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Automatic Part Sorting Robotbased On Colour Code

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Abstract

This research focuses on the design and development of an automatic part sorting robot based on colour detection to improve industrial efficiency and reduce manual effort. The primary purpose of the study is to address challenges associated with manual sorting, such as human error, fatigue, and inconsistency, by implementing an automated solution using robotics and embedded systems. The methodology involves several stages, including requirement analysis, selection of components, mechanical and electrical design, programming of the control system, and testing and optimization. The system integrates a TCS3200 colour sensor to detect object colours, an Arduino Mega 2560 microcontroller to process the data, and servo motors to control the robotic arm for sorting operations. The findings indicate that the developed system successfully identifies objects based on predefined colour parameters and sorts them accurately with minimal human intervention. It demonstrates improved consistency, faster processing time, and reduced operational errors compared to manual methods.

Keywords: Automation; Colour Detection; Robotic Arm; Arduino Mega 2560; TCS3200 Sensor; Servo Motors; Object Sorting; Industrial Automation; Embedded Systems; Productivity Enhancement.

How to Cite This Article

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Introduction

Automation has become a vital component of modern industrial systems, enabling faster production, improved accuracy, and reduced dependence on manual labour. With advancements in robotics and embedded systems, automated solutions are increasingly being adopted in industries such as manufacturing, packaging, food processing, and quality control. One such application is object sorting, where items are categorized based on specific characteristics like size, shape, or colour. Colour-based sorting, in particular, is widely used due to its simplicity and effectiveness in distinguishing products.

Despite its importance, many industries still rely on manual sorting methods, which are prone to human error, fatigue, inconsistency, and reduced efficiency over time. These limitations can lead to increased operational costs, lower productivity, and compromised quality standards. Therefore, there is a growing need for an automated system that can perform sorting tasks accurately and consistently without human intervention.

The main objective of this study is to design and develop an automatic part sorting robotic arm based on colour detection. The system aims to integrate a colour sensor with a microcontroller to identify objects and control a robotic arm for sorting them accordingly. Additional objectives include reducing human effort, improving sorting accuracy, and enhancing overall productivity.

Literature Review

Other research has explored robotic arm-based sorting systems, where objects are picked and placed based on colour. These systems demonstrate good accuracy (around 90%) and are widely applied in areas like fruit grading and industrial processing. More advanced approaches incorporate machine vision and artificial intelligence models, such as CNN and Faster R-CNN, to classify objects based on multiple features including colour and shape, offering higher flexibility but increased complexity and cost.

Comparatively, Arduino-based systems are simpler, cost-effective, and suitable for small-scale applications, while AI-based systems provide higher precision and scalability for complex industrial environments. However, existing studies reveal several research gaps, including challenges in sensor calibration, performance under varying lighting conditions, limited adaptability to different object types, and lack of real-time optimization.

Problem Statement

Manual sorting leads to inefficiency, errors, and increased labor costs.

Methodology

This study adopts an experimental research design focused on the development and testing of an automatic colour-based part sorting robot. The approach involves designing a prototype system, integrating hardware and software components, and evaluating its performance under controlled conditions.

The data collection method is primarily based on real-time sensor readings and system observations. The TCS3200 colour sensor is used to capture colour data from objects in the form of frequency values corresponding to red, green, and blue components. These readings are processed by the Arduino Mega 2560 microcontroller to classify objects based on predefined colour thresholds. The system's performance is assessed by observing sorting accuracy, response time, and consistency during repeated trials.

The tools and components used in this research include the TCS3200 colour sensor, Arduino Mega 2560, MG995 servo motors, and a robotic arm structure. Additional tools include Arduino IDE software for programming and debugging, as well as basic electronic components such as power supply units, connecting wires, and breadboards for circuit assembly.

Components

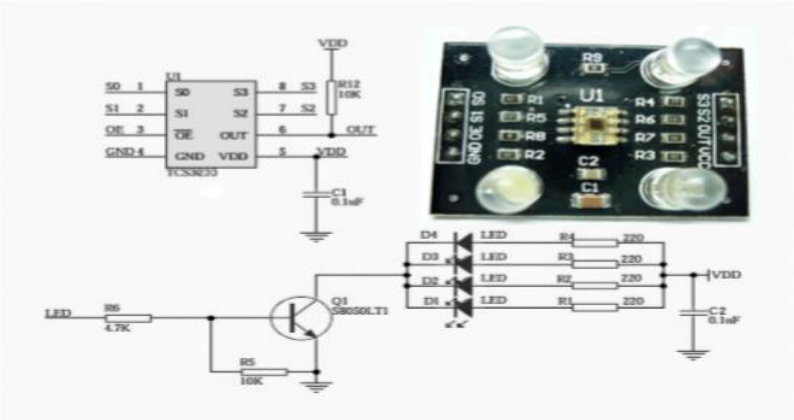

Fig. 1. *TCS3200 Color Sensor Module and Circuit Configuration*

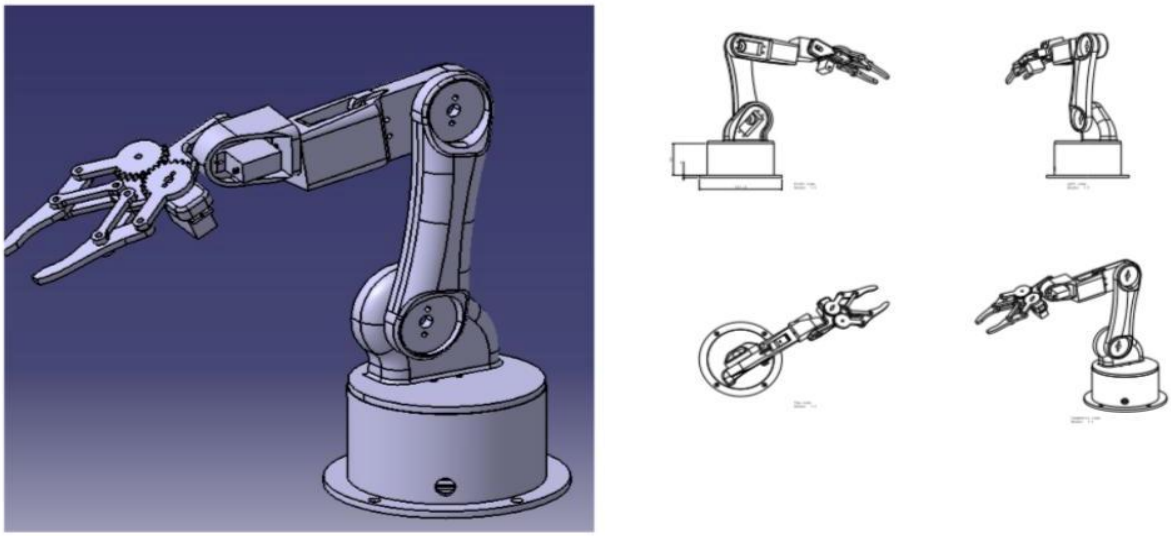

Fig. 2. *Robotic Arm CAD Model Developed in SolidWorks*

Fig. 3. *Arduino Mega 2560 Microcontroller Board*

Fig. 4. *Servo Motor (MG995) Used for Robotic Arm Actuation*

Discussion

The Results of the study demonstrate that the automatic colour-based part sorting robot performs with high accuracy (approximately 93–95%) and consistent response time, effectively addressing the primary research objective of reducing manual effort and improving sorting

efficiency. The system successfully identifies and sorts objects based on predefined colour parameters, confirming that the integration of a TCS3200 sensor with an Arduino-based control system is a viable solution for automated sorting tasks.

The minor errors observed during testing, particularly in green object detection, can be attributed to variations in lighting conditions and overlapping sensor values. This finding aligns with previous studies, which highlight that colour sensors are sensitive to environmental factors and require proper calibration for optimal performance. The response time of 3–5 seconds per object also supports existing research, indicating that such systems are suitable for small- to medium-scale industrial applications where speed and accuracy are balanced.

Applications

Manufacturing, food processing, logistics, quality control.

Flow Process

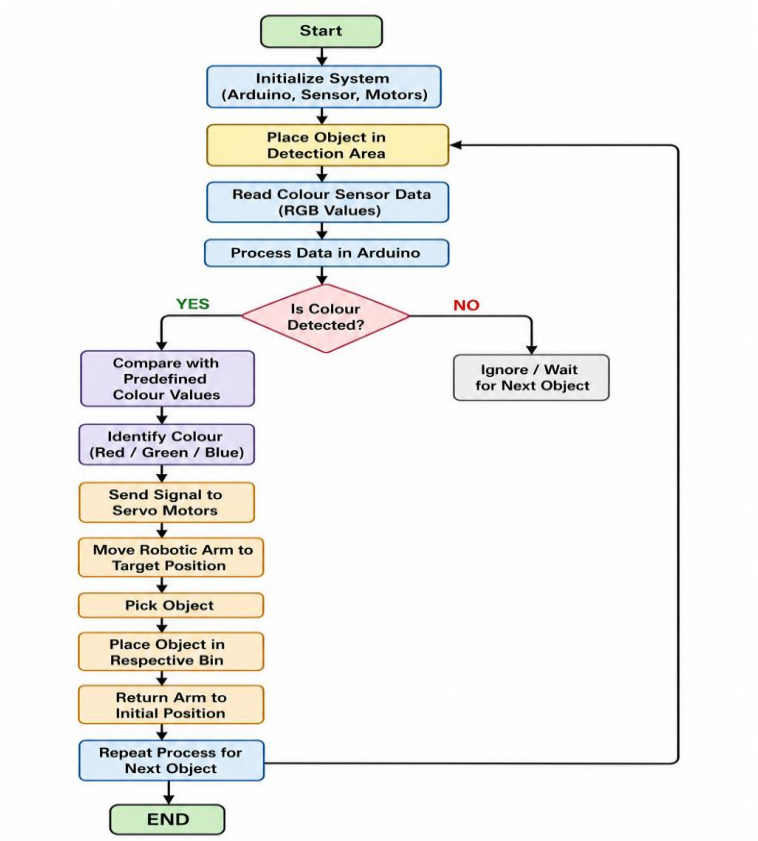

Fig. 5. *Flowchart of Colour Detection and Robotic Part Sorting Process*

Conclusion

This study successfully designed and developed an automatic part sorting robot based on colour detection, demonstrating its effectiveness in improving sorting accuracy, consistency, and operational efficiency. The system achieved an overall accuracy of approximately 93–95% with a response time of 3–5 seconds per object, confirming that automation can significantly reduce human effort and minimize errors in sorting processes. The integration of a TCS3200 colour sensor with an Arduino-based control system proved to be a cost-effective and reliable solution for small- to medium-scale industrial applications.

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