

## **Real Time Industrial Colour Shape And Size Detection System Using Single Board**

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### **Abstract**

**This paper presents an application for the detection of colour, shape and size of various objects at real time. This design of system is accomplished using a raspberry pi as a system of on chip, along with a USB camera, display unit and mechanism such as conveyor belt use for the transport of object in the industrial environment. In order to determine the colour of the object placed over a moving conveyor belt. OpenCV is used at real time. The main purpose of design of this particular system is to identify the colour, shape and size as well as the number of object moving with the help of conveyor belt. So at the real time data will be updated and continuously displayed over the display unit. If camera does not provide any image on screen for a particular duration (defined in OpenCV) then the system would be shutdowned.**

### **1. Introduction**

Nowadays , importance and the study over the computer vision in field of industrial, academics are on a hike. Specifically when dealing with the industrial environment, This design can be used for various application based upon vision through computer for the purpose of identifying, differentiating and collection of various object are done based upon colour ,shape and size which are the primary factors. This can be done with help of an OpenCV.

This design system can be implemented in various field for various purposes such as Defence, industrial purposes, games, automation, security, monitoring etc .Even these systems can also play a vital role in field of radar and navigating such as detecting, tracking of a moving coloured object etc

Detection of colour play an important role even in the field of medical, such as detection of colour of skin ,identification of a face, recognizing license plate .Major purpose is to determining the colour of packages passing over a conveyor belt and also providing the quality of a particular colour packages by outnumbering. Which is fulfilled by a processing unit i.e. a raspberry pi along with a USB camera for capturing the package ,a display unit for displaying the count and the packaging along with its identified colour . which is done through OpenCV.

### **2. OpenCV Library**

OpenCV is an (open-source computer vision) library programming function for real time computer vision. OpenCV is released under a BSD (Berkeley Software Distribution (BSD) licensed library developed by Intel organization. It is free for both commercial and non-commercial use. The OpenCV Library is developed using C and C++

programming languages by Intel organization and soon java interfaces runnings on window, linux, android, iOS, and MAC. A great number of real-time image processing applications can be implemented .It has C, C++ and python etc programming languages by intel organization. The library has more than 2500 optimized algorithm resources.[6,8,7,3,12,13]

OpenCV is used on Google maps, and street view, Analyzing objects ,Controlling processes, Academic and Industry, Structure from motion, Machine vision factory production inspection system Video search, image retrieval, and safety monitoring applications are generally use OpenCV and single board

OpenCV provides you with set of modules that can execute roughly the functionalities listed as follows .

- **Core:** This module include core data structure , datatypes and memory management.
- **Imgproc:** This module is an image processing module. Image filtering, geometric image transformations, structure and shape analysis.
- **Video:** video analysis module that includes motion analysis, background subtraction, and object tracking algorithms.
- **Calib3d:** This module includes basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence algorithms, and elements of 3D reconstruction.
- **features2d:** This module includes salient feature detectors, descriptors, and descriptor matchers.
- **Objdetect:** Object detection using cascade and histogram of gradient classifier. object module that uses to recognize face, eyes, etc.
- **Highgui:** This module contains user interface GUI, reading and writings images and video .
- **Nonfree:** Implementation of algorithm that are patented in some countries.

### **3. Single Board Computer**

A single board computer is a complete computer built on a single circuit board, with microprocessor,memory,input/out(I/O) and other feature required of a function computer. single-board computers were made as demonstration or development systems, for educational systems, or for use as embedded computer controllers. many types of home computer or portable computer integrated all their functions onto a single printed circuit board

A desktop personal computer, single board computers often did not rely on expansion slots for peripheral functions or expansion. some single-board computers are made to plug into a backplane for system expansion. single board computers have been built using a wide range of microprocessors. simple designs, such as built by computer hobbyists, often use static ram and low-cost eight or 16 bit processors.Processor[9]

single board computers were made possible by increasing density of integrated circuits. a single-board configuration reduces a system's overall cost, by reducing the number of circuit boards required, and by eliminating connectors and bus driver circuits that would otherwise be used. by putting all the functions on one board, a smaller overall system can be obtained, for example, as in notebook computers. connectors are a frequent source of reliability problems, so a single-board system eliminates these problems.

It is widely used BeagleBoard, BeagleBoard-xM, PandaBoard, PandaBoard ES, Rasperry Pi, CubieBoard and BeagleBone .

### 3.1. RasperryPi

Rasperry Pi is a card sized single-board computer developed in the UK by the rasperry pi foundation with the intention of promoting the teaching of basic computer science in schools.

The rasperry pi manufactured in three board configuration through licensed manufacturing agreements with network element14(Premier Farnell),RS Component and Egoman. These companies sell the Rasperry Pi online .Egoman produce a version for distribution soley in China and Taiwan, which can be distinguished from other Pis by their red colouring and lack of FCC/CE marks. The hardware is the same across all manufactures .[1,2,4,5]

In 2014 Rasperry pi Foundation launched the compute module ,which packages a Rasperry Pi Model B into a SODIMM 200-pin module, to encourage its use in embedded systems .The Rasperry Pi is based on the Broadcom BCM2835 system on chip(SoC),which includes an ARM1176JZF-S 700 MHz processor, videocore IV GPU and was originally shipped with 256 MB of RAM ,later upgraded ( Model B & Model B+) to 512 MB. The system has secure SD or MicroSD socket for boot media and persistent storage .T he foundation provide Debian and Arch Linux ARM distribution for download. Tools are available for Python as the main programming language, with support for BBC BASIC(via the RISC OS image or the Brandy Basic clone for Linux ),C,C++,Java, Perl and Ruby.



**Fig.1.** Rasperry Pi

It provides hardware specifications as follows

- ARM1176JZF –S Core (ARMv6K) 700 MHz
- 4 USB port (via the onboard 5-port
- USB OTG (mini AB)
- 512MB of Memory
- uSD Card
- S-Video
- DVI-D
- Ethernet port
- Camera port
- Stereo in and out jacks

### 4. RGB and HSV Color Space

A digital image is made up of basic element called Pixels. No of pixels an image depend on its resolution. Gray level image one pixel each defined as 8 bits unsigned values. In colour image three such 8 bits unsigned values are used per pixels .In gray image only one channel in present, but in colour image three channel are present so in RGB image one pixel get RGB values as RGB is 0 to 255.If one pixel get values as RGB (255,0,0) means colour pixel is pure “RED” .If one pixel get values as RGB (0,255,0) means colour pixel is pure “GREEN” .If one pixel get values as RGB (0,0,255) means colour pixel is pure “BLUE” .If all the pixel as value as (255,255,255) means colour pixel is “white” and vice versa[10]

HSV is mean another color space was founded Alvy Ray Smith in 1978 . HSV mean Hue, Saturation and Value. Hue represent the colour , Saturation represent amout to which that respective colour is mixed with white and Value represents the amout to which that respective colour is mixed with black. It is closer to human vision than RGB. It is obtained by non linear transformation of RGB . In this project HSV colour space is used to detect colour of package passing on conveyor beltalso named as HSB. In HSB, H and S have the same meaning with HSV and B is for Brightness. HSV color space was found out by Alvy Ray Smith in 1978. It is closer to human vision than RGB color space is. It is obtained by non-linear transformation of RGB color space. [11,17]

The equation of RGB to HSV transformation is shown in Equation (1), transformation from HSV to RGB is given in Equation (2) . HSV color space is used to detect the color of the packages passing on the conveyor belt in this study.

$$\begin{aligned}
 M &= \max(R, G, B) \\
 m &= \min(R, G, B) \\
 C &= M - m \\
 H' &= \begin{cases} \text{undefined,} & \text{if } C = 0 \\ \frac{G-B}{C} \bmod 6, & \text{if } M = R \\ \frac{B-R}{C} + 2, & \text{if } M = G \\ \frac{R-G}{C} + 4, & \text{if } M = B \end{cases} \\
 H &= 60^\circ \times H' \\
 S_{HSV} &= \begin{cases} 0, & \text{if } C = 0 \\ \frac{C}{M}, & \text{otherwise} \end{cases} \\
 V &= M
 \end{aligned} \tag{1}$$

$$C = V \times S_{HSV}$$

$$H' = \frac{H}{60^\circ}$$

$$X = C(1 - |H' \bmod 2 - 1|)$$

$$(R_1, G_1, B_1) = \begin{cases} (0, 0, 0) & \text{if } H \text{ is undefined} \\ (C, X, 0) & \text{if } 0 \leq H' < 1 \\ (X, C, 0) & \text{if } 1 \leq H' < 2 \\ (0, C, X) & \text{if } 2 \leq H' < 3 \\ (0, X, C) & \text{if } 3 \leq H' < 4 \\ (X, 0, C) & \text{if } 4 \leq H' < 5 \\ (C, 0, X) & \text{if } 5 \leq H' < 6 \end{cases} \quad (2)$$

$$m = V - C$$

$$(R, G, B) = (R_1 + m, G_1 + m, B_1 + m)$$

### 5. Mechanism for Color, Shape, Size Detection and Display

This system for detection of parameter of the objects moving over the conveyor belt are obtained real time color. Primary theme is to identify and obtain the number of objects having same parameter. Thereby displaying it over the display unit. As shown in Fig 2 show a view representing the system mechanism through which the required objective is reached. so the particular system consists of a power supply unit, a Raspberry Pi as a processing unit, mechanism for the object movement i.e conveyor belt, a USB camera to capture the image and a displaying unit to display required content of information.

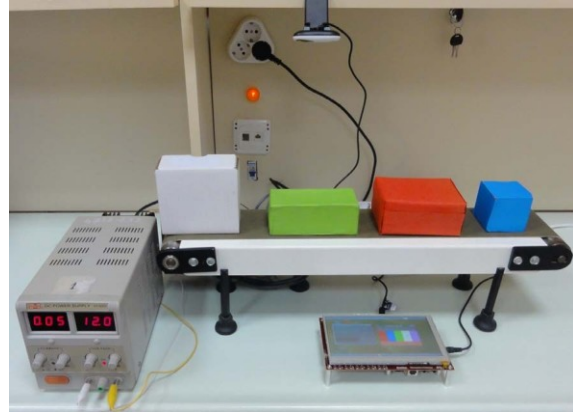


Fig.2. The system used in laboratory environment

Fig.3 shown a block diagram of the system, So the system starts functioning as soon as object start passing over the conveyor belt thereby the image of the object is captured with the help of an USB camera. The captured image is sent to Raspberry Pi. Parameter of the particular object is determined by processing the captured image in OpenCV. Then whatever details are obtained after processing are displayed with help of displaying unit..

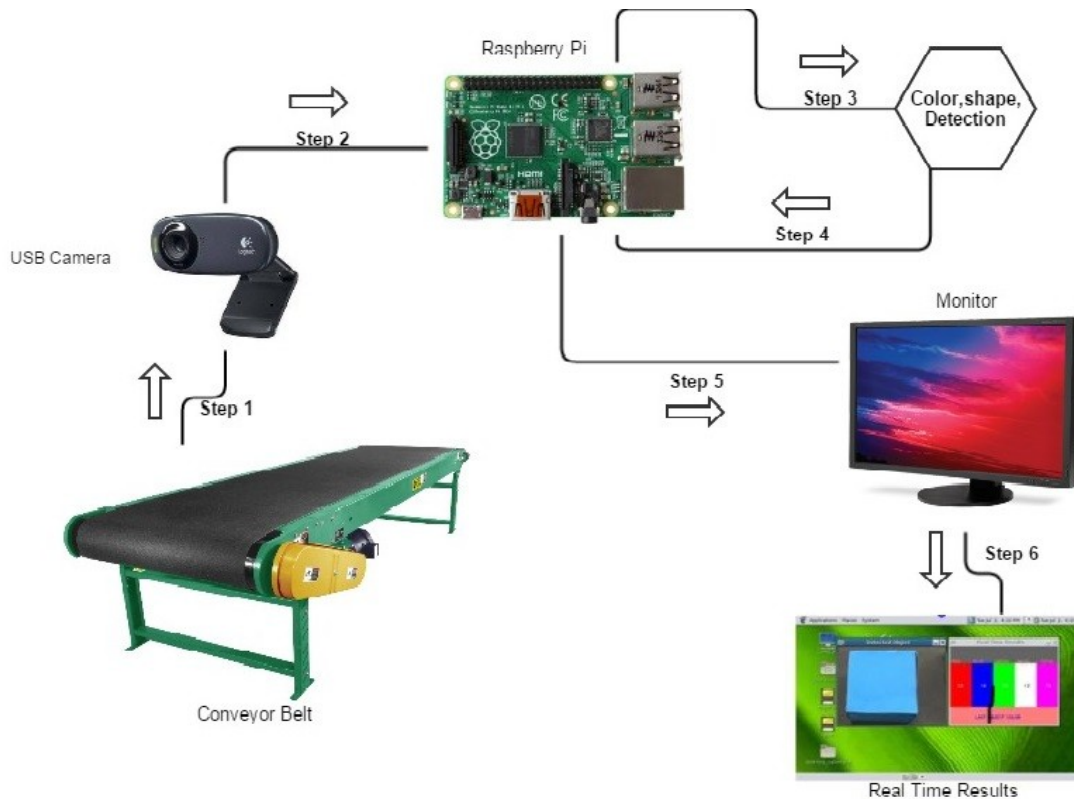


Fig. 3. The block diagram of the system

As shown in Fig. 3, In order to detect the packages passing over a conveyor belt therefore a predefined time inter between the packages must be defined .This defined period based upon the speed with which the conveyor belt is operating .Here conveyor belt is built with the help of 12V dc motor's having 10 rpm capable of moving belt tied between these two motor's so there by 12V supply is provided to the belt and relay can be used to rotate the motor's in reverse direction by providing reverse supply to motor or to stop the belt for a short interval of time so that packages can be captured by camera .Camera is fixed at an desired space so as to capture the image sharply.

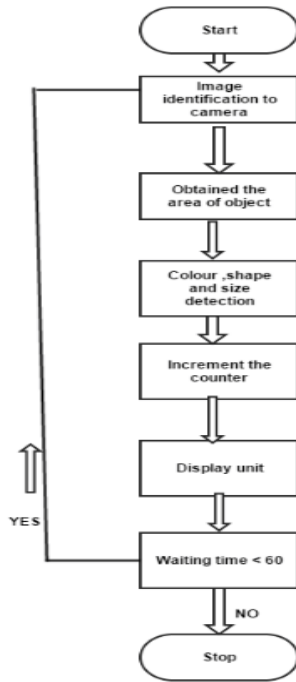


Fig. 4. Flowchart of the system

The process of detecting a colour of a package is processed in the processing unit that is in Raspberry pi .The process is shown in the flowchart shown in figure 4.

The area of image obtain with the use of USBcamera is considered as RGB which is needed to be converted into HSV colour space using some defined mathematical equation. In fig 5,6 When the colour of that particular package is determined, then we will go for the detection of shape and size of the package there by increasing the number i.e counter used to display the number of similar packages and the total number . This updated counter is displayed on the display unit The display unit will consist of number of column's equal to the number of colour system would be able to detect that is each column will show the colour with the number similar parameter packages passed over the conveyor belt.[3,14,15,16]

In last there would be an additional column showing the total number of packages passed over the conveyor or belt. If no packages passes through the conveyor belt for a prescribed period then the system would turned off.

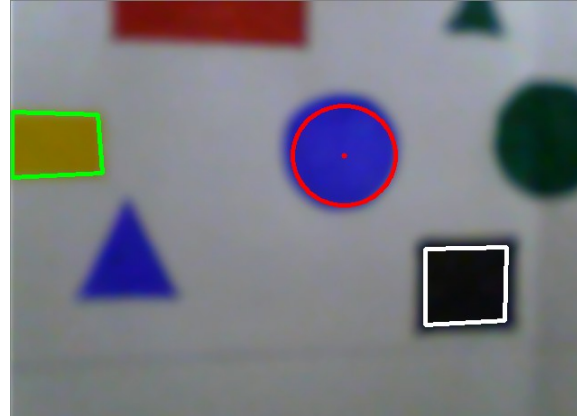


Fig. 5. Blue, Black, Yellow, coloured detection and shapes

TOTAL NUMBER OF COLOR PACKAGES:				
blue	red	black	yellow	Total
2	8	27	7	44

Fig. 6. Table showing no of packages in Real time result

### 6. Conclusions

An application for the detection of various parameters of various packages passing over conveyor belt is characterized in this paper. The system is able to primary classify the packages based on colour then differentiates based upon shape and size. The primary objective of this study is to differentiate various different types of packages at the real time while passing over a conveyor belt serially.

## 7. Acknowledgements

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