Design and Development of an Arduino-Based Intelligent Object Sorting System

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Peer Review Information	Abstract
	This research paper presents the design and implementation of an Arduino Uno-based automated object sorting system aimed at enhancing efficiency in industrial applications, particularly within warehouses handling bulk materials such as glass bottles and other packaged goods. The system integrates an embedded microcontroller with a color sensor and servo motors to enable real-time, automated sorting based on object color. The primary goal of this system is to streamline the sorting process, minimize manual labour, and reduce operational costs. The prototype demonstrates a sorting speed of approximately six seconds per object, showcasing significant potential for deployment in mechatronics-based industrial environments. Future enhancements may include integration with artificial intelligence (AI) and the Internet of Things (IoT) to improve precision and scalability.

Introduction

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.

In the modern industrial landscape, optimizing production efficiency is essential to maintaining competitiveness and ensuring sustainable growth. Efficiency in industrial operations is defined by factors such as production speed, cost-effectiveness, product quality, and minimal downtime. To address these challenges, automation has emerged as a crucial solution, replacing traditional manual processes with intelligent, sensor-driven control systems.

Automation enhances productivity, improves product consistency, and reduces dependency on human labour. Although initial implementation costs may be high due to sophisticated algorithms and hardware requirements, long-term benefits justify the investment. Additionally, automation enhances workplace safety by reducing human exposure to hazardous conditions.

Embedded systems play a vital role in automation by integrating microcontrollers into industrial processes. These systems leverage programmable controllers such as the Arduino Uno to perform dedicated tasks efficiently. Industries such as automotive manufacturing, food processing,

pharmaceuticals, and agriculture extensively use automated sorting to improve quality control and operational efficiency. This paper explores the development of a color-based sorting system using an Arduino Uno microcontroller. The study focuses on the impact of automation in sorting operations and highlights how such technologies contribute to improved industrial productivity.

1. Motivation

With growing demand for high-speed and high-accuracy production, industries increasingly rely on automated sorting solutions. Traditional manual sorting is slow, prone to errors, and labour-intensive, creating inefficiencies in industrial workflows. Implementing an automated object sorting system not only reduces labour costs but also enhances precision, efficiency, and scalability in industrial operations.

2. Problem Definition and Objectives

Manual sorting processes lead to inefficiencies due to their time-consuming nature, high labour costs, and potential for human errors. Addressing these limitations through automation ensures a more reliable and cost-effective approach.
Objectives:

- Develop an Arduino Uno-based automated sorting system.
- Optimize sorting accuracy using color sensors.
- Reduce manual labour dependency and improve sorting speed.
- Assess the feasibility of integrating automation in warehouse operations.
Explore potential advancements through AI and IoT applications.

3. Project Scope

This project involves designing, developing, and evaluating an Arduino Uno-based color sorting system for industrial applications. It utilizes color sensors and servo motors to execute sorting tasks with enhanced efficiency.

Literature Review

[1] Ch. Shravani, G. Indira, V. Appalaraju, "Arduino Based Color Sorting Machine using TCS3200 Color Sensor", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8, Issue- 6S4, April 2019. Sorting of object is an essential mechanical process in which difficult work is quite required. Chronic manual arranging makes consistency troubles. Machines can perform mainly dreary assignments superior to human beings. Laborer exhaustion on sequential manufacturing structures can result in decreased execution, and purpose troubles in retaining up object fine. A employee who has been appearing research undertaking again may additionally in the end forget about to recognize the color of item, but a machine in no way. On this paper a compact record close to arranging of articles based totally on shading has been implemented making use of TCS3200 shading sensor with SERVOMOTORS associated with AURDINO UNO.

[2] K.Sasidhar, Shahwar Farooqi, Mohammed Abdul Moin, M Sachin, "Design and Development of a Colour Sorting Machine using PLC and SCADA", International Journal of Research and Scientific Innovation (IJRSI), Volume V, Issue VII, July 2018, ISSN 2321– 2705. The purpose of this project is to present a Programmable Logic Control (PLC) and SCADA based control system that is applied to the Colour Sorting Machine. In many industrial applications, there is a need of sorting. Sorting can be done by using many ways according to the dimensions, colours, weight, using machine vision (image processing), material of an object etc. For example, in Thermal Power Station, electromagnetic sorting technique is used to sort ferromagnetic materials from coal. This project consists of components such as PLC, SCADA software, conveyors, colour sensors, electronic system and motors. The objects are being sorted according to their respective colour. The main conveyor is supported of two branches to load the distinguished object on to the respective one as separated by the electronic system and detected by the proximity sensors. In this project, SCADA provides a user-friendly environment to establish an easy communication between humans and process. SCADA shows the activation of various parts of the system, i.e. conveyors, motors, LDRs and electronic devices.

[3] Kunhimohammed C. K, Muhammed Saifudeen K. K, Sahna S, Gokul M. S and Shaeez Usman Abdulla, "Automatic Color Sorting Machine Using TCS230 Color Sensor And PIC Microcontroller", International Journal of Research and Innovations in Science and Technology, Volume 2, Issue 2, 2015, ISSN(Online): 2394-3858 ISSN(Print) : 2394-3866. Sorting of products is a very difficult industrial process. Continuous manual sorting creates consistency issues. This paper describes a working prototype designed for automatic sorting of objects based on the color. TCS230 sensor was used to detect the color of the product and the PIC16F628A microcontroller was used to control the overall process. The identification of the color is based on the frequency analysis of the output of TCS230 sensor. Two conveyor belts were used, each controlled by separate DC motors. The first belt is for placing the product to be analyzed by the color sensor, and the second belt is for moving the container, having separated compartments, in order to separate the products. The experimental results promise that the prototype will fulfill the

needs for higher production and precise quality in the field of automation.

[4] Aung Thike, Zin Zin Moe San, Dr. Zaw Min Oo, "Design and Development of an Automatic Color Sorting Machine on Belt Conveyor", International Journal of Science and Engineering Applications Volume 8–Issue 07,176-179, 2019, ISSN: -2319–7560. Automatic color sorting is very much convenient in industry. Color and size are the most important features for accurate classification and sorting of product which can be done by using some optical sensors or analyzing their pictures. Color sorting machines are machines that are used on the production lines in bulk food processing and other industries. They separate items by their colors, detecting the colors if things that pass before them and using mechanical or pneumatic ejection devices to divert items whose colors do not fall within the acceptable range. The Color sorting machine using Arduino is a fascinating and renowned project for techies, who would like to combine electronics, machine building and programming. The Color Sorting Machine is used for sorting mainly RGB colors. A simple robot arm is used to apply a color sorting to a physical system. The objects are placed to the conveyor belt using robot arm with servo motors. One conveyor belt is used, which is controlled by DC motors.

[5] Aye Myat Myat Myo, Zar Chi Soe, "Automatic Color Sorting Machine Using Arduino Mega Microcontroller", International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS), Volume VIII, Issue VIII, August 2019, ISSN 2278-2540. In this digital world, color processing gives us a greater impact in different industries to solve the consistency issue of continuous manual sorting. This paper will be a new approach to recognize and sort the objects continuously and keep them in a designated location. Nowadays, image or colors processing attract massive attention as it leads to possibility of widening scope of application in different field with the help of modern technology. A color sorter is researched, designed and created with Arduino Mega microcontroller, TCS230 color sensor, servo motor and other electronic components. This work involves sensors that sense the object's color and sends the signal to the Arduino. The microcontroller sends signal to circuit which drives the various motors to allow the object and place it in the specified location. Based upon the detection, the hole moves to the specified location, releases the object and comes back to the original position. The system has the ability to sort the object according to their colors into respective color station in minimum time.

[6] Lim Jie Shen, Irda Hassan, "Design and development of colour sorting robot", Journal of Engineering Science and Technology EURECA 2014 Special Issue January (2015) 71– 81, © School of Engineering, Taylor's University. This paper shows a new approach for continuous recognition and sorting of objects into desired location. Image or colours processing nowadays attract massive attention as it leads to possibility of widening scope of application in different field with the help of modern technology. A colour sorting robot is researched, designed and created with Arduino Uno microcontroller, TCS3200D Colour Sensor, SG90 Tower Pro Servo Motor and other electronic components. The system has the ability to sort the object according to their colours into respective colour station in minimum time. Specific programming code for this system is written.

[7] Dharmannagari Vinay Kumar Reddy, "Sorting of objects based on colour by pick and place robotic arm and with conveyor belt arrangement", International Journal of mechanical engineering and robotic research (IJMERR), Vol. 3, No. 1, January 2014, ISSN 2278 – 0149. In many situations, autonomous robots can provide effective solutions to grueling tasks. In this case, it is desirable to create an autonomous robot that can identify objects from the conveyor belt and relocate them if the object meets certain criteria. Dealing with a large number of objects is a very menial task, this is an excellent application for a robot of this type. In this case, to keep costs and design complexity low, the robot is designed around the platform and uses several different sensors to collect information about the robots environment to allow the robot to react accordingly. This paper aims at the problem I am attempting to solve is to create an autonomous robot that can identify objects when placed on the conveyor belt based on color sensing and then sort by relocating them to a specific location. It will be using a picking arm which uses a controller motor to pick the particular object from the conveyor belt and place it according to the color sensing. Micro controller (AT89S52) allows dynamic and faster control. Liquid Crystal Display (LCD) makes the system user-friendly. AT89S52 Micro controller is the heart of the circuit as it controls all the functions.

[8] Mr.V.A.Aher, Mayur Dukre, Ganesh Abhang, Trupti Thorat, "Colour based object sorting machine", International Research Journal of Engineering and Technology (IRJET), Volume 08, Issue 02, Feb 2021, ISSN(print): 2395-0072, ISSN(online): 2395-0056. Sorting is a process in which two or more objects of similar, yet different characteristics are arranged in a systematic order. This is generally carried through manually or by using sensors in automation. Automatic color sorting is very much convenient in industry. Color and size are the most important features for accurate classification and sorting of product which can be done by using some optical sensors or analyzing their pictures. Color sorting machines

are machines that are used on the production lines in bulk food processing and other industries. They separate items by their colors, detecting the colors if things that pass before them and using mechanical or pneumatic ejection devices to divert items whose colors do not fall within the acceptable range. The Color sorting machine using microcontroller is a fascinating and renowned project for techies, who would like to combine electronics, machine building and programming. The Color Sorting Machine is used for sorting mainly RGB colors. A simple robot arm is used to apply a color sorting to a physical system. The objects are placed to the conveyor belt using robot arm with servo motors. One conveyor belt is used, which is controlled by DC motors.
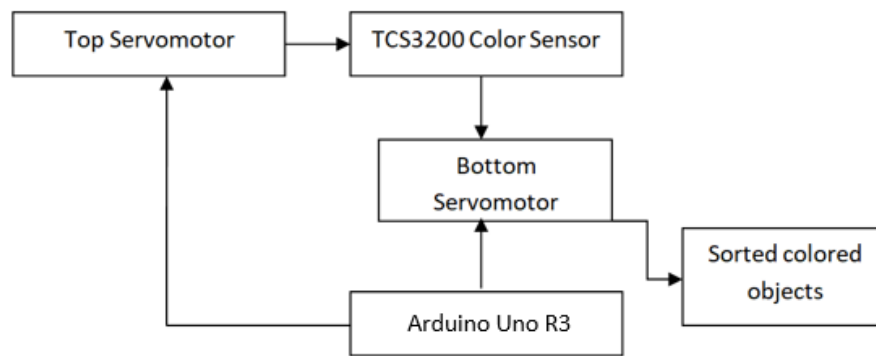
Methodology

Fig 1. Block Diagram

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.

Fig 2. Proposed Hardware View

Proposed System

The proposed system for an Arduino-based automatic color sorting machine typically involves several key components and functionalities:

1. Color Sensing Module: This module consists of one or more-color sensors (such as TCS3200 or TCS34725) that can detect the color of objects passing through the sorting mechanism. The sensors capture data about the RGB (Red, Green, Blue) values of the objects, which are then processed by the microcontroller.

2. Conveyor Belt or Mechanism: Objects to be sorted are placed on a conveyor belt or similar mechanism that moves them past the color sensing module. The conveyor belt ensures a smooth and consistent flow of objects for sorting.

3. Microcontroller (Arduino): An Arduino board serves as the brain of the system, responsible for controlling the operation of the color sorting machine. The microcontroller receives input from the color sensors, processes the data, and activates the sorting mechanism accordingly.

4. Sorting Mechanism: The sorting mechanism separates objects into different bins or containers based on their color. This could involve actuators such as servo motors or solenoids that divert objects into the appropriate bin based on instructions from the microcontroller.

5. User Interface: The system may include a user interface for configuring settings, monitoring the sorting process, and displaying relevant information. This could be a simple LCD display and a few buttons or a more sophisticated graphical interface depending on the complexity of the system.

6. Power Supply: A stable power supply is essential to ensure the proper functioning of the color sorting machine. This may involve using a regulated DC power supply or batteries, depending on the application and environment.

7. Calibration and Maintenance: The system should include mechanisms for calibration to ensure accurate color detection and sorting. Additionally, provisions for maintenance and troubleshooting should be considered to keep the machine running smoothly over time.

8. Safety Features: Safety features such as emergency stop buttons, protective enclosures, and sensors to detect obstructions or malfunctions should be incorporated to prevent accidents and ensure operator safety.

The overall design and implementation of the proposed system may vary depending on factors such as the specific application, budget constraints, and desired level of automation. However, the key components outlined above form the basis of an Arduino-based automatic color sorting machine.

Result

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 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.

Conclusion

This study presents an Arduino Uno-based automated object sorting system designed for industrial efficiency. By integrating colour sensors and servo motors, the system accurately categorizes objects based on color, reducing manual labour and improving productivity. The prototype demonstrates a sorting time of six seconds per object, proving its feasibility in real-world applications. Future enhancements could involve incorporating AI-driven decision-making

algorithms and IoT connectivity to further optimize accuracy and scalability.

Arduino UNO based object sorting system for industrial applications is implemented that is well suited for industries where sorting of objects is requires based on its colors. Proposed design implementation will enhance the efficiency, production cost, speed of packing objects with less manual power. Arduino nano controls the process of sorting with color identification. This system sorts colored objects and differentiate the objects to separate case. Identification of color is based on the frequency analysis from output of sensor. Chutes are used to place the product for color identification and for moving the container. Adding IR sensor at the input indicates the presence of the object. Cost effective implementation of the system and size scalability makes the proposed system easier to implement in small scale industries minimizing the manual power.

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.

References

Ch.Shravani, G. Indira, V. Appalaraju, "Arduino Based Color Sorting Machine using TCS3200 Color Sensor", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8, Issue- 6S4, April 2019.

K.Sasidhar, Shahwar Farooqi, Mohammed Abdul Moin, M Sachin, "Design and Development of a Colour Sorting Machine using PLC and SCADA", International Journal of Research and Scientific Innovation (IJRSI), Volume V, Issue VII, July 2018, ISSN 2321–2705.

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4. Lim Jie Shen, Irda Hassan, "Design and development of colour sorting robot", Journa of Engineering Science and Technology EURECA 2014 Special Issue January (2015) 71–81,©School of Engineering, Taylor's University.

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6. Mr.V.A.Aher, Mayur Dukre, Ganesh Abhang, Trupti Thorat, "Colour based object sortingmachine", International Research Journal of Engineering and Technology (IRJET), Volume 08, Issue 02, Feb 2021, ISSN(print): 2395-0072, ISSN(online): 2395-0056.