Colour based Capsule Sorting using Image Processing

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***Abstract*— Medicines are an important source for the revitalization of the human body. The same importance must be given to the organization and the sorting of the medicines in pharmacies. However, the overall process of manual sorting is tedious and time consuming. The process of arranging items systematically is called sorting. Automation has led to the growth of industries in recent years. For better performance of industrial process automated machines are used. Image processing has led to advancements in applications of robotics and embedded systems Throughout history, manual sorting of objects is preferred and implemented at various sectors of the industry including manufacturing units, healthcare pharmacies, etc. It comprises different attributes such as size, shape, quality, etc. Although it has been a preferred method of sorting, it's a time consuming, less efficient, and inconsistent method. The existing systems in the market can sort single objects with single or multiple parameters. To replace this traditional sorting way, the proposed system presents an Automatic object sorting mechanism using the image processing technique. In this report, the topic of discussion is the sorting of the medicines at pharmacies using a camera module and a container.**

Keywords*— *Capture Sorting, Image Processing, Raspberry Pi sensor, Machine Learning Algorithm, Camera module sensor, HSV Colour Saturation Model

I. INTRODUCTION

The "Colour Based Capsule Sorting using Image Processing" project employs a novel approach by integrating image processing with a servo motor-based sorting mechanism to automate the sorting of capsules based on their colors. The system utilizes a camera to capture real-time images of moving capsules, and through advanced computer vision algorithms, distinguishes between different colors. Image processing is the process of converting an image to digital form and then performing operations on it to create a better image or extract important information.in this the input is in the form of the image captured from the camera and output is some information extracted from the image. In this project, a low-cost automation system will be developed as a part of a project for sorting the medicines according to their colors.

A servo motor is employed in the sorting mechanism to precisely control a gate or flap, diverting each capsule to the appropriate bin according to its color classification. This innovative combination of image processing and servo motor technology ensures accurate and efficient capsule sorting, making it suitable for applications where precision and compact design are crucial, such as pharmaceutical manufacturing or laboratory automation.

The camera clicks the image and checks for the color of the object. If the color of the object is red then it will command the servo motor to move it right and if the color of an object is yellow then it will command the servo motor to move left and so on.

II. LITERATURE SURVEY

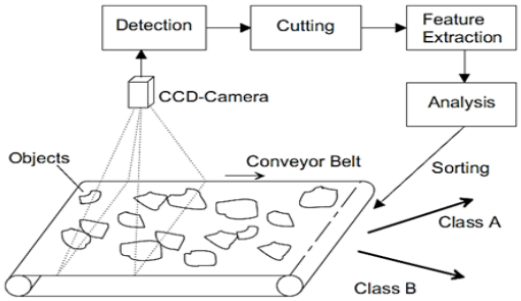
Application of image processing in industries has gained a lot of scope. The research on automation and robotics has shown importance in industries, defence, surveillance and security using image processing [1]. Object sorting is one of the challenges faced by the industries. The main objective is to build a conveyor belt system that is capable of identifying and sorting various objects by using image processing. The system should detect the objects based on their properties. Objects will have different shapes and colors. This process is made easy by using automation. Automation provides mechanical assistance by using a control system. This reduces manual efforts done by a human, time consumed and also improves the time to market. The aim of the proposed project is to develop a system that can identify various objects running through a conveyor belt and sort them based on their properties by designing mechanical structures, hence automating the process of segregation of products.

Object Recognition is the most important task in the computer vision field. The increasing demand for real time image processing, has led to a great deal of research in Object Recognition algorithms. Object Recognition is widely used in various applications like automation, surveillance, medical field, etc. The goal of object recognition is to automatically detect the objects in the screen and classify them according to their properties. This process has to be repeated for all the frames of the captured images. The region of interest is determined by training a model from object samples.

Using Image processing techniques [2], the various objects or products are identified. OpenCV (Open-Source Vision Library) is used for image processing using with Python scripting language. OpenCV has powerful image processing functions which is suitable for real time. Raspberry Pi is used as the controller to control hardware components like stepper motors and servo motors. Raspberry Pi is a portable computer with the ARM11 architecture which runs on Linux Debian environment. The proposed system has a conveyor belt on which the objects to be separated are placed. A camera constantly captures the objects passing on the conveyor belt. The captured frames are processed to identify and recognize various objects and then the decision is made for classifying the products. Stepper motors and servo motors are used to sort the objects running through the conveyor belt by mechanical structures which directs the objects to their destination. Electrical actuators will be activated which will push away the objects into a different path in a conveyor belt or into a container.

Object sorting machine has been developed previously using optical sensors and color sensors. Also using Image processing techniques, the colored objects are detected and segregated using a robotic arm. Object tracking robots are also developed using adaptive color thresholding technique. There are various recognition techniques like boosted learning algorithms, Bag of Words model, template matching, blob analysis, segmentation. Recognition algorithms are used to identify the object of interest in video or real-time web camera. The approaches based on a Bag of Words or Bag of features has many applications like object and scene recognition [2]. The Bag of features or Bag of words is a well-known classification method for object recognition. An image feature identification algorithm has key point detection and descriptor extraction using SIFT method because of its invariance to the scale, the orientation and almost to the illumination. Key feature points are extracted from an image and based on its features; a descriptor vector is created. Bag of Words is a representation based on visual histogram. Features are created by clustering all the extracted features from training images. Each feature is mapped into visual word and it is represented by the histogram of visual words. Later, Support Vector Machine (SVM) is used as supervised learning classifier while testing an unknown image.

Computer vision provides innovative solutions in the direction of industrial automation. In many situations, it provides effective solutions to menial tasks. Moreover, the repetitive tasks with more accuracy and sensitivity can be completed using automated instruments. Normally, sorting of the objects is done by manually. Old sorting method uses a set of inductive, capacitive and optical sensors do differentiate object color in the testing station. No vision capability exists in the system to improve its performance and flexibility. In this case, there is a possibility of minor error which will affect the accuracy in sorting. Automated systems can be used to remove such human errors and also it saves time and money. In Fig.1 is shown the simplified diagram of an automated visual sorting system [3] [4].



HSV Colour Model

The HSV colour space [5] has the following three components:

H – Hue (Dominant Wavelength).

S – Saturation (Purity / shades of the colour).

V – Value (Intensity).

Hue (H) defines the colour itself. Saturation (S) is the amount of gray from zero percent to 100 percent in the colour. The value (V) Component captures the amount of light falling on it thus it changes due to illumination changes. HSV uses only one channel to describe colour, making it very intuitive to specify colour as shown in figure 2.

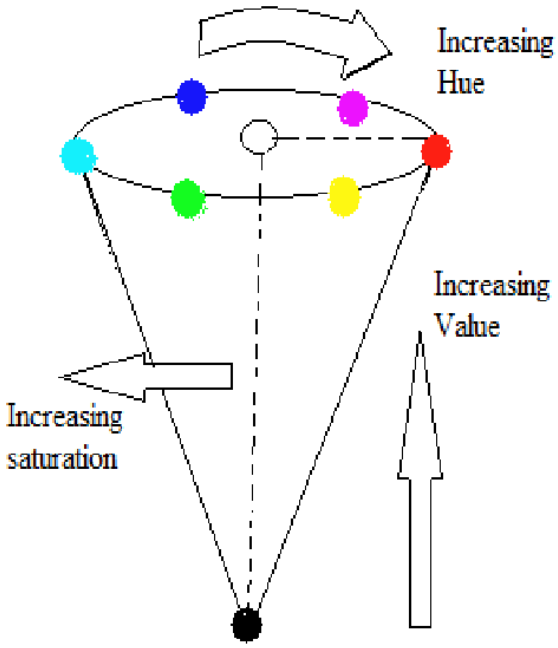


Figure-2 HSV Colour model

Observation

We analyzed images using RGB and HSV colour model.

1. It is difficult to set threshold value for specific colour in RGB colour model as red, green and blue component varies drastically for same colour when it is observed in bright and dark light. In OpenCV RGB values of pixel is represented in BGR form..

Table 1: BGR and HSV components of different colour blocks

Sr. No.	Colour Blocks	BGR Value	HSV Value
1		[57 89 255]	[5 198 255]
2		[57 138 255]	[12 198 255]
3		[135 174 161]	[40 57 174]
4		[58 252 0]	[67 255 252]
5		[255 157 88]	[108 167 255]

Table 1: HSV Values of different colour components.

2. It is inferred from table 1 that in HSV components hue increase linearly starting from red colour. BGR has random variations for different colour.

Recently, great advances have been achieved in artificial intelligence, image recognition, and other technologies, greatly promoting related technologies. In order to develop a fast, automatic, and accurate image recognition system, convolutional neural network (CNN) has received widespread attention (Artzai et al., 2019). In particular, CNN can complete the extraction of low-level features to high-level semantics (Kattenborn et al., 2019), significantly increasing the accuracy of identification and identification in various fields. Park et al. (Park et al., 2017) proposed a player evaluation model based on deep learning to analyze the impact on baseball leagues. Batchuluun et al. (Batchuluun et al., 2018) used CNN models to recognize human bodies in motion. Hansen et al. (Hansena et al., 2018) implemented the recognition of individual pigs using deep learning methods, with an accuracy rate of 96.7%. [6]

The application of sorting systems is in all industrial sectors such as sorting fruits by size with three categories, finding the radius, and calculating the area and perimeter based on light detection and ranging (LIDAR) sensor. [7] Some researchers design the systems to sort fruits using a vision system and robot with tracking the positions. PLC controller is used to sort objects based on the material of the subject such as wood, steel, and plastic with three sensors at different positions with acceptable average time. Machine vision adds to sorting systems for detecting and automated sorting. Also, the image processing approach with deep learning as a system is used to sort objects.

The sorting of an object is based on four methods that are related to color, shape, texture, and hybrid approach. The support vector machine (SVM) [8] is utilized in some systems with a mobile manipulator in cases where the system accomplished the step tasks such as the recognition of objects at any varying scales and rotations, motion control plan for mobile manipulation, and grasping control plane for objects at any position implemented with the vitals monitoring system through a smart bracelet. All the vital signs can be uploaded and monitored in real time, with a high accuracy. Communication in the network was taken care of through the 5G network.

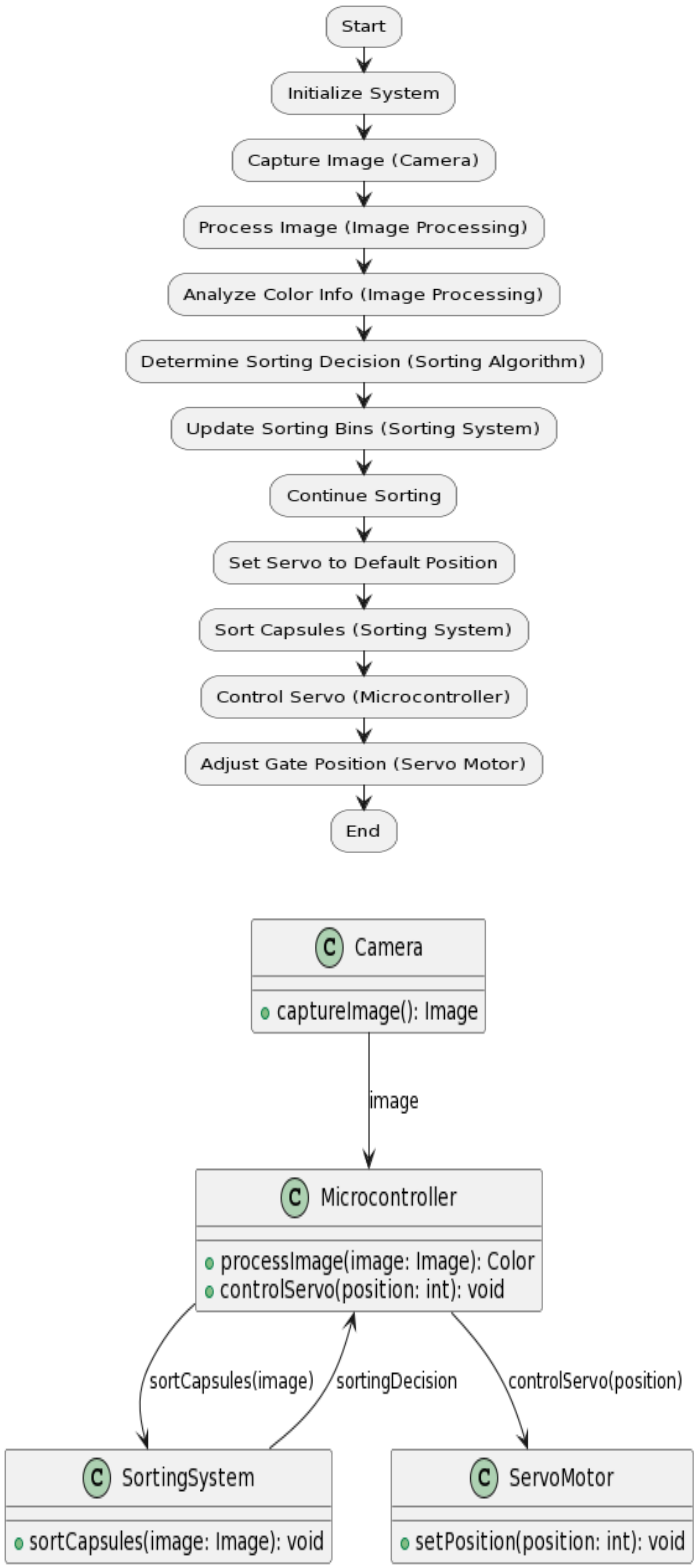
The main objective of this work is to develop a real-time sorting system for any specific product (complex shape) that can detect it from different products by using a camera and based on an image processing approach with minimum cost and time. The matching method is applied in this system at a speed that is calculated according to the characteristics of a camera such as the number of the frame. Increasing the characteristics of the selected camera will increase the system performance and accuracy. [9] [10] The developed system can match the target product with high accuracy and in different positions and orientations. The main contribution of this work was building a new sorting system with cost and high accuracy to sort any complex product/object with an acceptable time. Based on the available literature, it was found that most of the researchers used or developed complex and expensive sorting systems, which is considered an economic disadvantage from the view of the industrial sector.

Proposed Sensors and Modules for Camera Detection

This design uses a low-cost hardware and open-source software for achieving the goal. Raspberry Pi 3 and a computer are used as the controlling unit. The proposed system has a drop-down pipe through which the medicines are entered into the system. Then, one medicine falls into a container driven by a servo motor, which then after a certain time delay, pushes the medicine to the camera module slot. The camera module is used to continuously monitor the objects and identify them. The recognized objects are sorted by the actuators which can be a linear actuator or a servo motor.

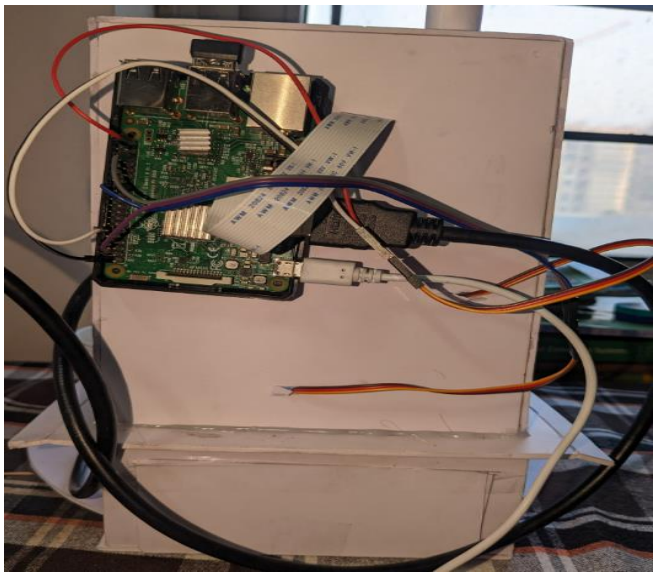
The basic block diagram of the proposed system is shown below. This design uses a low cost hardware and open source programming language and image processing libraries for achieving the goal of sorting objects. CPU is used to process the images from the webcam and Raspberry Pi 3 with Linux operating system is used as the controlling unit to drive various hardware devices. The CPU acts as a server and the Raspberry Pi acts as a client. The CPU will send a command to the Raspberry Pi when an object a particular object is detected. The Raspberry Pi client will receive the command and runs the corresponding script for driving the stepper

motor, based on the object detected. The server and client model separates the software and hardware operation and will speed up the process in real time.



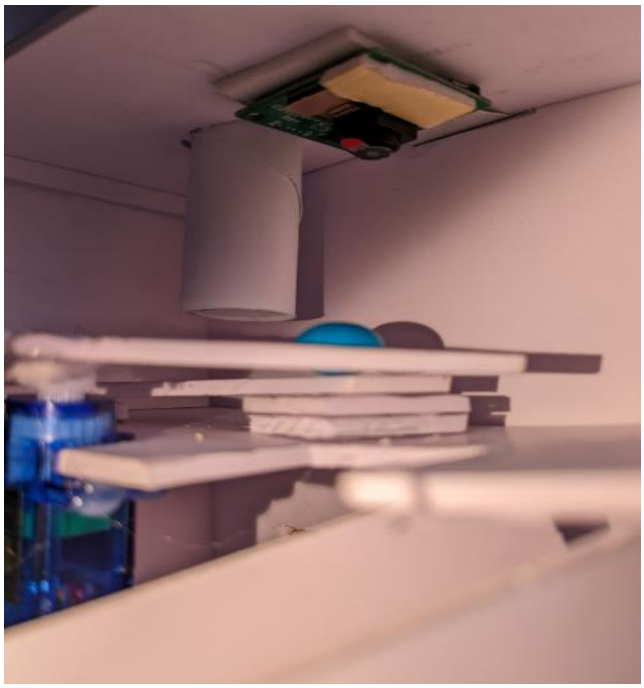
A. Flowchart of the Colour Sorting Algorithm

Below are the components used to make the working model or the prototype.



The Raspberry Pi is directly connected to the computer source using a HDMI cable. The power source is plugged in as well. For the skeleton or the external structure, the proect made use of cardboard. First a box has been vertically stacked which would house all the components as shown above. Then there were slots provided for the horizontal stacking of the cardboard slices which would hold the camera module and the servo motors along with the belt. The wire connected with the camera module is extended through the box towards the behind where the Raspberry Pi is situated and is connected accordingly. The three wires extending from the two servo motors each are as well extended towards the back of the board. The ground port is connected to the ground pin of the R Pi, while the power port is connected to the 5V of the R Pi. The main output port is connected with any one of the I/O ports of the R Pi. A SD Card has been inserted into the board to drive the Open CV module and libraries into the device. We have utilized the Thonny interface for the programming aspect.

Figure 2 shows an image of the temperature sensor used. The conducting matrix is sandwiched between the PDMS, with the copper wires acting as electrically conductive links. Out of the two copper terminals, one is connected to the power supply and the other one to the ground, like a passive resistor component. Then temperature readings were taken using this sensor.



B. Placement of the upper servo motor and the camera module

The pipe hanging from above as shown in Fig, B is the slot through which the medicines are deployed into the sorting machine. The alignment of the servo motor has been placed in an inclined manner so as to avoid multiple medicines to be deposited into the slots. A cardboard piece is attached to the servo motor which pushes the medicine towards the camera module placed on the top of the cardboard after a certain time duration. Based on the OpenCV modules and the HSV value, it performs the different machine learning and image processing algorithms. Based on the HSV value, it will detect the color of the medicine. Note that the color is detected by the majority portion occupied by the medicine. For example, if the medicine is of two colours, red and white. However, the portion of red is higher than that of white, then the image processing will consider the entire medicine to be of color "Red". Once the color has been detected, the upper servo motor holding the medicine will put it backwards and then pushes it with a force that is sufficient to drop it onto the belt. Simultaneously, the lower servo motor, based on the color obtained changes its direction towards the specific container that is supposed to hold the color. The inclination of the belt then causes the medicine to be dropped into the respective container.

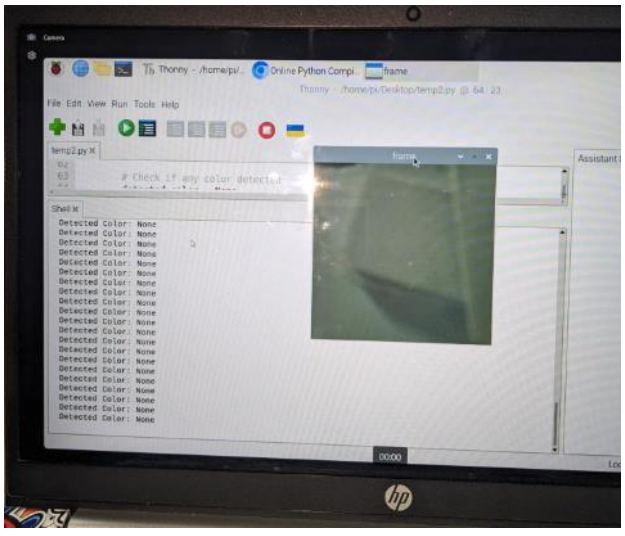
III. RESULTS AND DISCUSSION

The project focused on developing an automated capsule sorting model based on their colour. It addresses challenges such as excess dependency on manual labor and extending this project to adapt and sort other objects based on their characteristics. The proposed work presents a reliable and robust architecture for the implementation with R-Pi which involves the design, implementation, and real-world testing with the prototypes. Therefore simple Image processing with OpenCV in an inexpensive setup with very low processing power making the overall system very cheap and widely accessible.

Figures A, B, C, D and E will show the software output of the project. Different cases have been utilized and observed such as when the medicine is red color, or when the medicine is in blue color. The servo motor was generating vibrations during its movement and this can be attributed to the loose wiring of the motor to the Raspberry Pi board. This can be further expanded upon by filtering techniques and adding the size parameter where in the medicine, if not the ideal size, should be properly discarded, etc.

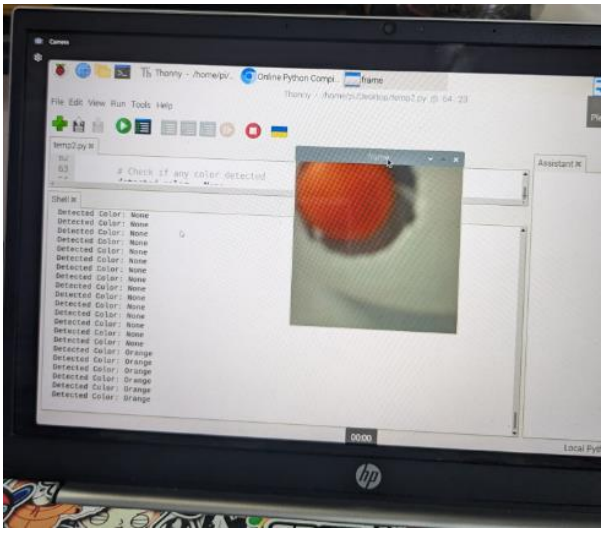
A. The final prototype design

In this model, we have made use of four different containers for the four different colors. The belt is attached to the extended arm which would drop the medicine obtained from the first servo motor into the respective container.



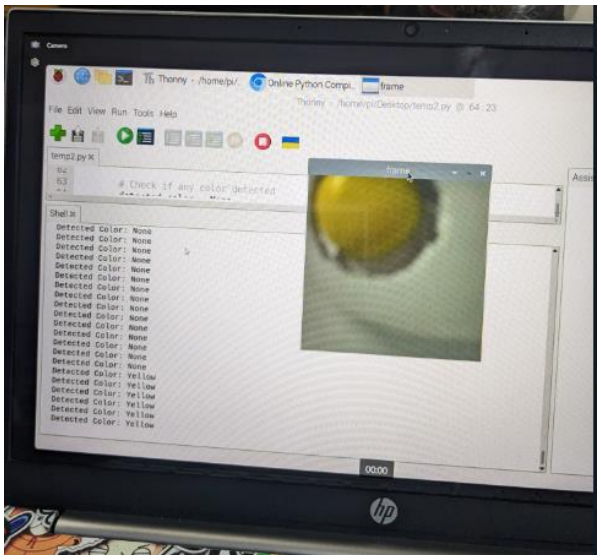
B. When there is no medicine in the slot

Coming to the software aspects, the output initially projects the value as “None” since the camera module does not detect any color.



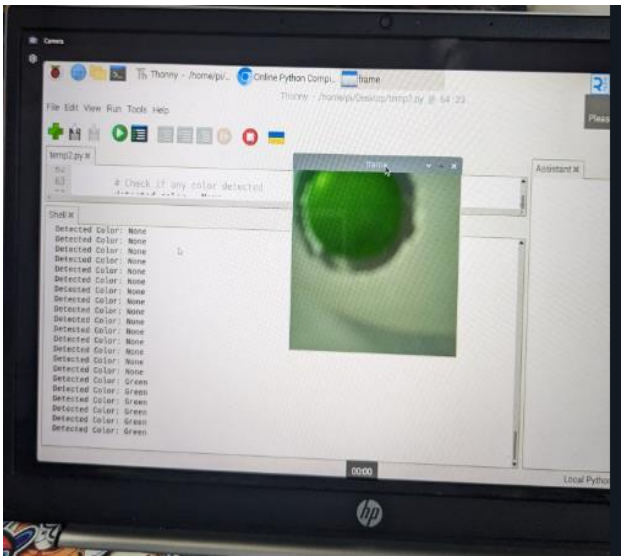
C. When the deposited medicine is color “RED”

When the camera detects the color “RED”, it will immediately take into consideration the HSV value and then prompts the lower servo motor to change the direction of the arm accordingly. The color is displayed on the computer screen.



D. When the deposited medicine is color “YELLOW”

When the camera detects the color “YELLOW”, it will immediately take into consideration the HSV value and then prompts the lower servo motor to change the direction of the arm accordingly. The color is displayed on the computer screen.



E. When the deposited medicine is color “GREEN”

When the camera detects the color “GREEN”, it will immediately take into consideration the HSV value and then prompts the lower servo motor to change the direction of the arm accordingly. The color is displayed on the computer screen.

IV. CONCLUSION AND FUTURE SCOPE

The project presents a healthcare maintaining system, especially with respect to the sorting of medicines in pharmacies in a bid to reduce the manual labor and the errors associated with it. The color detection was done using the camera module connected to the Raspberry Pi board which then prompts the servo motors to change the directions accordingly. The real time readings were displayed on the computer screen along with the photo captured by the camera.

The novelty of this project is tremendous since the working has not been implemented using a Raspberry Pi board before. This concept has been in research and its implementation with the motive to replace manual labour is crucial. This is especially important in a hospital environment, considering the urgency and the accuracy required while sorting certain medicines. Not only in the medical field, but such a project could also be extended to the stationary shops as well to meet with the increasing customer bases all across the globe. In the case where there cannot be a specific individual allocated for that purpose alone, that is, if the staff strength is low, the proposed system will perform the necessary actions such as staking the pencils according to the colors, stacking the erasers based on their label colors, etc. thereby increasing the efficiency of emergency services and the response/traveling times.

V. ACKNOWLEDGMENT

We would like to thank our teacher R. Sujatha ma’am, Associate Professor Senior, School of Electronics Engineering (SENSE), Vellore Institute of Technology, for

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POSTER

Colour Based Capsule Sorting Using Image Processing

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Abstract:

Throughout history, manual sorting of objects is preferred and implemented at various sectors of the industry including manufacturing units, healthcare pharmacies, etc. It comprises different attributes such as size, shape, quality, etc. Although it has been a preferred method of sorting, it's a time consuming, less efficient, and inconsistent method. The existing systems in the market can sort single objects with single or multiple parameters. To replace this traditional sorting way, the proposed system presents an Automatic object sorting mechanism using the image processing technique. In this report, the topic of discussion is the sorting of the medicines at pharmacies using a camera module and a container.

Problem Definition:

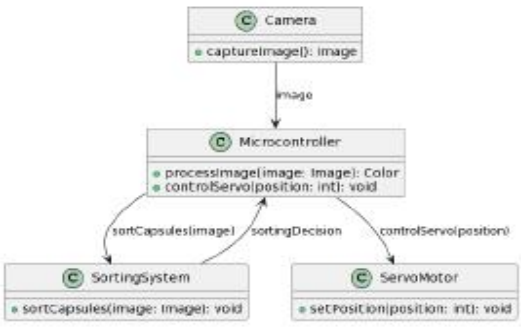
In this project, a low-cost automation system will be developed as a part of a project for sorting the medicines according to their colors.
A servo motor is employed in the sorting mechanism to precisely control a gate or flap, diverting each capsule to the appropriate bin according to its color classification. This innovative combination of image processing and servo motor technology ensures accurate and efficient capsule sorting, making it suitable for applications where precision and compact design are crucial, such as pharmaceutical manufacturing or laboratory automation.
The camera clicks the image and checks for the color of the object. If the color of the object is red then it will command the servo motor to move it right and if the color of an object is yellow then it will command the servo motor to move left and so on.

Objectives and Methodology:

The scope of this project includes principally the following topics:

- Develop an automated system to sort capsules based on their colors using image processing.
- To identify and separate capsules of different colors with minimal errors.
- Utilize readily available and affordable hardware and software to make the system commercially viable.

Working

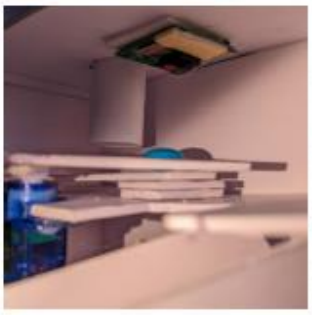


Implementation:

It employs a novel approach by integrating image processing with a servo motor-based sorting mechanism to automate the sorting of capsules based on their colors. The system utilizes a camera to capture real-time images of moving capsules, and through advanced computer vision algorithms, distinguishes between different colors.
A servo motor is employed in the sorting mechanism to precisely control a gate or flap, diverting each capsule to the appropriate bin according to its color classification. This innovative combination of image processing and servo motor technology ensures accurate and efficient capsule sorting, making it suitable for applications where precision and compact design are crucial, such as pharmaceutical manufacturing or laboratory automation.

Results & Discussion:






Conclusions:

The project focused on developing an automated capsule sorting model based on their colour. It addresses challenges such as excess dependency on manual labor and extending this project to adapt and sort other objects based on their characteristics. The proposed work presents a reliable and robust architecture for the implementation with R-Pi which involves the design, implementation, and real-world testing with the prototypes. Therefore simple Image processing with OpenCV in an inexpensive setup with very low processing power making the overall system very cheap and widely accessible.

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