Arduino Mega Microcontroller based Automatic Color Sorting System

V. Anantha Lakshmi[1*], Y. Ram Mohan[2], B.V. Arun Kumar[3], Satheesh G[1] and G. Kishor[4]

[1]Associate Professor, EEE Department, G. Pulla Reddy Engineering College, Kurnool
[2]Associate Professor, ECS Department, G. Pulla Reddy Engineering College, Kurnool
[3]Assistant Professor, EEE Department, G. Pulla Reddy Engineering College, Kurnool
[5]Professor, EEE Department, G. Pulla Reddy Engineering College, Kurnool
val.eee@gprec.ac.in

Abstract. In today's digital era, color processing plays a critical role across industries by addressing the challenge of achieving consistency in continuous object sorting, which is traditionally prone to errors in manual handling. This paper introduces a novel approach for automated object recognition and sorting, ensuring items are accurately placed in designated locations. Modern advancements in image and color processing have garnered significant interest, opening the door to diverse applications across fields by leveraging cutting-edge technology. The color sorter system presented here was developed using an Arduino Mega microcontroller, Huskylens, servo motor, and various electronic and mechanical components. The Huskylens detects the color of an object and transmits this information to the Arduino, which then directs the circuit to activate specific actuators, guiding the object to its allocated position. Based on color detection, the conveyor belt moves to the appropriate location, pushes the object into place, and then awaits the next item. This system can efficiently sort objects by color into designated stations with minimal delay, offering a reliable solution for real-time sorting needs.

Keywords: Arduino Mega, Servo Motor, Color Sorting, huskylens, Color Sensor.

1 Introduction

In today's highly competitive environment, production efficiency is widely viewed as a key factor for success. This efficiency encompasses the speed of production processes and equipment, reducing material and labor costs, enhancing product quality, minimizing rejects, and decreasing equipment downtime. To support these goals, color sorting technology has been developed, providing valuable benefits for various industries.

In agricultural industry for rice sorting, bean sorting, and peanut sorting etc the primary sorter is color sorters only. They also serve various industrial applications, including sorting quartz sand, plastic granules, and colored nuts and bolts. These ma

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chines reduce human effort, labor, and costs. Sensor-driven systems can operate pick-and-place robots, enabling them to identify, pick up, and place objects accurately in their designated locations.

A survey in [1-3] outlines a functional prototype developed for automatic color-based object sorting. The system uses a TCS230 sensor to detect product color and a PIC16F628A microcontroller to manage the process. Color recognition relies on output from the TCS230 sensor. The system consists of two conveyor belts, each driven by its own DC motor. The first conveyor carries products to a color sensor for inspection, while the second positions a compartmentalized container to organize the sorted items. Testing demonstrates that the prototype effectively achieves both high production speeds and accurate quality control, making it well-suited for automation tasks.

In [4, 5], researchers highlights that color matching of components is a critical aspect of leather product manufacturing, currently performed manually by skilled assorters. Errors in color matching can lead to product rejection, even when other quality standards are met. As a result, major leather manufacturers are looking for a faster, more affordable, and objective system for color sorting. Manual color sorting is not only subject to fatigue and subjective variation but also limits productivity.

From [6 - 8] aimed to design and construct an optical sorting machine based on a color sensor, with development proceeding through several stages. At the start of the process, products are shrunk in a hot chamber, and later, products of different sizes are sorted onto separate conveyors for final preparation for the market.

A system that combines two separate processes into one integrated solution. First, products are shrunk in a hot chamber; afterward, items of varying sizes are sorted onto different conveyors for final preparation before reaching the market [9].

A system leveraging an open-source, Linux-based Raspberry Pi controller board, widely employed in automation applications.. The study aims to evaluate its effectiveness in object sorting as a mechanical system. The setup includes a webcam that captures an image of each object to be sorted, which is then processed with OpenCV (Open Source Computer Vision) to identify the object's shape and color. OpenCV, a library of programming functions for real-time computer vision, enables precise image analysis. Additionally, a robotic arm is employed for handling objects of various sizes, ensuring versatility in sorting [10-12].

In [13, 14], Researchers describes a sorting system utilizing a 4-degree-of-freedom manipulator with a monocular camera for machine vision control, enabling accurate positioning and classification of target items. The team developed an automated sorting test platform for agricultural products, using oranges and tomatoes as test objects. Results showed a target positioning success rate of nearly 98%, a classification accuracy of approximately 98%, and a grasping success rate of around 95%. This system employs a target-based sorting technique to streamline the process.

A SCARA robotic arm is designed for RGB color sorting designed to identify and sort color-coded products within a designated workspace based on their color. This low-cost, quick-to-market color-sensing solution, built for academic purposes, leverages System-on-Chip (SoC) technology and uses SCARA geometry as the test platform. The design features a PSoC-based solution combining an RGB light-to-frequency sensor network (using the TCS230 module) and IR sensors. It also includes signal processing capabilities and the assembly of the SCARA robotic arm, as detailed in [14].

In [15], discusses the development of an autonomous robot designed to identify objects on a conveyor belt and relocate them if they meet specified criteria. The system aims to streamline targeted tasks by utilizing a robotic arm to carry out precise object handling and relocation based on preset requirements.

In [16], researchers present a sorting system that uses a camera mounted above a conveyor belt. The camera captures images, which software processes to identify the object's location and features (e.g., tomatoes). This information is then used for a pick-and-place operation, synchronized with the robot's controller. The sorting process involves detecting the object, determining its properties (like color, size, and shape), locating it, and calculating the gripping position. The data is converted into signals for the robot's control system. The system will be tested on a Delta robot with 3 degrees of freedom (DOF), and the results will be analyzed for workspace, productivity, and energy efficiency. While this system uses a robot for targeted tasks, it requires more maintenance and has lower efficiency compared to other methods.

The project in [17] combines electrical, mechanical, and visual subsystems, using a Pixy camera for color detection and multiple servomotors for arm movement. This multi-DOF robotic sorter enhances automation in production processes with conveyor belts, improving efficiency. However, as it is designed for predefined tasks, its efficiency in providing results may be limited.

The design features a color-sorting robotic arm that detects object positions and places them accurately using an ATMEGA328P microcontroller. The system, which uses ultrasonic and color sorting sensors, currently identifies red, green, and blue objects [13, 17].

2 Operation of the Proposed Color sorting system.

The proposed machine consists of mainly four parts: conveyor belt with servo motor drive, huskylens color sensor, double acting pneumatic cylinders. The input and output of each component were interfaced using an Arduino. This color sorting machine is designed primarily to sort RGB colors, separating objects by color and placing them into designated containers or cups.

The sensing component involves three main steps: detecting, identifying, and recognizing the color of objects. The system effectively performs the handling station tasks—specifically the push-and-drop mechanism—using a lens, conveyor belt, and double-acting cylinders.The Arduino microcontroller sends signal to circuit which drives the various motors of the conveyor belt and the object is to be placed in the specified location by running the motors. Now the double acting cylinders are acting to move the objects in to a basket.

Later the control is again send back to lens to detect another piece of object and the operation will continue until the end of the detection. The key advantages of this system include faster product sorting, minimal risk of errors due to full automation, and reduced manpower requirements. By maintaining production within the desired specifications, the system can help increase product demand.

The construction is divided in to two parts one is mechanical structure and other is electrical control structure.

3 Mechanical Structure Development

A conveyor system is a commonly used mechanical handling device designed to transport materials from one location to another.

Conveyors are especially useful for moving heavy or bulky items. In this setup, a horizontal belt conveyor system with an aluminum frame is utilized. The belt conveyor is a type of conveyor system that uses a continuous loop of carrying medium—the conveyor belt—passing over three pulleys. One pulley, known as the drive pulley, is powered to move the belt and materials forward, while the upper pulley is referred to as the idler pulley. The drive pulley is motor-driven, with its direction controlled by a microcontroller. Additionally, a linear actuator is used to position the color blocks placed in the slot stand.

4 Electrical Control System Development

The electrical control system is central to the all sensor sensing and conveyor cum two way controlled cylinder sorting process. The Huskylens color sensor is employed to detect different colored objects. The 12 V DC motor driver IC - L293D IC is employed to control the rotation speed of the DC motor via the microcontroller. A servo control circuit is also designed on a PCB, primarily utilizing an Arduino UNO.

A HuskyLens sensor detects the presence of blocks in front of the lens, while the Arduino manages the conveyor motor. When a block is detected in the slot, the system runs continuously; however, if no blocks are present, the entire system stops automatically. The entire sensor operation and work process is explain in the flowchart in Fig.1.

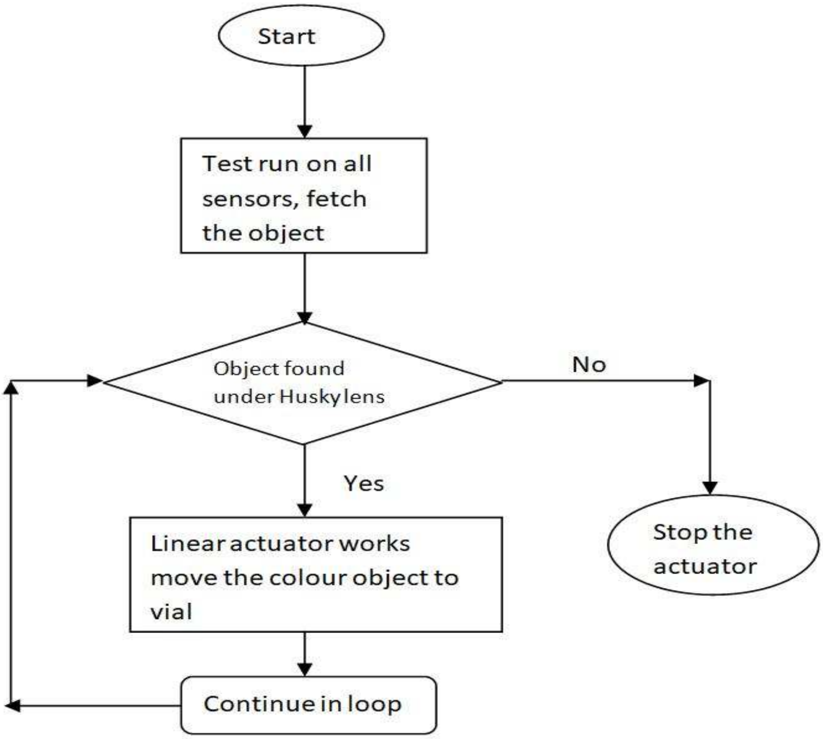

Fig. 1. Process of Automatic Color Sorting Machine Using Arduino Mega Microcontroller.

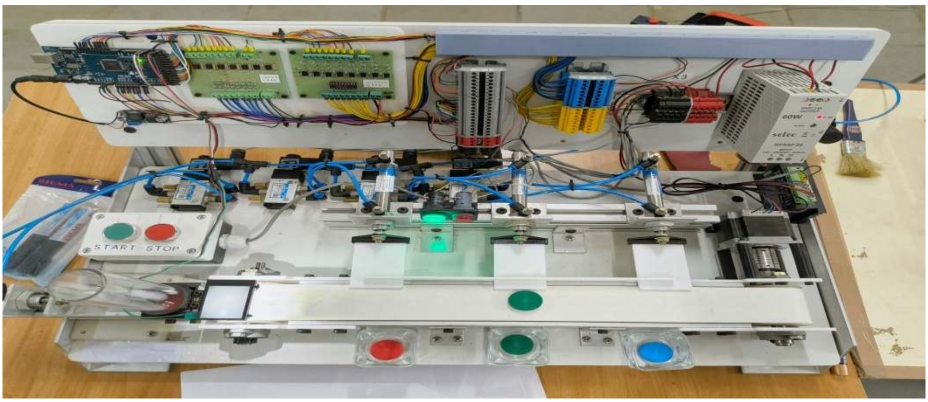

Fig. 2. Initial position and working model of Automatic Color Sorting Machine Using Arduino Mega Microcontroller.

Fig. 3. Red Colour is coded as ID:1 is identified by the huskylens.

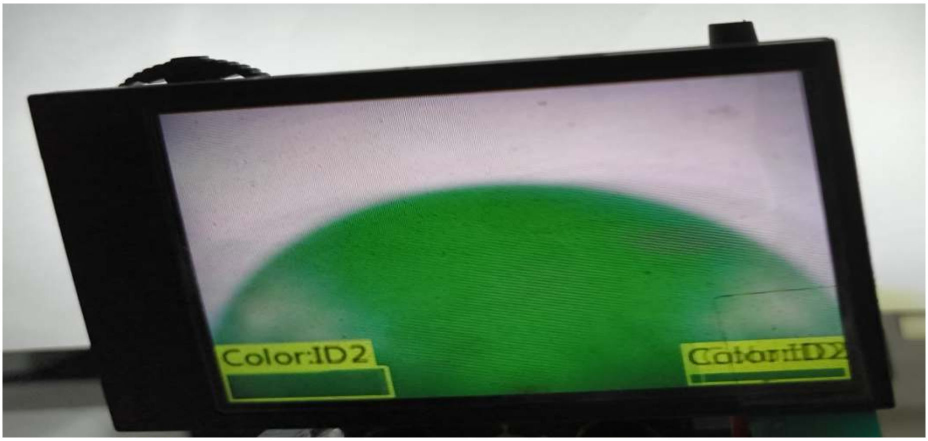

Fig. 4. Green Color is coded as ID:2 is identified by the huskylens.

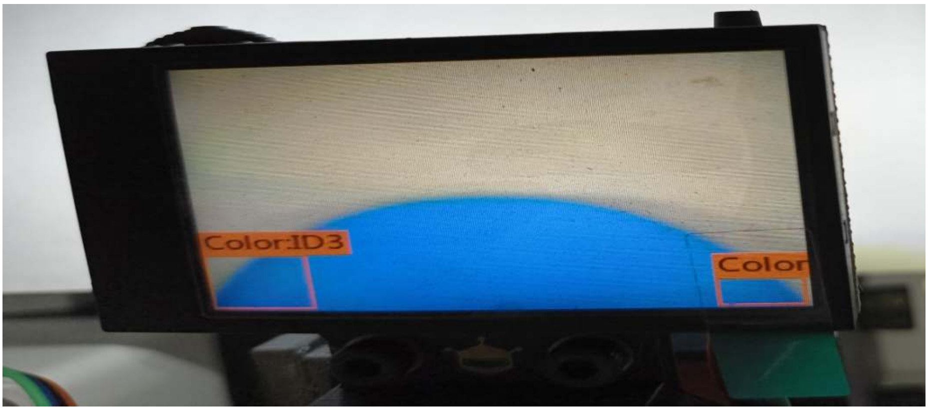

Fig. 5. Blue Colour is coded as ID:3 is identified by the huskylens.

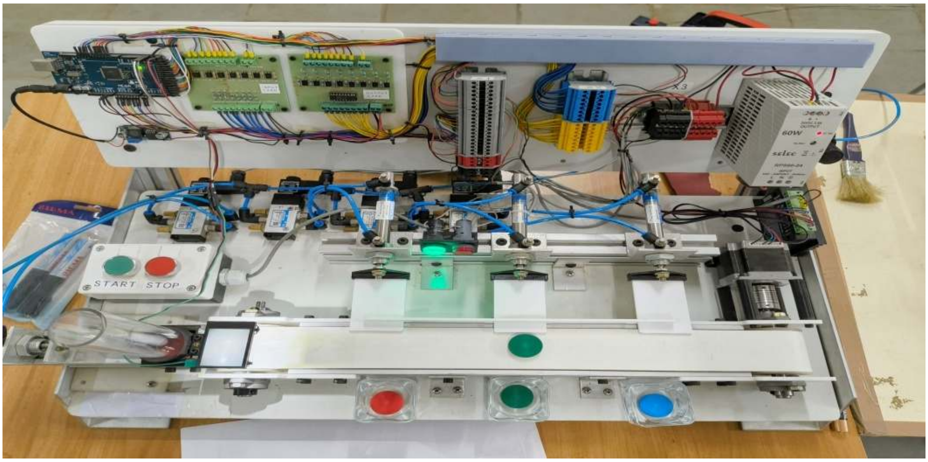

Fig. 6. Pushing the Green Color coin in the selected place.

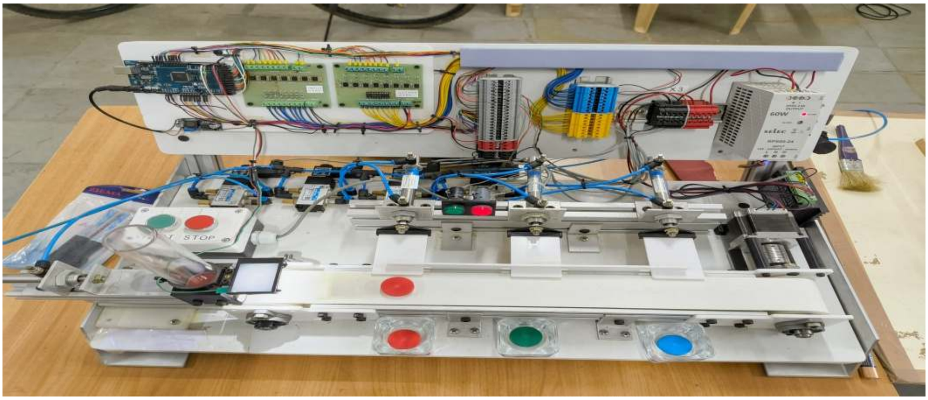

Fig. 7. Pushing the Red Color coin in the selected place.

5 Experimental Results And Analysis

All components are interconnected, with the main devices placed adjacent to one another. The Arduino board is mounted and connected to an external power supply to ensure it receives the required current. All appliances will be linked to the Arduino board, and the wiring on the breadboard has been installed. The Figure 2 explains the initial operation of color sorting system when power is supplied to the system.

Initially the cylinder beside the huskylens is starts push the colored objects to conveyor belt which comes exactly under the lens, the color is recognized by the lens and respective double action cylinder is activated by the pneumatic pressure, three double acting cylinders are used to sort the objects at the conveyor belt. The color sensor is used to distinguish between different color blocks, such as red, green, blue, and others. It is highly sensitive to changes in light intensity.

The proposed color sorter system is a sophisticated integration of mechanical, pneumatic, and electronic components designed to handle small objects such as bottles, caps, or containers. This system is a testament to the advancements in automation technology, showcasing the seamless collaboration of various subsystems to achieve efficient and precise operation.

At the heart of the color sorter system lies the mechanical components, which provide the foundation for the entire setup. The conveyor belt, powered by a motor, moves objects from the input area to the output stations with consistent motion. The support frames, made of aluminum extrusions, offer stability and mounting points for all components, ensuring durability and precision alignment. The conveyor belt keep items aligned, ensuring accurate positioning for operations like sorting, filling, or inspection.

The pneumatic components of the color sorter system play a crucial role in moving or manipulating items. The pneumatic cylinders, connected to solenoid valves, are responsible for tasks such as pushing items into designated bins or performing actions like stamping, pressing, or sealing. The solenoid valves act as switches, controlling the air supply to the cylinders and allowing for dynamic, real-time control.

The electrical control system is centered around an Arduino microcontroller, which processes inputs from sensors and outputs commands to the actuators and other components. The nearby PCB modules provide additional I/O connectivity, linking the Arduino to external devices like motors, valves, and sensors. The relay modules manage high-power components, ensuring safe operation.

The control panel and user interface of the color sorter system feature start/stop buttons (fig.1, 6, 7) which are part of the system's manual control interface. The green button likely starts the operation, while the red button serves as an emergency stop. Indicators, such as LEDs, display system status, providing the operator with real-time feedback.

The operation workflow of the color sorter system involves item detection (fig. 3, 4, 5), item movement, sorting or processing (fig.6, 7), output, and feedback and monitoring. The system is modular and can be expanded for more complex tasks, making it suitable for educational, prototyping, or light industrial use.

The potential applications of the color sorter system are diverse, including packaging, pharmaceuticals, food and beverage, and education and research. This system demonstrates principles of automation and control systems, making it an ideal tool for educational and research purposes.

In conclusion, the color sorter system is a remarkable example of automation technology, showcasing the seamless integration of mechanical, pneumatic, and electronic components. Its modular design, safety features, and potential applications make it an ideal solution for various industries and educational institutions. As automation technology continues to evolve, systems like color sorter system will play a crucial role in shaping the future of manufacturing and industry.

6 Conclusion

This automatic color sorting system is highly effective due to its working principle and broad potential for implementation. By utilizing the concept of this system, industries can efficiently sort products based on color. While there are some limitations, with modifications, this concept can be adapted for a wide range of applications. It conclude that implementing this automatic color sorting system in industries such as chemicals, food, chip manufacturing, and others can significantly reduce time and human effort.

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