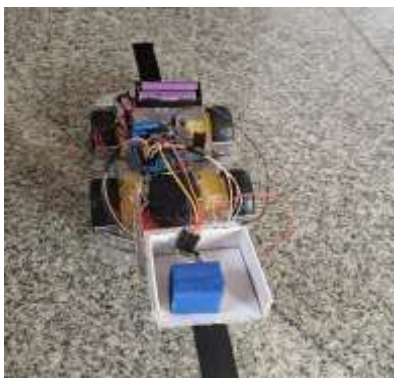
C. FLOWCHART

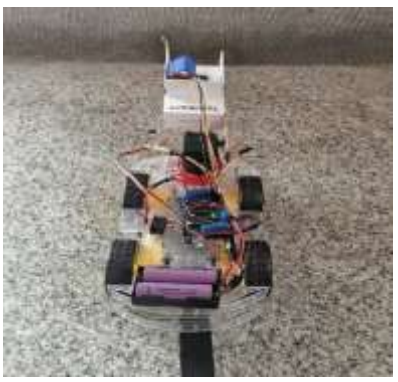


The flowchart outlines the operational process of a color sorting and line-following robot. The system begins by initializing its components, such as the color sensor, IR sensor, and servo motor. It then identifies the color of an object using the color sensor. If a color is detected, the robot follows a specific line assigned to that color, ensuring accurate navigation. Once the object reaches its designated area, the servo motor is activated to unload it. If no color is detected, the system halts operations. This loop continues, automating the sorting and navigation process, improving efficiency and reducing manual intervention.

III. RESULTS

The prototype of the proposed system is shown in Figure 3.





Case 1: Start

When the system is powered through color sensor it detects the color and start following the line.

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Case 2: Based on the color it starts following the line , if the is blue it turns left based on code and if the color is red it runs straight , if the color is green it turns right and follow through the end of the line.

Case 3: Based on the color it follows the line and reaches the destination and unload the color block which is placed on the block.

I. APPLICATIONS

1. Manufacturing Plants: The robot can be used in assembly lines to sort components based on color or material type, increasing efficiency in the sorting and packaging processes.
2. Warehouses: The robot can assist in sorting packages or inventory based on color coding, improving organization and accuracy in stock management and retrieval.
3. Recycling Centers: The robot can be used to sort recyclable materials based on their colors, ensuring more efficient waste management and recycling processes.
4. Agricultural Sector: The robot can be used to sort fruits and vegetables on the basis of color, ensuring only ripe produce is selected for packaging or sale.
5. Retail Stores: The robot can assist in organizing products by color, such as sorting clothes or merchandise, making it easier to track inventory and enhance customer experience.
6. Education and Research Institutes: The robot can be used as a teaching aid in robotics labs, helping students learn about automation, color detection, and line-following algorithms through practical implementation.
7. Automated Quality Control: The robot can be integrated into production lines to perform quality checks, sorting defective items or detecting color inconsistencies, ensuring only products that meet quality standards are shipped.

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