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IOT BASED COLOR AND SIZE WISE SORTING MACHINE USING CAMERA

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Abstract

The process of arranging items systematically is named sorting. Manual sorting of Object is preferred at the wholesale market and industries supported different parameters like size, shape, quality, etc. But it's a time consuming, less efficient, and inconsistent method. The existing systems in the market can sort single Object with single or multiple parameters. To replace this traditional sorting way, the proposed system presents an automatic Object sorting mechanism with an image processing technique. It recognizes and classifies two different Object with two different Color analysis method.

***Key Words*: Image Processing, Python, Arduino Uno, Color Detection, IR Sensor Web Camera, Conveyor Belt.**

1. INTRODUCTION

In today's fast-paced industrial landscape, efficiency and precision are paramount. Traditional sorting methods often struggle to keep pace with modern demands, leading to inefficiencies, errors, and increased operational costs. However, with the advent of Internet of Things (IoT) technology and advancements in computer vision, a new era of sorting solutions has emerged, promising unprecedented levels of accuracy and speed.

This paper introduces an innovative IoT-based sorting machine designed to revolutionize the sorting processes across various industries. Unlike conventional sorting systems, which rely solely on manual labour or basic mechanical sorting mechanisms, our proposed solution harnesses the power of IoT and camera technology to achieve highly accurate color and size-based sorting.

At the heart of our system lies a sophisticated array of sensors and cameras, seamlessly integrated into a robust IoT framework. These sensors work in tandem to capture real-time data on the color and size attributes of the objects passing through the sorting conveyor. Leveraging advanced image processing algorithms, the system accurately identifies and classifies each item based on predefined color and size parameters.

The integration of IoT technology enables seamless communication and data exchange between the sorting machine and external systems, such as inventory management software or production control systems. This connectivity facilitates real-time monitoring and control, allowing for dynamic adjustments to sorting criteria and ensuring optimal performance under varying operating conditions.

Furthermore, our system prioritizes scalability and flexibility, making it suitable for a wide range of applications across industries, including manufacturing, logistics, recycling, and more. Whether sorting products on a production line or segregating recyclable materials at a recycling facility, our IoT-based solution offers unparalleled versatility and reliability.

1.1 OBJECTIVES OF STUDY

The integration of color recognition, sorting, and motor control functions with a microcontroller represents a significant advancement in automation technology. By combining these functionalities, the system can accurately identify and sort objects based on their colors, streamlining production processes in various industries. This level of automation reduces the need for manual intervention, leading to increased efficiency and throughput rates.

The efficiency of the system is crucial for its successful implementation. Thorough checking of the code and troubleshooting any issues ensures that the system operates smoothly and reliably. This process involves rigorous testing and optimization to minimize errors and maximize performance. By maintaining code efficiency, the system can handle complex sorting tasks with precision and consistency.

Automation of the sorting process offers numerous benefits for industries that rely on color-based classification of products. It eliminates human errors that can occur during manual sorting, such as misclassification or misplacement of items. Furthermore, it reduces the time and effort required for sorting, allowing companies to optimize their production workflows and meet tight deadlines more effectively.

1.2 PROBLEM STATEMENT

The problem we're addressing is the consistent performance and efficiency in tasks that require precision and repetition. Unlike humans, robots execute programmed operations with identical results each time, reducing variability and time consumption. Leveraging their ability to maintain quality and repeat precise movements, we aim to enhance the speed and reliability of processes.

2. DESCRIPTION OF WORK

The proposed system nullifies the human error which is generated within the traditional method and to offer quality result at the output. to try to do so we've used Sensors, a Camera, a 2 DC motor for push mechanism and conveyer belt, a Microcontroller with USB TTL cable, and the OpenCV software. Fig 2.1 shows the diagram of the system.

I. **IR Sensor: -** during this system we've used 1 IR sensor. Basically, when the power supply is on, the conveyer belt starts moving so when the object is kept on the conveyor belt the IR sensor detects it and stops the conveyor belt near the camera.

II. **Camera: -** the type of camera utilized during this technique is a USB camera. It captures the image of the object and provides it to the computer.

III. **Conveyor belt:** - The platform where the object is placed is that the conveyer belt which is controlled by the IR sensor& Microcontroller.

IV. **USB TTL Cable: -** The USB TTL serial cable connects the serial UART interface to the USB port. It's a two-way data transmission device that converts USB data signals to normal serial data ports.

V. **DC motor:** -The DC-based conveyor is driven by a 12V DC motor. The AC must be able to supply the DC motor with the required quantity of current. As a result, the DC motor driver L293D is used.

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2.1 BLOCK DIAGRAM

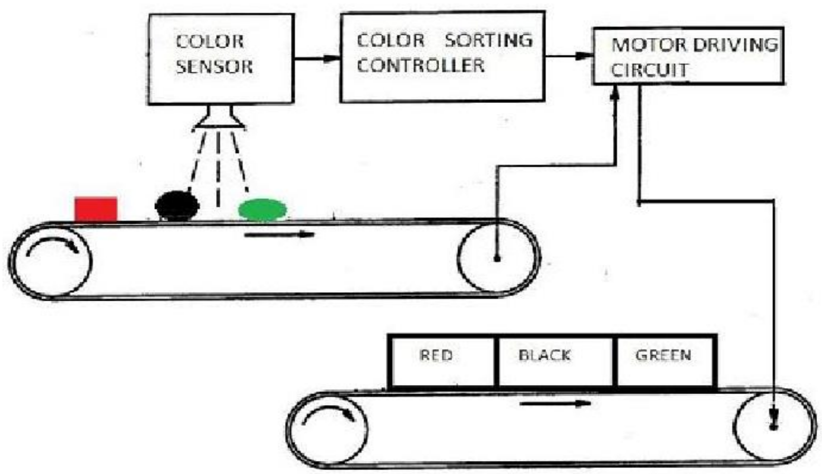

FIG - 2.1: Block Diagram Of System

It is designed such that it will classify and distribute objects through a conveyor belt towards the dispatch section and it will check the object based on the color, if it is found green color then the conveyor belt will move continuously otherwise it will stop and the object will be passed to basket. To do so we are using Arduino, conveyor belt, sensor, and motor. as the signal is applied to the conveyor belt through Arduino it starts moving, then the web camera will detect the object and stop the conveyor belt. The camera clicks the image of the object and checks the color of the object. If the color of the object is red then it will command the conveyor belt to move right otherwise it will move straight forward, and if the color of object is yellow then it will command the conveyor belt to move left otherwise it moves straight forward.

3. METHODOLOGY

The project comprises three main phases: software design, hardware design, and programming. In the software design phase, we develop the flow of the software, focusing on integration with OpenCV, and create a graphical user interface (GUI) using OpenCV.For the hardware design phase, we focus on two main components: designing the layout of the printed circuit board (PCB) and constructing the mechanical aspect, such as the conveyor belt. Lastly, in the programming phase, we focus on programming both the microcontrollers and the OpenCV software to ensure seamless interaction and functionality.

3.1 SOFTWARE REQUIREMENT

PYTHON IDE (Programming):- Python Integrated Development Environments (IDEs) are tailored to facilitate coding and debugging processes for programmers. They streamline the management of extensive codebases and expedite deployment. These robust tools are instrumental in crafting both desktop and web applications. Distinguishing themselves from conventional text editors, Python IDEs boast advanced code comprehension capabilities. They offer a plethora of functionalities including build automation, code linting, testing, and debugging, thereby enhancing productivity. However, mastering IDEs may pose a challenge due to their complexity. Below are some Python IDEs commonly used by developers.

OpenCV Lib:- OpenCV, short for Open-Source Computer Vision Library, is a freely available software library designed for computer vision and machine learning tasks. Its primary objective is to establish a standardized framework for applications in computer vision and to expedite the integration of machine perception into various consumer products. OpenCV, distributed under the BSD license, offers companies the flexibility to utilize and modify its codebase with ease. It serves as a valuable asset in simplifying complex tasks, such as color detection. For instance, to identify the presence of red color in an image, you can define a range of red hues using code like this:

```
lower_range = np.array([0,100,100])
```

upper_range = np.array([5,255,255])

mazsk = cv2.inRange(hsv, lower_range, upper_range)

This snippet efficiently creates a mask to isolate the red color components within the image based on specified lower and upper threshold values.

3.2 COLOR DETECTION

Step 1: Image Capture : To commence the process, the camera snaps an image, typically in the RGB format. Each pixel in the image is represented as a 3-dimensional matrix in OpenCV, matching the image's dimensions.

Step 2: Color to Monochrome Conversion : The colorful RGB image undergoes a transformation into a grayscale image before proceeding to black and white. This grayscale conversion involves computing luminance values based on predefined coefficients, typically utilizing the formula: $Y = 0.3R + 0.59G + 0.11*B$. Once grayscale, the image is further transformed into a binary black and white representation. This conversion is often facilitated by OpenCV functions, such as im2bw(I, threshold).

Step 3: Color Recognition : Following the conversion, the system focuses on recognizing the colors present in the image. Initially, the centroid pixel of the object of interest is detected and isolated. This centroid pixel's RGB values are then retrieved using the OpenCV function impixel(I, x, y), where 'x' and 'y' denote the centroid coordinates. By analyzing the RGB values at this specific pixel, the system determines the predominant color of the object. For instance, if the object primarily exhibits shades of red and yellow, it will be categorized accordingly based on the proportion of red, green, and blue components within the selected centroid pixel.

3.3 HARDWARE DESIGN

The hardware configuration of computer-based Computer vision systems is comparatively standard. Typically, a computer vision system consists of:

- An illumination device that shines a light on the sample being tested.
- A solid-state Charged Coupled Device array camera, to accumulate a picture
- The A/D (analog-to-digital) conversion of scan lines into picture elements or pixels digitized during an N row by M column image is performed by a frame-grabber.
- A high-resolution color monitor, which aids in visualizing the pictures and therefore the effects of varied image analysis routines, on the pictures.

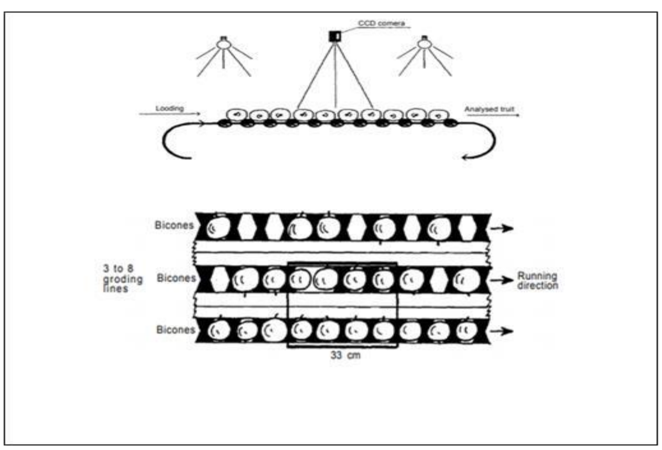

Fig -3.1: - A side and front view of the conveyor

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4. AURDINO UNO

The Arduino Uno is a microcontroller board developed on the Arduino-designed Microchip ATmega328P microprocessor, offered as open-source hardware. It boasts analog input/output (I/O) pin sets that facilitate interfacing with various expansion modules and circuits. Featuring 14 digital I/O pins (six with PWM capability) and 6 analog I/O pins, the board is programmable through the Arduino Integrated Development Environment (IDE). The term "Uno" originates from Italian and signifies the launch of Arduino Software (IDE) version 1.0 and the corresponding Uno board. Initially introduced as the flagship Arduino USB board, the Uno board serves as the foundation for subsequent Arduino iterations and advancements in the platform.

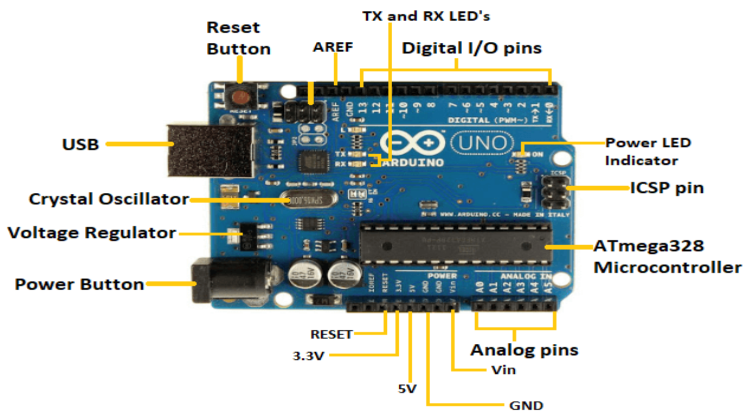

Fig- 4.1: - Arduino Uno

5. WEB CAMERA

A webcam may be a video camera that feeds or streams a picture or video in real-time to or through a computer to a network, like a web. Small cameras that sit on a desk, attach to a user's monitor, or are incorporated into the hardware are known as webcams. During a video chat conversation with two or more individuals, webcams are frequently used. with conversations that include live audio and video. For example, Apple's iSight camera, which is made into Apple laptops, iMacs, and a variety of iPhones, is often used for video chat sessions, using the iChat instant messaging program (now called Messages). Webcam software allows users to record or stream video over the internet. As video streaming over the web requires tons of bandwidth, such streams usually use compressed formats. The maximum resolution of a webcam is additionally less than most handheld video cameras, as higher resolutions would be reduced during transmission. Webcams are less expensive than most video cameras due to their lesser resolution, yet the impact is sufficient for video chat conversations.

Fig- 5.1: - Web Camera

6. CONVEYOR BELT

The carrying medium of a belt conveyor system is a conveyer belt (often shortened to a belt conveyor). A belt conveyor system is one among many sorts of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes mentioned as drums), with an endless loop of carrying medium the conveyer belt that rotates about them. The belt, and hence the material on the belt, is moved forward by one or both of the pulleys being powered. The drive pulley is the powered pulley, whereas the idle pulley is the unpowered pulley. Belt conveyors are divided into two categories in the industrial world: material handling and transportation. such as moving boxes throughout a plant, and bulk material handling, such as transporting vast volumes of resources and agricultural goods such as grain, salt, coal, ore, sand, overburden, and more.

Fig- 6.1: - Conveyor Belt

7. FUTURE SCOPE

Improve accuracy, speed, and adaptability for object sorting. Integrate with robotics and IoT, enhance sustainability, and optimize costs.

8. ADVANTAGES

- Boosts efficiency by enhancing productivity.
- Minimizes human intervention.
- Enhances both production capacity and quality.
- Easily attainable in development.
- Saves time and enhances efficiency.
- Elevates sorting accuracy for products.

9. CONCLUSIONS

Manual sorting, being laborious and consuming time and energy, poses a significant challenge globally. Hence, automatic sorting systems offer a solution for swiftly and effectively categorizing products. With careful consideration of process requirements, this project was conceived and executed to sort products on a designated conveyor belt configuration.

10. RESULT

Image processing is done in OpenCV which is an interface with a USB web cam on a PC/ laptop that captures the image of the object. According to the command given by OPENCV the sorting of object is done. We are using the RGB color model for image processing so it will sort on the basis of three-color RED, GREEN, and BLUE combination.

The whole sorting process takes approx. 5 seconds to sort one object.

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