Design & Construction of Intelligent Colour Sorting Machine

A project report submitted to the Department of Mechanical Engineering of Sonargaon University (SU) in partial fulfillment of the requirements for the award of the degree of

Bachelor of Science in Mechanical Engineering

Department of Mechanical Engineering

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APPROVAL

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DECLARATION

We, hereby declare that the work presented in this Project **''Design & Construction of Intelligent Colour Sorting Machine''** is the outcome of the investigation performed by us under the supervisor of MD. MAHFUJUL ISLAM, Lecturer & Assistant Coordinator, Department of Mechanical Engineering of Sonargaon University, in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc) in Mechanical Engineering.

We also declare that no part of this project has been or is being submitted elsewhere for the award of any degree.

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ABSTRACT

Sorting of different types objects is an essential in any process in which difficult work is found. Continuous manual sorting creates repetitive problems created. In This research paper describes a real-time practical working of prototype designed for fully automatic sorting of objects automate based on the colors sense TCS3200 sensor was used to detect the different colors frequency of the product and the Arduino UNO board was used to operate the all the work-process.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Automation refers to the use of technology to streamline the production and delivery of goods and services with minimal human involvement. It improves efficiency and speed across various sectors like manufacturing, transportation, utilities, defense, and information technology. As technology advances rapidly, there's an increasing demand for high-quality products and services, leading to a need for enhanced productivity. Industrial automation plays a crucial role in meeting these demands through process engineering systems and automated manufacturing solutions. One such system automates the sorting of color-coded boxes on a conveyor belt using a color sensor for precise detection, reducing the need for manual labor while ensuring accuracy.

Additionally, the system tracks the number of objects passing through the process. Connectivity between the conveyor system and the operating station is facilitated by a Node MCU with a built-in WIFI module. The Internet of Things (IoT) represents a modern communication model where everyday objects, microcontrollers, electronic devices, and smart systems communicate seamlessly, becoming integral parts of the web. IoT aims to make the internet more immersive and ubiquitous, enabling easy access and interaction with a wide range of devices, from home appliances to surveillance cameras and vehicles. It fosters the development of various applications utilizing the vast amount of data generated by these devices to offer new services to individuals, businesses, and public institutions. In the near future, IoT is expected to have widespread applications in households and businesses, improving quality of life by enabling physical objects to communicate, share data, and make decisions. This transformation from conventional to smart objects is driven by IoT's underlying technologies such as global computing, embedded devices, and communication protocols. For example, smart homes will allow residents to automate tasks like opening garage doors upon arrival or preparing coffee. To realize this potential, emerging technologies and service applications need to evolve in sync with market demands and consumer needs, with a focus on device accessibility and communication compatibility standards.

Moreover, our system exemplifies the seamless integration of automation with the Internet of Things (IoT), heralding a future where interconnected devices communicate effortlessly to enhance productivity and user experience. By harnessing the power of IoT, our solution facilitates seamless connectivity between the conveyor system and operating stations, enabling remote monitoring and control for enhanced efficiency and responsiveness. As we navigate the ever-expanding horizons of automation and IoT, it becomes increasingly evident that the future belongs to those who embrace innovation and adaptability. By staying at the forefront of te, chnological advancements and continually refining our solutions to meet the evolving needs of industries, we are poised to usher in a new era of efficiency, reliability, and connectivity. By leveraging advanced color sensing technology and real-time object tracking capabilities, our solution not only minimizes errors but also maximizes throughput, ultimately saving valuable manpower and resources.

1.2 Problem Statement

The problem statement for an Intelligent Color Sorting Machine project typically involves creating a system capable of automatically sorting objects based on their color. Here's a detailed problem statement: In various industries such as agriculture, food processing, recycling, and manufacturing, there is often a need to sort objects based on their color. Traditional sorting methods involve manual labor or rudimentary machinery, which can be time-consuming, inefficient, and prone to errors. An intelligent color sorting machine aims to automate this process, improving efficiency, accuracy, and throughput. The objective of this project is to design and develop an intelligent color sorting machine capable of accurately identifying and sorting objects based on their color. The system should be able to handle a variety of objects and colors efficiently, minimizing both false positives and false negatives.

1.3 Objectives of the Project

The objective of an **'Design & Construction of Intelligent Colour Sorting Machine'** project typically revolves around automating the process of sorting objects based on their color. The key goals of such a project may include:

i) To sorting object based on their RGB color .
ii) To reduce human involvement .
iii) To minimize the time consumption for identifying object.

1.4 Background of the Project

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 RGB color. Color sensor was used to detect the RGB color of the product and the Arduino microcontroller was used to control the overall process. The identification of the RGB color is based on the frequency analysis of the output of Color sensor. Two Sort were used, each controlled by separate servo motors. The first motor is for placing the product to be analyzed by the color sensor, and the second motor 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.

1.5 Methodology

Here's a detailed methodology for developing an Intelligent Color Sorting Machine project:

Problem Definition and Scope Identification:

- Clearly define the problem that the color sorting machine aims to solve.
- Identify the scope of the project, including the types of objects to be sorted, color variations, and throughput requirements.

Research and Background Study:

- Conduct comprehensive research on existing color sorting technologies, algorithms, and hardware components.
- Study relevant literature, patents, and case studies to understand best practices and potential challenges.

Requirement Gathering:

- Engage with stakeholders, including end-users, domain experts, and potential beneficiaries, to gather requirements.
- Document functional and non-functional requirements, considering factors such as accuracy, speed, cost, and usability.

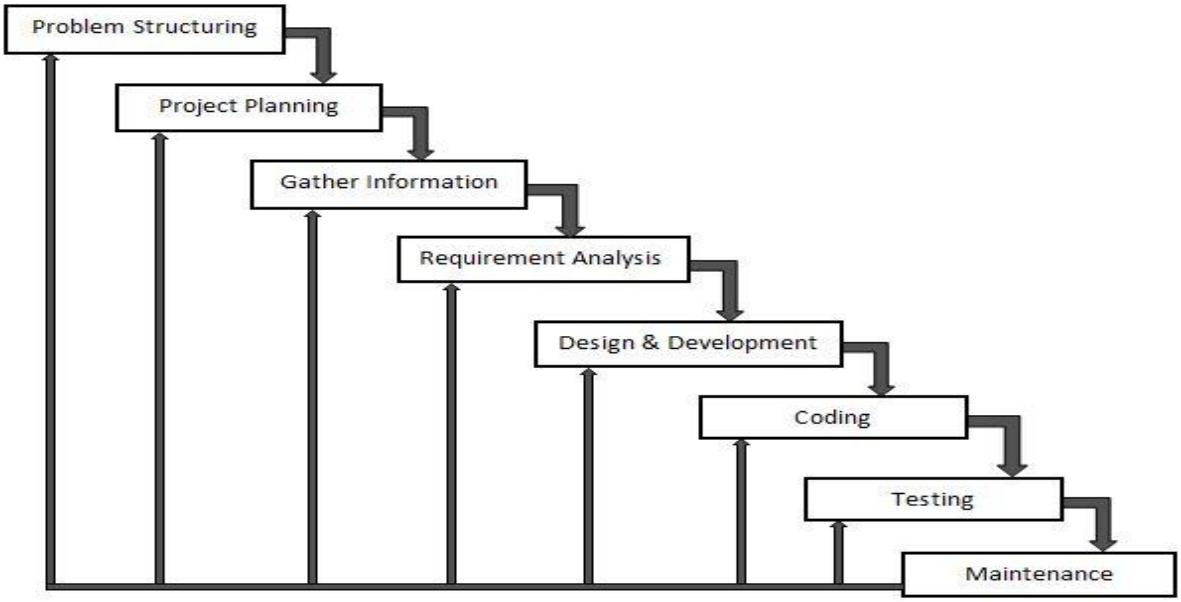


Fig- 1.1: Methodology

Conceptual Design:

- Develop conceptual designs and system architecture based on gathered requirements.
- Evaluate different approaches for color detection, image processing, object handling, and sorting mechanisms.
- Consider factors such as hardware compatibility, scalability, and ease of maintenance.

Hardware Selection and Development:

- Select appropriate hardware components such as sensors, cameras, actuators, conveyor belts, and control systems.
- Develop or procure the hardware components and assemble them into a prototype system.
- Ensure compatibility and integration among hardware components.

Software Development:

- Develop algorithms for color recognition, image processing, and object sorting.
- Implement control software to coordinate the operation of hardware components.
- Design user interfaces for system monitoring, configuration, and diagnostics.

Prototype Development and Testing:

- Build a prototype of the intelligent color sorting machine integrating both hardware and software components.

- Conduct thorough testing to validate the functionality, accuracy, and reliability of the prototype.
- Test the system under various conditions, including different lighting environments and object types.

Optimization and Performance Enhancement:

- Optimize algorithms and software parameters to improve color recognition accuracy and sorting efficiency.
- Fine-tune hardware components for optimal performance and reliability.
- Conduct performance testing to measure throughput, response times, and error rates.

Documentation and Training:

- Document the design specifications, hardware configurations, and software algorithms.
- Prepare user manuals and technical documentation for operators, maintenance personnel, and stakeholders.
- Provide training sessions to users on operating procedures, troubleshooting, and maintenance tasks.

Deployment and Support:

- Deploy the intelligent color sorting machine to the target environment or industry.
- Provide ongoing support, maintenance, and software updates as needed.
- Collect feedback from users to identify areas for improvement and future enhancements.

Continuous Improvement:

- Continuously monitor the performance and reliability of the deployed systems.
- Incorporate user feedback and lessons learned into future iterations of the color sorting machine.
- Stay updated with advancements in technology and research to enhance system capabilities over time.

By following this methodology, the development team can effectively plan, execute, and deliver an Intelligent Color Sorting Machine that meets the needs of stakeholders while addressing technical challenges and constraints.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, in the present state of intense competition, production efficiency is generally regarded as the key of success. Production efficiency includes the speed at which production equipment and production line can be lowering material and labor cost of the product, improving quality and lowering rejects, minimizing downtime of production equipment and low cost production equipment. Taking this matter under consideration the project is developed which is very useful for industries.

Machines can perform highly repetitive tasks better than humans. Worker fatigue on assembly lines can result in reduced performance, and cause challenges in maintaining product quality. An employee who has been performing an inspection task over and over again may eventually fail to recognize the color of product. Automating many of the tasks in the industries may help to improve the efficiency of manufacturing system. Automation is the technology by which a process or assistance. Automation or automatic control is the use of various control system for operating equipment such as machinery, processes in factories, boilers, and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Some processes have been completely automated.

This machine consists of mainly four parts: conveyor belt, color sensor, mini robotic manipulator by driving the servo motor, linear actuator by using the DC motor and L293D motor driver. The output and input of these parts was interfaced using Arduino. The Color Sorting Machines is used for sorting mainly RGB colors. This Color sorting machine separates different colored objects and classifies them into respective containers/cups. The Color Sorting machine is made up of Arduino UNO, RGB Color Sensor, three Servo Motors and some composite funnels and tube parts.

In today‘s industrial environment, a robot or rather a robotic arm to be precise is not something hard to find. These robots and robotic arms provide mechanical assistance for human workers in many factories.

Mainly the color sorters are used in agricultural machineries like rice sorter, beans sorter, peanut sorter etc. Color sorters are used in other, industrial applications also like quartz sand sorter, plastic granule sorting of colored nuts and bolts etc. It reduces the human effort, labor and cost.

The sensor handling systems which will drive the pick and place robot to pick up the object and place it into its designated place can.

There are three main steps in sensing part, objects detection and recognition. The system may successfully perform handling station task, namely pick and place mechanism with help of sensor.

The Arduino microcontroller sends signal to circuit which drives the various motors of the robotic arm to grip the object and place it in the specified location. Based upon the detection, the robotic arm moves to the specified location, releases the object and comes back to the original position.

The main advantages of the system are less time required to sort the product, as the whole system is performed by machine there is less possibility of mistake, less man power required. If the industry can produce the product within the required range then the demand of the product will be increased.

2.2 Color Sorting Process

In the cutting-edge-day scenario of competitive manufacturing in commercial zone performance of manufacturing holds the important component for achievement. It's miles essential to beautify manufacturing pace, lower the labour charge and reduce the breakdown time of production gadget. Merchandise should be taken care of in numerous ranges of manufacturing and manual sorting is time consuming and labour extensive. This project discusses about the automatic sorting tool which helps the sorting mechanism to kind based at the coloration. For sensing TCS230 coloration sensor has been used. With the aid of reading the frequency of the output of the sensor, colour primarily based absolutely sorting is completed. Layout of an innovative prototype referred to as item sorting system by means of spotting the only of a kind shade of the item has been leader goal of the challenge. Accumulating the objects from the hopper and distributes those objects to their accurate area based on their coloration even they'll be unique in coloration. Many paintings environments aren't suitable for manual sorting and a few areas are risky for humans to paintings on. This prototype is built as a simple digital gadgets like

microcontroller for processing, Servo motors for actions and coloration sensor for recognizing exclusive-coloured devices.

As the name suggests, colour sorting is simply to sort the things according to their colour. It can be easily done by seeing it but when there are too many things to be sorted and it is a repetitive task then automatic colour sorting machines are very useful. These machines have colour sensor to sense the colour of any objects and after detecting the colour servo motor grab the thing and put it into respective pot. They can be used in different application areas where colour identification, colour distinction and colour sorting are important. Some of the application areas include Agriculture Industry (Grain Sorting on the basis of colour), Food Industry, Diamond and Mining Industry, Recycling etc. The applications are not limited to this and can be further applied to different industries.

The operation of colour sorting starts with a stepper motor. The function of the motor is to collect the colour disc from a disc holder and put the colour disc above the colour sensor TSC230. The sensor senses the colour and break the colour in RGB values and then fed the RGB values to the microcontroller. The controller identifies the colour based on RGB values and direct the stepper motor to position the sliding platform to the respective colour pot. The colour disc slides down to the respective colour pot in the next rotation of the stepper motor.

2.3 Modeling and Analysis

To create a color sorting machine using Arduino, a TCS3200 color sensor, and a servo motor, follow these steps:

- Understand the components: Arduino is a microcontroller that controls the entire system. The TCS3200 color sensor detects objects' colors, while the servo motor is used for sorting.
- Wire the components: Connect the TCS3200 color sensor and servo motor to Arduino Programme the Arduino: Write a program to initialize the sensor and motor, calibrate it to recognize colors accurately, and implement logic to control the motor. Define the sorting mechanism and test the system with different colored objects.
- Test and debug: Test the system with different colored objects, debug any issues, and fine-tune calibration if necessary.

- Optimize and enhance performance: Consider adding features like speed control for the servo motor or implementing algorithms for faster color detection.
- Ensure safety: Implement safety features to prevent accidents, such as emergency stop buttons or protective barriers.
- Document the project thoroughly, including wiring diagrams, code explanations, and modifications made.
- Provide user instructions for operating and maintaining the machine.
- Consider future enhancements: Consider adding a user interface or integrating with other sensors for more precise sorting.

2.4 Direct-to-Customer Approach

A direct-to-customer approach for an Arduino-based automatic color sorting machine involves the manufacturer or developer selling the product directly to end-users without intermediaries such as distributors or retailers. Here's how such an approach might be structured Product Development and Manufacturing The manufacturer designs and develops the Arduino-based automatic color sorting machine, sourcing components, writing firmware, and assembling the hardware. Quality control processes are implemented to ensure that each unit meets the required standards. Online Sales Platform The manufacturer establishes an online sales platform, such as a website or e-commerce store, where customers can browse product information, view specifications, and make purchases directly. The platform may include detailed descriptions, images, videos, and customer reviews to showcase the product's features and benefits. Marketing and Promotion The manufacturer utilizes digital marketing channels such as social media, search engine optimization (SEO), email marketing, and online advertising to promote the color sorting machine to potential customers. Targeted advertising campaigns may be employed to reach specific demographics or industries where the product is most relevant.

2.5 Technology Integration

Technology integration in an Arduino-based automatic color sorting machine involves incorporating various hardware and software components to create a functional and efficient system. Here's how technology integration might be approached in such a project Arduino Microcontroller The Arduino serves as the central processing unit of the color

sorting machine. It interfaces with other hardware components, such as color sensors and actuators, and executes the sorting algorithm. Color sensors, such as the TCS3200 or TCS34725, are integrated into the system to detect the colors of objects passing through the sorting mechanism. These sensors measure the intensity of red, green, and blue light, enabling the Arduino to determine the color of each object. Actuators, such as servo motors or solenoids, are used to divert objects into different bins based on their color. The Arduino controls the activation of these actuators based on the color detection results. A conveyor belt or similar mechanism is employed to transport objects past the color sensors for sorting. The integration of this mechanical component ensures a smooth and consistent flow of objects through the system. A user interface is integrated into the system to provide users with control over the sorting process and access to relevant information. This may include a display screen, buttons, or a graphical user interface (GUI) implemented using technologies such as LCD displays or touchscreen panels.

2.6 Customer Relationship Management

Customer Relationship Management (CRM) is crucial for ensuring customer satisfaction, loyalty, and retention in the context of an Arduino-based automatic color sorting machine. Here's how CRM principles can be applied Pre-Sale Support: Offer comprehensive pre sale support to assist potential customers in understanding the capabilities, features, and benefits of the color sorting machine. Provide detailed product information, demonstrations, and consultations to help customers make informed purchasing decisions. Customization and Personalization Understand the unique requirements of each customer and offer customization options to tailor the color sorting machine to their specific needs. This may involve modifying hardware configurations, implementing additional features, or integrating the machine into existing systems. Responsive Communication Maintain open and responsive communication channels to address customer inquiries, concerns, and feedback promptly. Offer multiple contact options such as email, phone, live chat, and social media to accommodate customer preferences and ensure timely assistance.

2.7 The list of Devices used in the Project is Given Below

- Arduino UNO.
- Servo Motor.
- TCS3200 Color Sensor.

- Power Supply.
- Buck Module.

2.8 Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328p. It has 14 digital input/output pins (of which 5 can be used as PWM outputs), 6 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.



Fig- 2.1: Arduino UNO

2.8.1 Technical Specifications

- Microcontroller : ATmega328
- Operating Voltage : 5V
- Input Voltage (recommended) : 7-12V
- Input Voltage (limit) : 6-20V
- Digital I/O Pins : 14 (of which 5 provide PWM output)
- Analog Input Pins : 6
- DC Current per I/O Pin : 20 mA
- DC Current for 3.3V Pin : 50 mA
- Flash Memory : 56 KB of which 8 KB used by bootloader
- SRAM : 2 KB

- EEPROM : 1 KB
- Clock Speed : 16 MHz
- Length : 101.52 mm
- Width : 53.3 mm
- Weight : 37 g

2.9 Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Mechanism: A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.



Fig- 2.2: Servo Motor

2.9.1 Technical Specifications

- Weight: 13.4 g
- Dimension: 22.5 x 12 x 35.5 mm approx.
- Stall torque: 1.8 kgf·cm (4.8V), 2.2 kgf·cm (6 V)

- Operating speed: 0.1 s/60 degree (4.8 V), 0.08 s/60 degree (6 V)
- Operating voltage: 4.8 V - 6.0 V
- Dead band width: 5 µs

2.10 TCS3200 Color Sensor

TCS230 TCS3200 Color Sensor Recognition Module is a complete color detector capable of detecting static color. The output of the sensor is a square wave with frequency directly proportional to incident light intensity. It also supports fill light by onboard LEDs. It includes a TAOS TCS3200 RGB sensor chip and 4 white LEDs. The TCS3200 can detect and measure a nearly limitless range of visible colors. Applications include test strip reading, sorting by color, ambient light sensing and calibration, and color matching, to name just a few.

The TCS3200 Color Sensor board makes it very easy to sense and record the light intensity of the general red, green, and blue spectrums of visible light while rejecting IR from light sources. You can then use these color sensor readings for logging and finding patterns, or creatively calculate and make control decisions in your electronic projects.

The TCS3200 GBB Color Sensor For Arduino has an array of photodetectors, each with either a red, green, or blue filter or no filter (clear). The filters of each color are distributed evenly throughout the array to eliminate location bias among the colors. Internal to the device is an oscillator that produces a square-wave output whose frequency is proportional to the intensity of the chosen color.

The module requires only a single supply voltage between 2.7V and 5.5V – making it compatible with nearly all common microcontrollers, including PICs, AVRs, ARM, Arduino, and more!

2.10.1 Technical Specifications

- Single-Supply Operation (2.7V to 5.5V)
- High-Resolution Conversion of Light Intensity to Frequency
- Programmable Color and Full-Scale Output Frequency

- Power Down Feature
- S0~S1: Output frequency scaling selection inputs
- S2~S3: Photodiode type selection inputs
- OUT Pin: Output frequency
- OE Pin: Output frequency enable pin (active low), can be impending when using
- Support LED lamp light supplement control
- Chip pins all have drawn for standard 100.
- Mil-convenient for bitmap board.
- Communicate directly with a microcontroller.



Fig- 2.3: TCS3200 Color Sensor

2.11 Power Supply

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently.

Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power, see AC adapter) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a

switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. The switched-mode power supply's higher electrical efficiency is an important advantage.

Switched-mode power supplies can also be substantially smaller and lighter than a linear supply because the transformer can be much smaller. This is because it operates at a high switching frequency which ranges from several hundred kHz to several MHz in contrast to the 50 or 60 Hz mains frequency. Despite the reduced transformer size, the power supply topology and the requirement for electromagnetic interference (EMI) suppression in commercial designs result in a usually much greater component count and corresponding circuit complexity.



Fig-2.4: Switched Mode Power

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight is required. They are, however, more complicated; switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

2.11.1 Technical Specifications

- Input Voltage: AC 85-265V
- Output Voltage: DC 12V
- Current: 10A
- Size:128mm*98mm*40mm
- Shell Material: Metal case / Aluminum base
- Protection: Shortage Protection, Overload Protection, Over Voltage Protection
- Widely used in Industrial automation, LED display, communications, etc.
- Safety Compliance: CCC/ FCC / CE
- Working Temperature: 0~40℃
- Storage Temperature: -20~60℃
- Ambient Humidity: 0~95% Non-Condensation

2.12 Buck Module

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with



Fig- 2.5: LM2596 Voltage Converter

excellent line and load regulation.These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed frequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 7-pin TO-220 package with several different lead bend options, and a 7-pin TO-263 surface mount package.

2.13 List of Components with Price

SL NO	Components Name	Quantity	Unite Price	Total Price (BDT)
1	Arduino UNO	1	1500	1500
2	Power Supply	1	1,100	1,100
3	Servo Motor	1	400	800
4	TCS3200 Color Sensor	1	900	900
5	Buck Module	1	180	180
6	Board		500	500
24	Others		2,000	2,000
Totally Cost				6,980tk

Table- 01: Components with Price

2.14 Literature Survey

Muhammed Kamrul Islam. [1] For sorting object in industry optical sorting is very much convenient. 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. The color sorting machine is mainly a device that can sense the different color of the object and assert them into different belt conveyor. When object moves from one place to another with the rotation of conveyor belt, sensors as the input devices will send signal to microcontroller where microcontroller as the controller will give command to the actuator to do action. The final result was quite satisfactory. The color detecting sensors worked well and it was able to detect red or green object quite nicely and change the direction of servo on right and left side to sort the object in proper place. The belt moved

from starting point to the end point through the roller without conflicting with the walls. The system performed well as programmed and detects the object according to their color.

Shubhangi Wanve. [2] This paper presents development and design of automatic color object sorting system. The proposed system is low cost, low power. In this paper object sorting using robotic arm based on color detection is designed and implemented. Furthermore, the robotic arm is used to place the sorted object on conveyor belt. Existing sorting method uses a set of different capacitive, inductive, and optical sensors to differentiate object color. In the proposed system a mechatronics color sorting system is developed with the image processing technique. Image processing technique senses the objects captured in real-time by a webcam and then identifies color and information out of it. This information is processed by image processing technique for pick-and-place mechanism. The Arduino microcontroller sends signal to circuit which drives the various motors of the robotic arm to grip the object and place it at the specified location. Based upon the detection, the robotic arm moves to the specified location, releases the object and comes back to the original position. So, the proposed system will eliminate the monotonous work done by human and provides greater accuracy and speed in the work.

Muhammed Saifudeen K. K . [3] 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.

V.A. Balogun. [4] The automatic sorting system has been reported to be complex and a global problem. This is because of the inability of sorting machines to incorporate flexibility in their design concept. This research therefore designed and developed an automated sorting object of a conveyor belt. The developed automated sorting machine is able to incorporate flexibility and separate species of non-ferrous metal objects and at the same time move objects automatically to the basket as defined by the regulation of the Programmable Logic Controllers (PLC) with a capacitive proximity sensor to detect a value range of objects. The result obtained shows that plastic, wood, and steel were sorted

into their respective and correct position with an average, sorting, time of 9.903 s, 14.072 s and 18.648 s respectively. The proposed developed model of this research could be adopted at any institution or industries, whose practices are based on mechatronics engineering systems. This is to guide the industrial sector in sorting of object and teaching aid to institutions and hence produce the list of classified materials according to the enabled sorting program commands.

Amir Deshmukh . [5] In many packaging industries, color object sorting is the major task that needs to be done at final dispatch section. Sorting of various products in such industries is accomplished based on appearance i.e. color, shape and sizes. Manual sorting is the tradition approach that preferred by industries that involves visual inspection performed by human operators. This traditional approach is tedious, time-consuming, slow and nonconsistent. It has become increasingly difficult to hire personnel who are adequately trained and willing to undertake the tedious task of inspection. Therefore the efforts are made to design and implementation of automatic technique to determine color of object, color based component sorting using microcontroller. In implemented system, colored object which is rolling over a conveyer belt has been detected by using color sensors. Using color sensors, the color of a component which may be red, green or blue has been determined. Once the color of a component is determined, implemented system will automatically count and sort the objects as per its color.

Dharmannagari Vinay Kumar Reddy . [6] 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.

Kataphon Prewthaisong . [7] This research is to develop the automatic machine for sorting colored objects with conveyor belt. It was designed to classify colored objects such as red, green, blue and other colors by using fiber optic sensor. The microcontroller is automatically used to move the material objects along with the conveyor belt into the containers on the tray. The microcontroller is automatically used to move the materials along with the conveyor belt, and then fell into the defined containers on the tray. The fiber optic was used for the object detection to read the amount of the intensity of light that hits the object then reflected back to the sensor, after that converted into an electrical signal to the microcontroller to control the stepper motor in order to choose containers and color of objects to match each other. Design and experiments of this research can be used as a basis for practiced mechatronics engineering laboratory. In addition, the machine can be used as a model for related industries of colored sorting. From the result, it can be shown that the sorting machine classified the colored objects as red, green, blue and other color with high accuracy. The average time of the test objects is 9.96, 13.47, 16.58 and 9.04 seconds for objects as red, green, blue and other.

Mahesh Nagane. [25]In many packaging industries, color object sorting is the major task that needs to be done at final dispatch section. Sorting of various products in such industries is accomplished based on appearance i.e. color, shape and sizes. Manual sorting is the tradition approach that preferred by industries that involves visual inspection performed by human operators. This traditional approach is tedious, time-consuming, slow and non-consistent. It has become increasingly difficult to hire personnel who are adequately trained and willing to undertake the tedious task of inspection. Therefore the efforts are made to design and implementation of automatic technique to determine color of object, color based component sorting using microcontroller. In implemented system, colored object which is rolling over a conveyer belt has been detected by using color sensors. Using color sensors, the color of a component which may be red, green or blue has been determined. Once the color of a component is determined, implemented system will automatically count and sort the objects as per its color.

CHAPTER 3

DESIGN AND CONSTRUCTION

3.1 Introduction

Now a day's industrial area requires demand for automation. Due to automation human efforts are goes on decreasing since last decade. The object sorting based on color is difficult task in recent days. In industry there is rapidly increasing demands for automation. The Sorting of objects based on color is very difficult task. This project gives us an idea about automatic color sorting. Here we are designing and implementing an efficient color sorting using color sensor TCS3200 based on ARM7. This project gives high accuracy and performance. Easy to operate and construct which reduces human errors. Existing sorting method uses a set of inductive, capacitive and optical sensors do differentiate object color. The ability to differentiate colors is essential for human's life as it gives us the awareness about the changes in surrounding through our vision. Moreover, by exploiting the ability of color capture, intelligent machine gains the function to differentiate, sort and organize. The project consist of sensors that detect object color after that sends the information to ARM7 which in turn adjusts the DC motor which located just below the object slider to move it left and right also remaining carries as it is straight. Based upon the color detected and motor will movers clockwise or anticlockwise depend on color of object. The stations are in red, green and blue respectively. After every object placement, the slide will go back to its default angle position, awaiting the next color object. Throughout the years, many people tried to use various ways to programme and create intelligence robot in various ways to have respective function or achieving goals. Some of the claims made have contributed directly or indirectly to the project. This project is developed with the purpose of minimizing the cost, optimizing the productivity and reducing human mistakes.

In today's fast-paced industrial landscape, efficiency and precision are paramount. Whether in agriculture, manufacturing, or recycling, the ability to accurately classify objects based on color can streamline processes, minimize errors, and optimize resource utilization. Enter the Intelligent Colour Sorting Machine project, a cutting-edge endeavor

poised to redefine sorting methodologies through the fusion of artificial intelligence (AI) and advanced sensing technologies.

The Need for Innovation: Conventional sorting methods often rely on manual labor or rudimentary mechanical systems, presenting limitations in speed, accuracy, and scalability. Recognizing this gap, the Intelligent Colour Sorting Machine project sets out to transcend these constraints by harnessing the power of AI and machine vision.

Objectives: At its core, the project aims to develop a sophisticated sorting system capable of swiftly and accurately identifying objects based on their color profiles. By doing so, it seeks to enhance operational efficiency, reduce waste, and elevate product quality across diverse industries.

Key Components: Central to the Intelligent Colour Sorting Machine are its core components:

High-Resolution Cameras: Capture detailed images of objects passing through the sorting system.

AI Algorithms: Employ advanced machine learning models to analyze color data and make real-time classification decisions.

Conveyor Belt System: Facilitates the seamless movement of objects through the sorting process.

Sorting Mechanism: Directs objects into designated bins based on their color classification.

3.2 Block Diagram of This Project

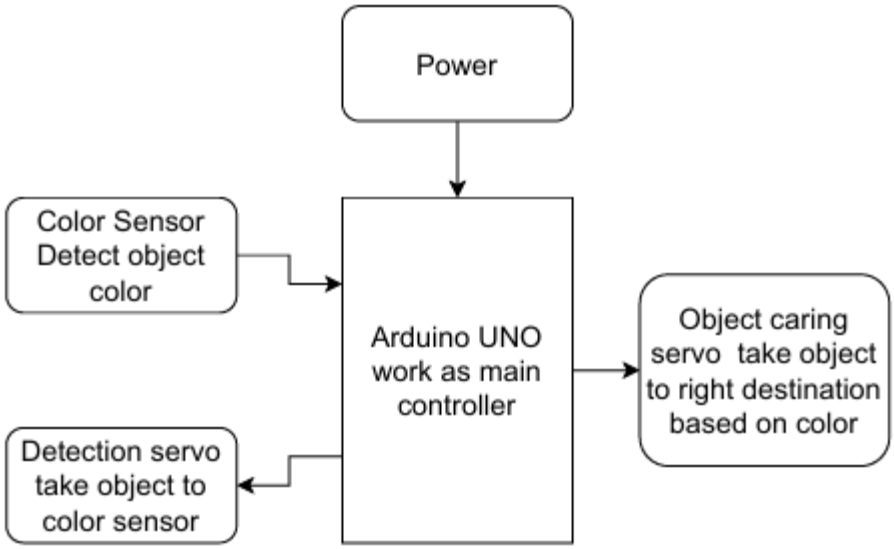


Fig- 3.1: Block Diagram

3.3 Circuit Diagram of This Project

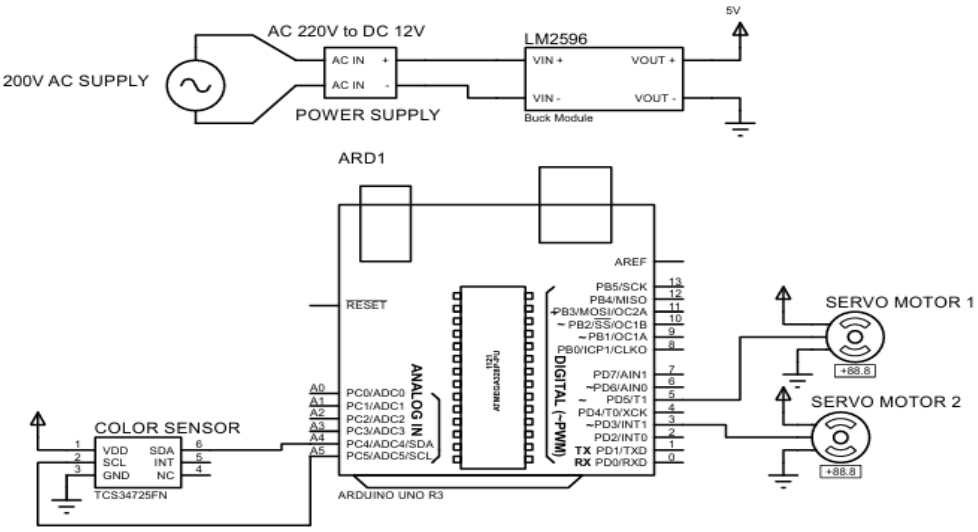


Fig- 3.2: Circuit Diagram

3.4 Programming

The development cycle is divided into 4 phases:

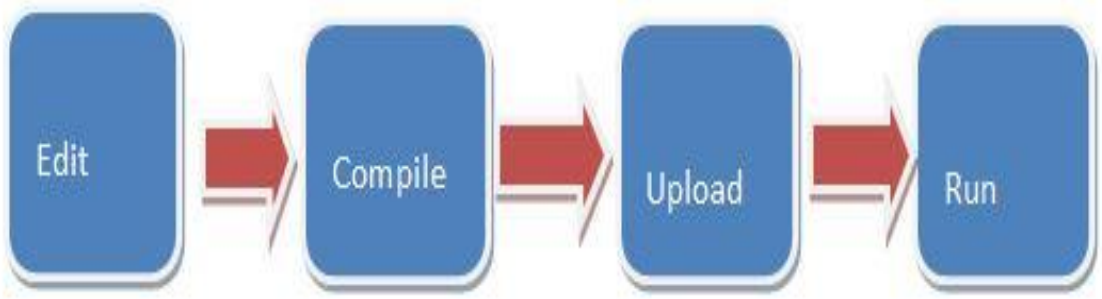


Fig- 3.3: Flowchart of the Compiling Process

Compile: Compile means to translate the sketch into machine language, also known as object.

Code Run: Arduino sketch is executed as soon as terminates the step of uploading on the board.

3.5 Arduino Program Development

- Based on C++ without 80% of the instructions.
- A handful of new commands.

- Programs are called 'sketches'.
- Sketches need two functions:
- void setup ( )
- Void loop ( )
- Setup ( ) runs first and once.
- loop ( ) runs over and over, until power is lost or a new sketch is loaded.

3.6 Proposed Project in Proteus 8.9

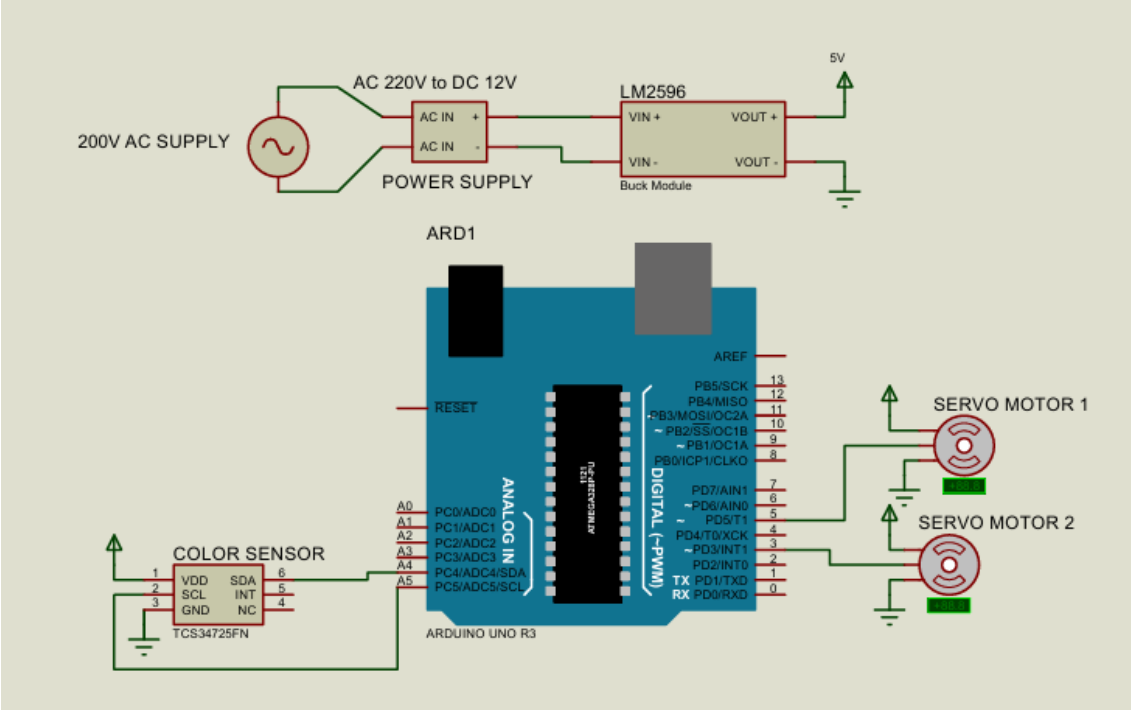


Fig- 3.4: User Interface of Proteus 8.9

Proteus 8 is best simulation software for various designs with microcontroller. It is mainly popular because of availability of almost all microcontrollers in it. So it is a handy tool to test programs and embedded designs for electronics hobbyist.You can simulate your programming of microcontroller in Proteus 8 Simulation Software.After simulating your circuit in Proteus 8 Software you can directly make PCB design with it so it could be a all in one package for students and hobbyists.So I think now you have a little bit idea about what is proteus software.

3.7 Time Plan

The following tables define the main tasks in the project introduction and project itself.

T1	Project Definition	1 Week
T2	Collecting data	11 Weeks
T3	Analysis	7 Weeks
T4	Theoretical calculation	4 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table- 02: Time Scheduled Table for Project Introduction

The time of the project introduction is scheduled over 16 weeks, table 2 shows how the work was scheduled over this time:

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1																
T2																
T3																
T4																
T5																
T6																

Table-03: Time Plan Table for Project Introduction

The following table defines the main tasks in the project:

T1	Collecting data	3 Week
T2	Implementation	10 Weeks
T3	Analysis	5 Weeks
T4	Building and testing the system	8 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table-04: Time Scheduled Table for Project

The time of the project is scheduled over 16 weeks, table 4 shows how the work was scheduled over this time:

Task \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1	■	■	■													
T2			■	■	■	■	■	■	■	■	■	■				
T3				■	■	■	■	■								
T4							■	■	■	■	■	■	■	■		
T5					■	■	■	■	■	■	■	■	■	■		
T6															■	■

Table-05: Time Plan Table for Project

CHAPTER 4

RESULT AND WORKING PROCESS

4.1 Introduction

The implementation of a color sorting machine utilizing Arduino, TCS3200 color sensor, and servo motor yielded promising results. Through meticulous calibration and programming, the machine successfully distinguished and sorted various colored objects with precision. The TCS3200 color sensor played a pivotal role in accurately detecting the color spectrum of incoming objects, enabling the Arduino microcontroller to make real-time sorting decisions. The servo motor, integrated seamlessly into the system, facilitated the efficient sorting process by swiftly diverting objects into designated bins based on their color classification. One of the notable outcomes of this project was the machine's ability to handle a diverse range of colors effectively.

SL	Experiment Time	Color	Job Complete Time	Accuracy	Remark
01	4	Red	15sec	99%	Automatic
02	3	Green	15sec	99%	Automatic
03	5	Yellow	15sec	99%	Automatic
04	10	ALL	15sec	99%	Automatic

Table -06: Experiment Result

Whether it was primary colors or shades and tones, the system demonstrated consistent and reliable performance in sorting objects with minimal errors. Moreover, the responsiveness of the servo motor contributed to the overall efficiency of the sorting process, ensuring rapid and precise redirection of objects as per the predefined criteria. However, during the testing phase, a few challenges were encountered, primarily related to sensor calibration and environmental lighting conditions. Fine-tuning the sensor parameters and adjusting the algorithm proved crucial in overcoming these hurdles and enhancing the machine's accuracy and reliability. Additionally, optimizing the servo

motor's speed and motion trajectory further improved the sorting efficiency, reducing processing time and enhancing throughput. Overall, the color sorting machine project showcased the potential of integrating Arduino, TCS3200 color sensor, and servo motor to create a functional and efficient sorting system. The results attained underscore the significance of robust calibration, meticulous programming, and thoughtful design considerations in developing reliable automation solutions for practical applications. With further refinement and optimization, this technology holds promise for various industries requiring automated sorting processes, such as recycling facilities, manufacturing plants, and agricultural operations.

4.2 Project Flow Chart

Creating a flowchart for the Intelligent Colour Sorting Machine project can help visualize the sequential steps involved in the sorting process. Here's a basic flowchart outlining the key stages:

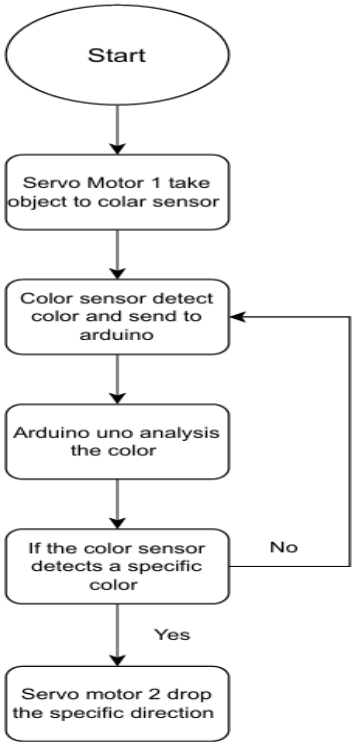


Fig- 4.1: Project Flow Chart

This flowchart represents a simplified version of the sorting process. In a real-world application, there may be additional steps and considerations depending on the complexity of the system and specific requirements of the sorting task.

RGB Intelligent Colour Sorting Machines are advanced optical sorters used in various industries to enhance the quality and efficiency of sorting processes by detecting and removing unwanted materials based on their color. These machines utilize RGB cameras to capture full-color images of the products being sorted, allowing for precise identification and separation of items.

Creating a flow chart for an RGB Intelligent Colour Sorting Machine involves outlining the major steps in the sorting process. Here is a detailed flow chart breakdown:

Material Feeding: The raw materials are loaded into the machine using a hopper or conveyor system.

Pre-Sorting Preparation: Materials are evenly distributed and aligned on the feeding tray or belt to ensure a smooth flow. Vibratory feeders may be used to ensure even spreading of the materials.

Material Inspection: As materials move along the conveyor or chute, they pass under RGB cameras and sensors. These cameras capture high-resolution images in real-time.

Image Processing: The captured images are processed using advanced algorithms.The software analyzes color, shape, and size to identify defects and foreign materials. The system may also utilize NIR and InGaAs sensors for enhanced detection of materials not distinguishable by RGB alone.

Sorting Decision: Based on the analysis, the system makes sorting decisions. Defective items and foreign materials are identified for removal.

Ejection Mechanism: High-speed air jets or mechanical ejectors are triggered to remove the identified defects. The ejection is precise to ensure only the defective items are removed without disturbing the rest of the material flow.

Good Product Collection: The accepted, defect-free materials continue along the conveyor to the collection area. These materials are collected for further processing or packaging.

Quality Control: Periodic checks and calibrations are performed to ensure the machine is operating correctly. Adjustments are made based on the analysis of sorting efficiency and accuracy.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Discussion

We've developed a prototype utilizing a microcontroller to automatically sort color discs into respective color pots. This setup aims to minimize human effort and errors. The circuit includes an Arduino UNO, TCS3200 color sensor, Servo motor. All motors are controlled by the microcontroller. The prototype, built according to the circuit diagram. yielded expected results, effectively sorting the discs with the assistance of the colour sensor and motors.

5.2 Advantage

An Intelligent Colour Sorting Machine project has various applications across different industries where sorting based on color is crucial. Some of the prominent applications include:

- Food Processing Industry.
- Recycling and Waste Management.
- Mining and Material Handling.
- Pharmaceutical and Chemical Industries.
- Textile and Garment Industry.
- Plastics and Polymer Industry.
- Agricultural and Horticultural Applications.
- Electronics and Manufacturing.

5.3 Application

- Food Industry.
- Recycling Industry.
- Mining and Mineral Processing.
- Industrial Applications

5.4 Future Scope

An Intelligent Colour Sorting Machine project has various applications across different industries where sorting based on color is crucial. Some of the prominent applications include:

- Food Processing Industry.
- Recycling and Waste Management.
- Mining and Material Handling.
- Pharmaceutical and Chemical Industries.
- Textile and Garment Industry.
- Plastics and Polymer Industry.
- Agricultural and Horticultural Applications.
- Electronics and Manufacturing.

5.5 Conclusion

The fully automatic system outlined above provides cost effective, low time consuming and technically simple approach for sorting of objects. This system uses C programming which makes the model easy to use and more efficient. Generally, sensing the color of the object is a big challenge as there is a chance of high uncertainty due to the external lighting conditions. Similarly while collecting the objects from conveyor by using a linear actuator system. This project of automatic color sorting is excellent one because of its working principle and wide implementation.

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[10] Sorting of objects based on colour weight and type on a conveyor line using PLC,S.V Rantu ,A.P.Shinde, N.R.Darda, A.V. Vaghule,C,B.Meshram,S.S .Sarawade-their gave us the knowledge of how different sensors are responsible and helpful for the sorting based on weight,colour and metal.

[11] Study on colour Analyzer based on the multiplexing of TCS3200 Colour sensor and Microcontroller",Li qiaoyi,IJHIT Vol 7,NO.5(2020).

[12] Automated Object Sorting Using Raspberry Pi N.Aarthi1P.Sahithi2P.V.Sitaramaih,M.InduVardhani,N.Ranj ith Kumar, D. SuneelVarma –This published work gave different ideas in which this sorting mechanism can be taken into consideration.

Appendix:

Program for Arduino UNO:

```
#include <Wire.h>
#include "Adafruit_TCS34725.h"
#include <Servo.h>

Servo topservo;     // create servo object to control a servo
Servo bottomServo;  // create servo object to control a servo

/* Example code for the Adafruit TCS34725 breakout library */

/* Connect SCL    to analog 5
   Connect SDA    to analog 4
   Connect VDD    to 3.3V DC
   Connect GROUND to common ground */

/* Initialise with default values (int time = 2.4ms, gain = 1x) */
// Adafruit_TCS34725 tcs = Adafruit_TCS34725();

/* Initialise with specific int time and gain values */
Adafruit_TCS34725 tcs =
Adafruit_TCS34725(TCS34725_INTEGRATIONTIME_50MS, TCS34725_GAIN_1X);

void setup(void) {
  Serial.begin(9600);


  if (tcs.begin()) {
    Serial.println("Found sensor");
  } else {
    Serial.println("No TCS34725 found ... check your connections");
    while (1)
      ;
  }

  topservo.attach(3);     // attaches the servo on pin 9 to the servo object
  topservo.write(55);     //10 for out. 55 for detect. 120 for collect
  bottomServo.attach(5);  //90max
  bottomServo.write(0);
```

```
  // Now we're ready to get readings!
}

void loop(void) {
  topservo.write(125);
  delay(500);
  topservo.write(i);

  delay(1000);

  uint16_t r, g, b, c, colorTemp, lux;

  colorTemp = tcs.calculateColorTemperature(r, g, b);
  Serial.print("R: ");
  Serial.print(r);
  Serial.print(" ");
  Serial.print("G: ");
  Serial.print(g);
  Serial.print(" ");
  Serial.print("B: ");
  Serial.print(b);
  Serial.print(" ");
  Serial.print("C: ");
  Serial.print(c);
  Serial.print(" ");
  Serial.println(" ");
  delay(100);
  if (r > 450 && r < 450 && g > 350 && g < 450 && b > 70 && b < 150) {  //yellow
    bottomServo.write(0);
  }

   if (r > 150 && r < 200 && g > 350 && g < 400 && b > 350 && b < 400) {  //sky
    bottomServo.write(50);
  }

  if (r > 200 && r < 300 && g > 80 && g < 120 && b > 70 && b < 100) {  //
    bottomServo.write(90);
  }

  delay(500);

  for (int i = 55; i > 10; i--) {
    topservo.write(i);
    delay(10);
```

```
  }
  delay(200);

  for (int i = 10; i < 125; i++) {
    topservo.write(i);
    delay(5);
  }
  delay(500);
}
```