

# Low Cost Automation for Sorting of Objects on Conveyor Belt

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**ABSTRACT:** Sorting is a process in which two or more objects of similar, yet different characteristics are arranged in a systematic order. The sorting of objects on a conveyor belt is generally carried out manually or by using sensors and actuators. In this paper we have proposed a low cost automated system which uses Raspberry pi 3 and a USB camera for detecting the colour and size of the objects. We discard the objects which are not of desired colour or size by pushing them out of the conveyor belt. A linear actuator is used to discard the undesirable objects. We use openCV for detecting the colour and size of the objects.

**KEYWORDS:** Raspberry pi 3, conveyor belt, linear actuator, camera, openCV.

## I. INTRODUCTION

Sorting of objects is extensively used in many industries like food processing industries, toy industries, etc to ensure that the quality of the product is up to the mark. This process is simplified by the use of automation. Automation is the use of control systems like computers or robots for handling different process and machineries to replace a human being and provides mechanical assistance. Automated systems generally use more complex algorithms which increase the cost of the design and the power consumed. This not only reduces manual efforts, time consumed, gives more time for marketing, but also prevents danger which might occur when human beings work in hazardous environments. Automation greatly improves the productivity and is highly scalable.

We use OpenCV which is a computer vision library used extensively in the industry. We use Python programming language as it is easy to use and has sufficient speed for our task. Raspberry Pi 3 is a low cost single board computer which is powerful enough to do computer vision at real time. A simple USB camera which is supported by Raspberry Pi is used to capture the real time video. The frames of the video are analysed real time for colour and size estimation.

## II. LITERATURE SURVEY

The maturity levels of the mangoes were predicted by using the video signals of the CCD (Charge Coupled device) camera which was placed on top of the conveyer belt. The use of CCD cameras in the above method consumed lot of power, dissipated more heat and required additional ICs for operation. This also had a drawback that the maturity levels of mangoes with scratches and black spots on their skin could not be detected with the signals obtained from the CCD camera [1]. Robots were developed to sort the objects in bulk which required more mathematics and kinematics for their operation and made the system complex and also less economical. Robotic arms should be designed as to match to the size of the objects to be sorted which made it object specific design and hence less flexible [2]. Most of the Robots use Mat lab software for Image Processing that has less processing speed and they are controlled by Microcontrollers which is application specific [3]. Hence we tried to establish a system that overcomes some of the above mentioned drawbacks by using Raspberry pi 3.

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## III. PROBLEM DEFINITION

Manual sorting is the conventional approach that is preferred by industries which involves visual observation performed by human beings. This is an approach where human labourers are made to work for maximum time to

achieve the desired task. When we consider the large scale industries, segregation of objects that are bulk in number becomes a tedious task for labourers which consume lot of time. Recognizing a particular object and placing it in a required place is a tiring work, wherein one has to sort a bulk of objects with greater weight in quick time. This is slow and non-consistent when the human labourers do it manually. Sometimes humans are restricted to work in the hazardous conditions and it is the place where automation plays a major role.

Till today many efforts are made to design wise systems to fulfil object color recognition and sorting mechanism using various color sensors, image processing software's like MATLAB and necessary mechanical assembly to sort object that has been developed in the form of either conveyer belt or robotic arm using ARM processor, Arduino and Microcontroller.

## IV. EXISTING SYSTEM

Color is the most common feature to distinguish between objects by sorting, recognizing and tracking. Generally robot is mounted with a camera or the camera is mounted in the workspace to detect the object. This technology can be used in material handling in logistics and packaging industry where the objects moving through a conveyer belt can be separated using a color detecting robot. Another system separates the objects from a set, based on their color. The detection of the particular color is done by light intensity to frequency converter method, which consists of the robot with its arm supervised by a microcontroller based system which controls DC and servo motors. A mechatronics color sorting system is based on application of image processing. It aims in classifying the objects by color, size, which are coming on the conveyor by picking and placing the objects in the desired place, thereby eradicating the repetitious work done by human, achieving accuracy and speed in the work.

Color sorting systems in segregating crayons, uses visual color matching or color sorting techniques. For example, the crayon manufacturer guarantees that the green crayon in each color-assorted box will look identical in every box. In mineral sorting, the MSort scans bulk material in free fall by means of a color line camera. The respective data is evaluated by free programmable sorting software of an industrial computer by color, brightness and size into good product and rejected parts. Fruit grading and Multi scale edge detecting techniques are widely used for sorting fruits in large scale. The robotic arms are widely used in the industry, but most of them are used in a PTP (Point To Point) trajectory, where the movements of the robotic arms are learned previously. The use of sensors in various techniques also helps us to sort the objects based on the parameters like height, color, shape, size etc. This is implemented in the microcontrollers, arduino boards with the help of Mat lab software.

## V. PROPOSED SYSTEM

In this paper, we propose a system which uses low cost and open source software for achieving the goal of sorting the objects. We use Raspberry pi 3 with Linux operating system, low cost USB camera and openCV for sorting. Initially Arduino board was planned to be used but for it to work we need a colour sensor which is costly. Moreover Arduino is not as flexible as Raspberry Pi 3. It is also much slower and has lesser memory compared to Raspberry Pi even though the cost is very similar. The proposed model has a conveyor belt run with the help of dc motor and corresponding pulleys at the motor and its opposite ends which constantly run at a desirable speed with the help of Raspberry Pi 3. Material is fed on the feed-side of the belt and landed on the rotating conveyor belt, then rely on the conveyor belt friction to be delivered to discharge end. The pulley that drives conveyor belt is called drive pulley or transmission drum; the other one only used to change conveyor belt movement direction—is called bend pulley. Drive pulley is driven by the DC motor. It can also have a guiding pulley which just guides the motion of the conveyor belt between the drive and the bend pulley.

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Objects which are to be separated are placed on the conveyor belt. A camera constantly watches for the color of the objects passing in its view and program is coded in Python for raspberry pi in such a way that, when an object that is passing in front of the camera is of undesired color, the linear actuator is activated and it hits the undesired object away

from the conveyor belt, hence deselecting it. Those objects which are of desired color will be allowed to pass through the belt and are put into the trolley at the receiving end for packing. Therefore selecting and deselecting process of objects can be made easier with the use of raspberry pi 3 which is more efficient, cost effective and easier.

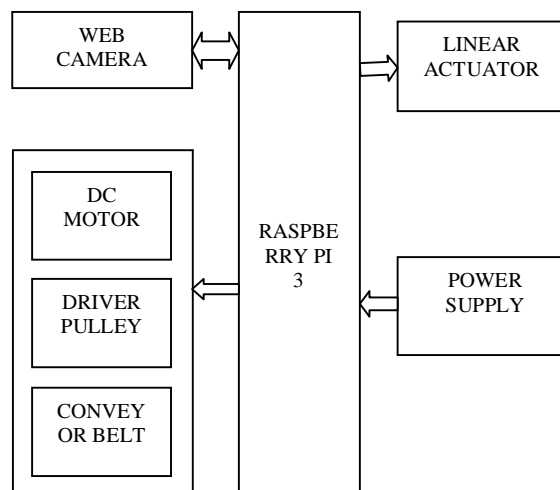


Figure 1. Block diagram of automation for sorting of objects.

Raspberry pi (RPI) is a low cost, portable, multipurpose and tiny computer. The latest version of it is Raspberry pi 3 which is used in this system. The Figure 1 shows Raspberry pi 3 interfaced with web camera, dc motor and linear actuator. A 5V and 2A power supply is given to the Raspberry pi to work.

Raspberry Pi 3 has 4 USB ports which can be used for connecting a webcam and it has 40 GPIO pins which are connected to the DC motor and linear actuator. We use a H bridge to drive the DC motor and linear actuator. PWM is used for controlling the speed of the DC motor. H bridge is used as it is available at low cost and can be used to run the motor in one direction or the other. Since H bridge generally supports 2 motors, we can use the other part of H-bridge for driving the linear actuator.

The system has a solenoid based linear actuator which creates motion in a straight line. Here we have used electrically operated solenoid as a linear actuator as it is low cost and can be replaced by any other type of linear actuators as per the requirement. It is connected to the GPIO pins via the H bridge which will receive a high signal as programmed when the object color is undesirable and will push away the objects in front of it and will remain low when objects of desired color is passed on the belt. It can be attached with more than one linear actuator on the conveyor belt to sort many colors and separate them into their respective trolley.

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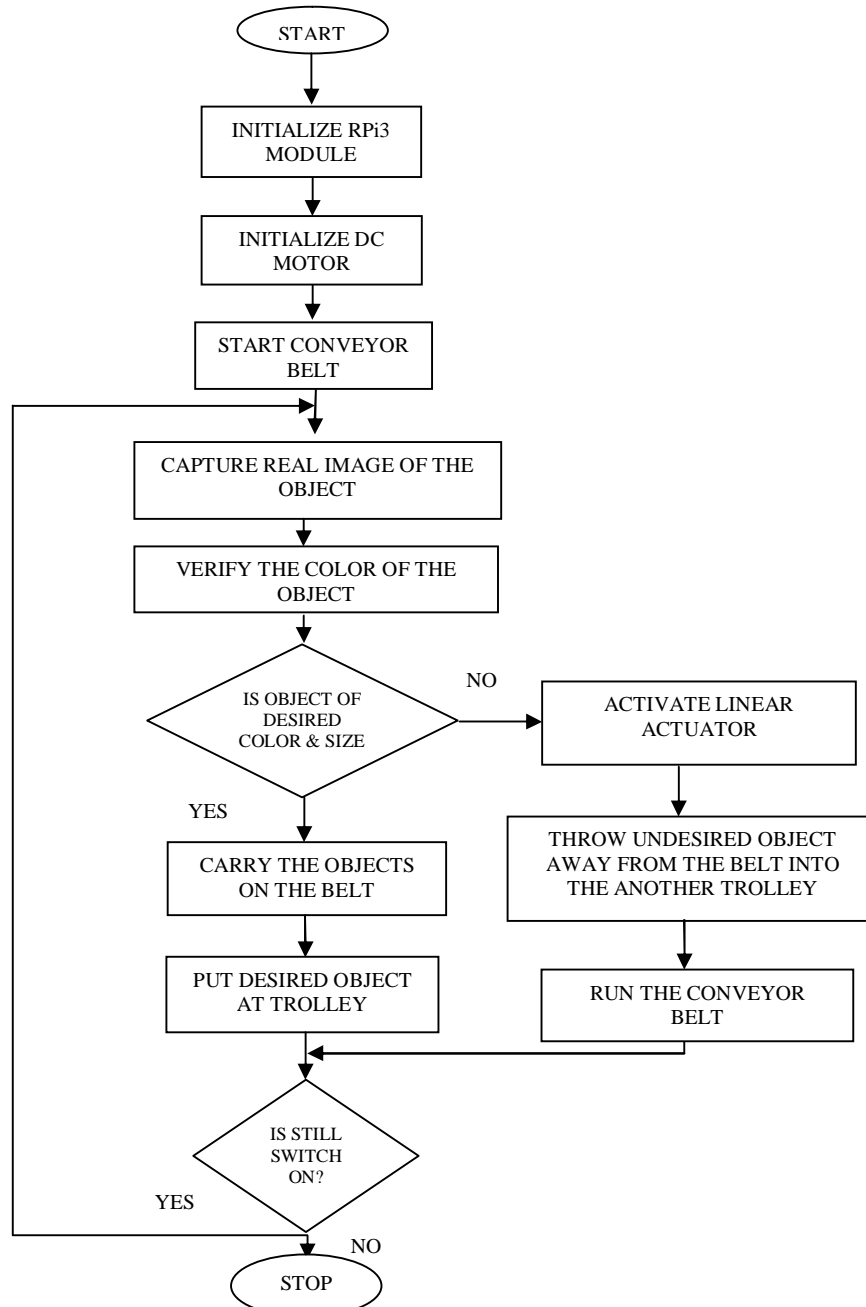


Figure 2. Flow chart of automation for sorting of objects

The figure 2 shows the flowchart of the procedure followed for this sorting of objects based on their color and size. Initialize the Raspberry PI3 module. Then the DC motor is initialized to rotate the belt and then the objects are placed which move along the belt. Camera is activated to capture the real image of objects as soon as the process is started. If any object is detected, the camera takes the picture of that object and detects the color of it and is compared to the pre assigned color and if they are the same, it will be allowed to pass through and if it is different to that defined, the

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electrically operated linear actuator will be activated and that will push away the undesired colored objects away from the belt into another trolley. The process will repeat infinite number of times until the power is turned off.

## VI. COLOUR AND SIZE RECOGNITION

We use Euclidian distance based approach to find the distance between the average color in a region to that of a desired colour. For simplicity we chose three primary colours namely, red, green and blue as our desired colours. The numeric values for colours are as shown below:

$$c_r = \begin{bmatrix} 255 \\ 0 \\ 0 \end{bmatrix}, c_g = \begin{bmatrix} 0 \\ 255 \\ 0 \end{bmatrix}, c_b = \begin{bmatrix} 0 \\ 0 \\ 255 \end{bmatrix}$$

Where color red is represented by  $c_r$ , green by  $c_g$  and blue by  $c_b$ . The distances from unknown colour  $c$  are measured as using Euclidian distance. We classify the colour to be the one with smallest distance below a threshold. The size is measured by the area of the region of the object in the image.

## VII. EXPERIMENTAL RESULTS



Figure 3. Interfacing Raspberry pi 3 to external devices

Figure 3 shows connection of devices like keyboard, mouse, and Monitor through USB and HDMI cable to Raspberry pi 3 in order to make it functional. It also shows the connection of Ethernet cable to RPI to obtain LAN connection.

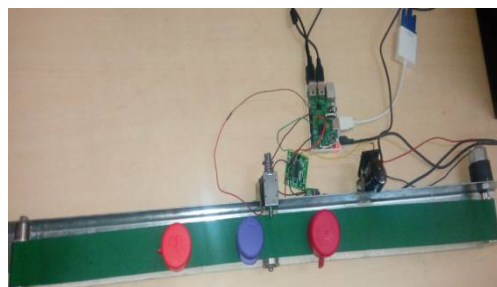


Figure 4. Conveyor belt with DC motor and linear actuator

The Figure 4 represents the hardware model of the project. The model consists of a conveyer belt, dc motor, solenoid and pulleys. The L clamp is used to fit the dc motor, solenoid and the pulleys as shown. The camera is adjacently placed to the solenoid such that as soon as the color is detected by the camera and the solenoid will be activated as needed.

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Objects of different colors are placed on a 20 mm width and 2 meters circumference conveyor belt of PVP material and a camera is fixed to L clamp to monitor the object continuously as shown in the figure. Raspberry Pi 3 detects the colour of the items, the solenoid will remain disabled and if the color is undesired, the solenoid will be actuated to throw the object out of the belt. We have almost 100% accuracy for objects which have closer to the target colour. The accuracy falls off as the colours are mixtures between two target colours.

## VII. CONCLUSION

The automated system outlined above provides cost effective, low time consuming and technically simple approach for sorting of objects. This system uses Raspberry pi 3 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 and other noise. Similarly, while collecting objects from conveyor system by a linear actuator, there are variations in weight and size of objects.

Further approaches to this system can be made to increase the capability to segregate large and heavy objects and sort them effectively. In this paper we have proposed a system which sorts the objects based on their color which can further be enhanced to sort them based on their size and shape with the help of IR sensors.

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