Raspberry Pi based image processing for automated Object sorting using shape and color

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ABSTRACT

Nowadays sorting is very important in production. Because of the increases of production and in some factories, the objects are manually sorted by hand workers, and in many cases, people need to sort a large number of objects in a short period of time and these objects may be very large and more weight that a person cannot bear. So, the automated sorting object is needed to take place the manual sorting. So, in this paper we make automated object sorting system, and we will discuss about sorting object automatically based on shape and color. We use raspberry pi 3 B+ which is processing and controlling unit. First the DC motor will drive the object to the camera which will scan the object to detect the color and shape. Then the servo motor will drive the object to bin. and motor driver to drive DC motor.

Introduction

There is a need to figure stuff out in the manufacturing sector. Things may be the same or different kinds of things. The machine must be able to detect objects and then, based on their characteristics like colors and shape, separate objects from each other. Objects can have various shapes or colors that are different. The stuff can have the same shape and color, but a different texture. Different things and different conditions also involve different things. As for the industrial settings, it is very important because it reduces the error rate in the system and thus saves time, unlike humans working in this field[1,2].

This paper present a system which is completely automated and can accurately sort objects based on their shape and color. We use the raspberry OS (is a Debian-based operating system for Raspberry Pi), also use the VNC server (virtual network computing). It is used to control the raspberry pi remotely from the PC [3,4]. Using python programming language as it is simple to use and has ample speed for our project. The Raspberry Pi 3 is single-board computer that is efficient enough for real-time computer vision, and with low-cost. To capture real time video, a simple USB camera that is supported by the Raspberry Pi is used. For color and shape estimation, the frames of the video are analyzed in real time.

Usually, in some factories, the objects are manually sorted by hand workers, and in many cases, people need to sort a large number of objects in a short period of time and these objects may be very large and more weight that a person cannot bear. So, our project will help hand workers to reduce the time and efforts. We use raspberry pi B+ and camera to scan the object to detect the color and shape and servo motor to drive the object to sort it [5]. We are motivated to develop project in new way so as we can sort objects in different shapes and colors. this machine easier to use and take less time to do the works [6,7,8]. That is what people look for it. Those are the most important incentives that encourage us to do this project. To sort object based on its

characteristics shape and color by using high images processing technology using Raspberry Pi 3 B+. The specific objective of this work is use camera, Raspberry Pi 3 B+, servo motor study the work of each component, programming the Raspberry Pi 3 B+, design the circuit and test it by using breadboard, design the machine, the connection and assemble the project.

Methods

Shape and color of an object are collected as pictures by using camera. This camera transfers the pictures to the Raspberry Pi to process the images and collect the data and information of the object. Our project is going to sort the object Based on the shape and color of that object. By using the Motor driver, we can control the DC motor. the conveyor belt is moving by using the DC motor. So, by use of the conveyor belt we can drive the object through the camera (to collect the data) into the sorting stage. So, after collecting the data and process it, the Raspberry Pi will drive the object to the correct sorting bin by using the servo motor. We design the Raspberry Pi based image processing for automated Object sorting using shape and color which use to sort object based on its color by using high images processing technology using Raspberry Pi 3 B+. Our project contains of Raspberry pi 3 model, USB camera, power supply, DC motor and server motor. Figure 1 shows the block diagram of the project.

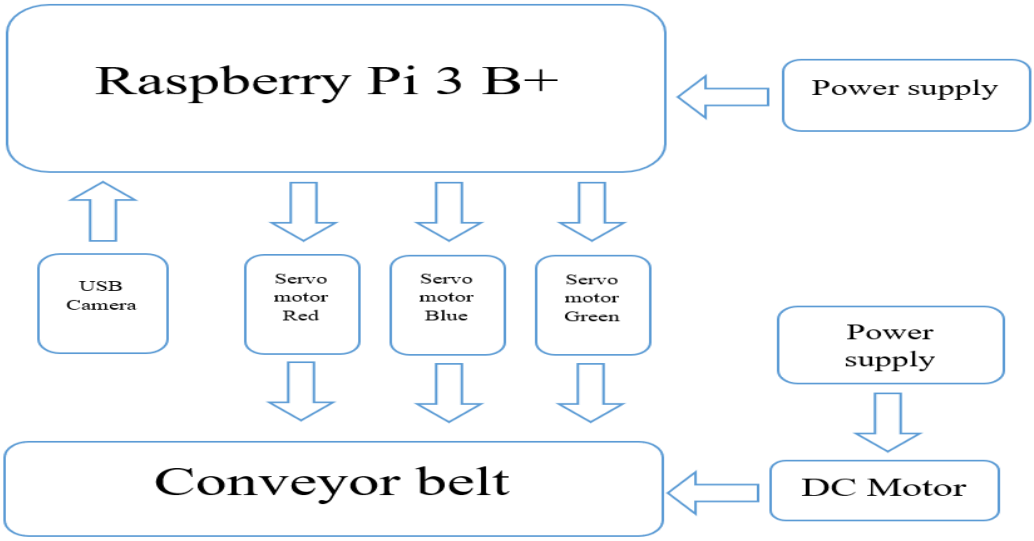

Figure 1. Block Diagram of Raspberry Pi based image processing for automated Object sorting using shape and color

Raspberry pi is a processing and controlling unit used to drive different component. Camera connecting with the raspberry pi to take image for the object. Also, we use 3 servo motor for different color connected to raspberry pi to drive the object to the box. the power supply connected with raspberry pi. The Dc motor connected to conveyor belt which is used to drive the object to sort it. and connected with power supply to power dc motors. The circuit diagram in Figure 2 shows all the components that are mainly used to develop this project. The function of each component in the circuit is discussed below. The aim of our project is to sort objects

automatically. It consists of Raspberry pi 3B+, camera, motor driver, DC motor and three servo motor. The camera is connected with raspberry pi will scan the object and send it to raspberry pi to detect the color. Then, DC motor will drive the object to sort it by servo motor which is connect with motor driver and drop it in a box.

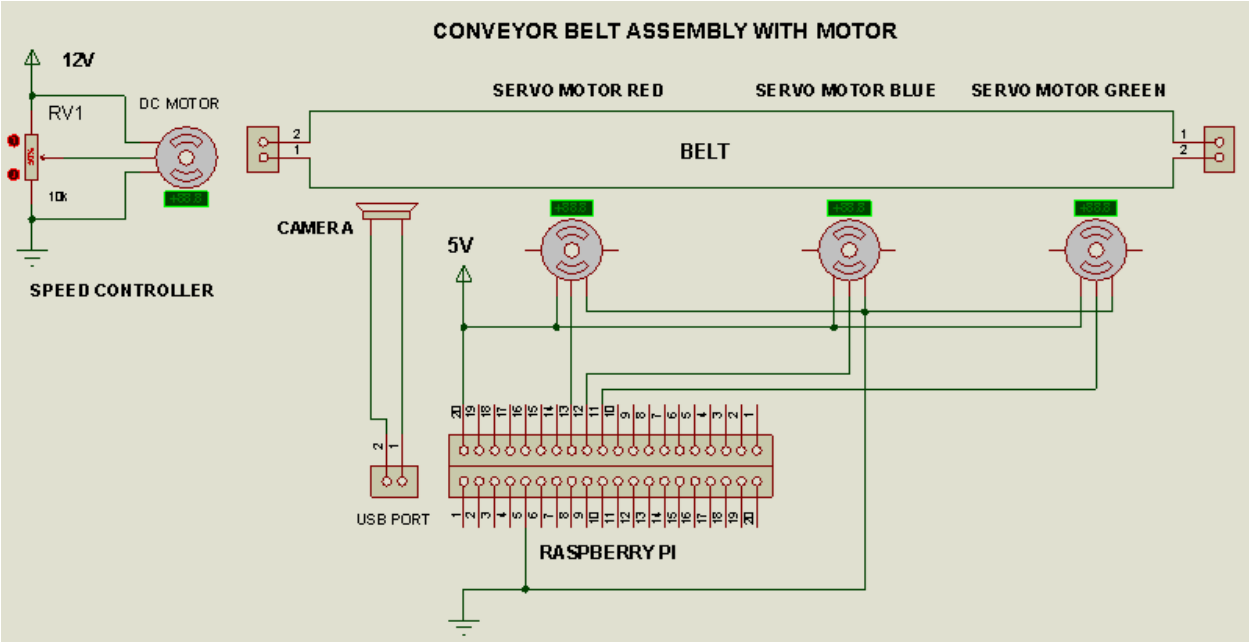

Figure 2. Circuit Diagram of Raspberry Pi based image processing for automated Object sortingusing shape and color

The Raspberry Pi was created in February 2012 by the Raspberry Pi Foundation, Originally setup to promote and teach basic computer science in schools and colleges around the UK. They initially released 2 Devices the Model A and the Model B, these computers ranged in spec and capabilities. Soon after the release of these products a community was formed and thousands of Tech-Heads‖ bought one and started to create new projects with it, for instance one of the first things I did was setup a Home Media Centre and played the popular game Mine craft. The products were so popular due to their cost ranging from $25 – $35 (£17 – £23) they were efficient and durable which made them easy to modify and crate projects on, the device ran Linux a popular OS for developers due to it being open-source. On the Raspberry Pi website they created 2 images that could be installed easily onto a sd card which would then act as the OS for the device, one of the images was based off of Debian a popular lightweight Linux OS and was called Raspbian, the other was called Raspbmc and was based off the popular media centre software Kodi (Formally known as XBMC).In February 2014 they had been reported to have sold 4.5 million boards, soon after this success they released the Model A+ and Model b+ which provided more GPIO's and used less power to run. In early 2015 the Raspberry PI 2 was announced with increased MHz by 200 to bring it to 900 MHz and doubled the ram to make it 1GB. Figure 3 shows the component of Raspberry pi-3 model B+.

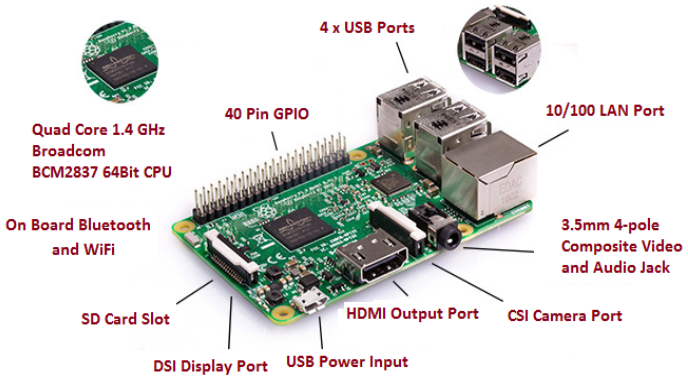

Figure 3. Shows the component of Raspberry pi-3 model B+

Specifications: CPU: 700 MHz ARM1176JZF-S single-cores with ARMv6 CPU architecture Memory: 512mb USB ports: 4 Video Output: HDMI (rev 1.3 & 1.4), 14 HDMI resolutions from 640×350 to 1920×1200 plus various PAL and NTSC standards, composite video (PAL and NTSC) via 3.5 mm TRRS jack shared with audio out GPIO: 17 Power Ratings: 600mA (3w) Power Source: 5V Micro USB Size: 85.60 mm × 56.5 mm (3.370 in × 2.224 in) – not including protruding connectors

Results

USB Camera which is used to capture the image to get the shape and color of the object to sort it. The image transferred from the camera to the Raspberry Pi to convert it into a frame to get collect the data from the frame. Raspberry Pi used to process the frame to get information about the object. Depend on the shape and color of the object the Raspberry Pi will give a command to the right servo motor to collect the object. Three servo motor used in this project to collect the object. DC motor connected to conveyer belt to drive the objects to through the camera into the servo motor to collect them.

After turning on the power supply, the Raspberry Pi will start the USB camera. Then it will start capturing frames for the object. Raspberry Pi will do some processing and calculations to get the color of the object. It will check if the color is red, if it is not, it will check if it is blue, if it is not, it will check if it is green, if it is not, it will capture the frame again. But if the color is red, it will count the number of contours and pixels of the object. If the number of the contours and pixel are 3 and 4000 pixels, that is mean the object is triangle and red, if it is 4 and 5000 pixels the object is red square and if it is more than 7 and less than 12 and have 15,000 pixels that is mean it is a red circle. And the same for the blue and green color. But deferent number of pixels for each shape. After that, the Raspberry Pi will be able to sort the object based on color and shape of the object. And by using the servo motor the Raspberry can collect the object to the sorting bin. Then it will do the same circulation for the other objects. Figure 4 shows the flow chart of Raspberry Pi based image processing for automated Object sorting using shape and color.

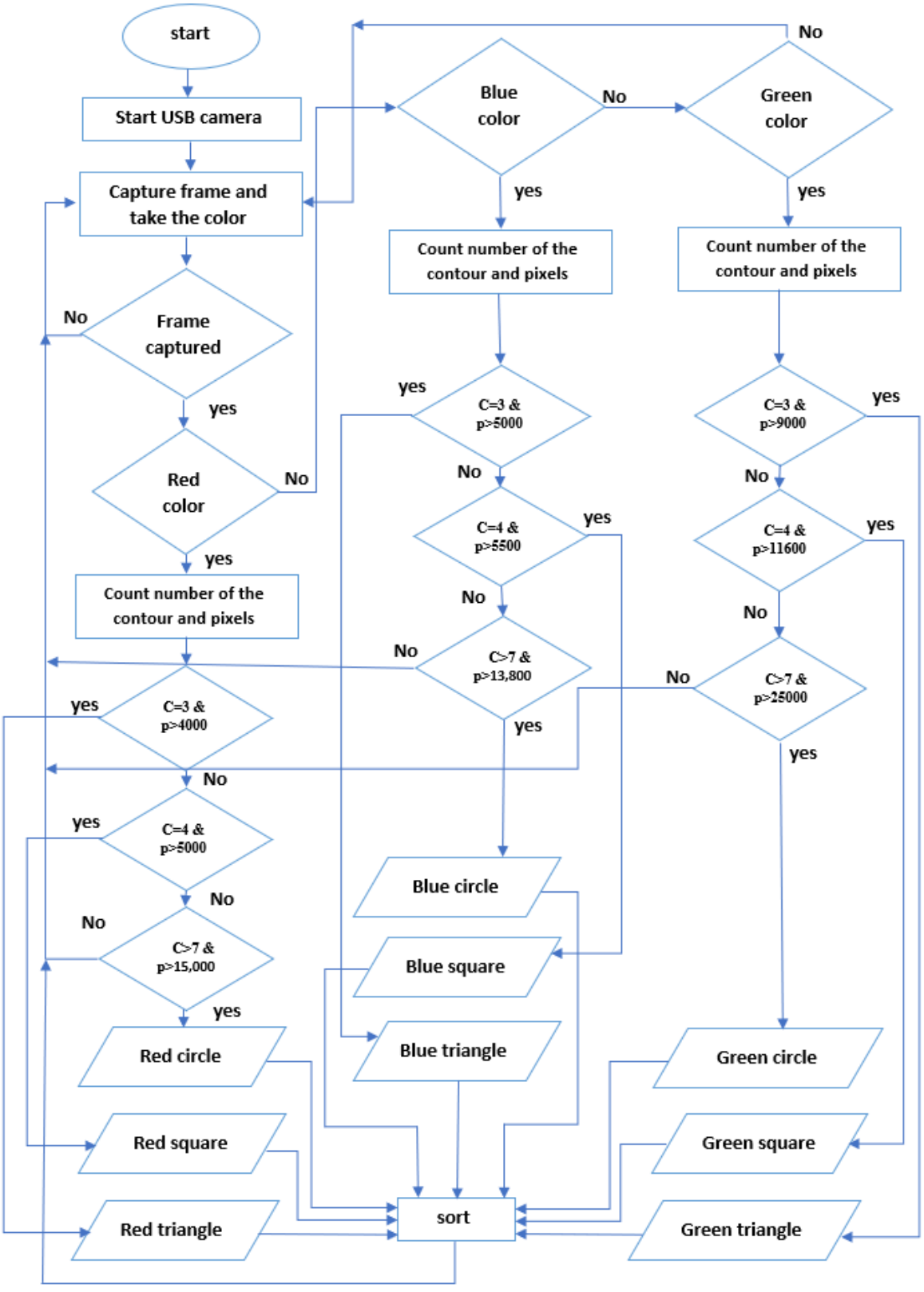

Figure 4. Flow chart of Raspberry Pi based image processing for automated Object sorting using shape and color

Using python programming language to enter the python terminal. We use three shapes and three colors for doing the test in the project. Then find "Trackbars" values for each object. Do three masks for that (Red mask, Blue mask, Green mask). These masks are used to find the colors and shapes for different objects. Do that by use HSV system to convert BGR in to HSV (Hue Saturation Value). In this project use different component to do automated object sorting based image processing for using shape and color. Use USB camera to capture a frame for the object and send to Raspberry pi to check the information (shape and color) for object and then control the servo motor to sort the object. First start with red color and write program for that in python by use the trackbars value which get before and run, when run program and put red color with circle shape in front the camera will get the circle in the red mask window as shown in Figure 5.

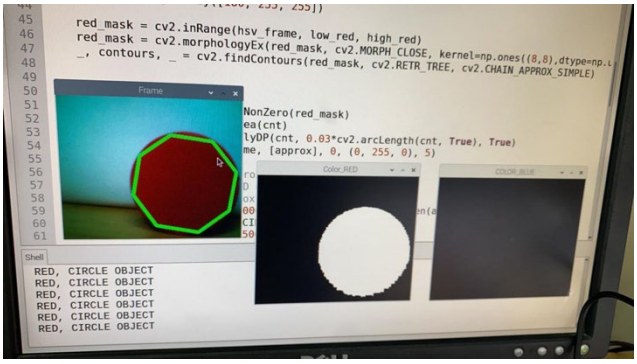

Figure 5. Counting pixel and contour for red circle

Then do for red color with square shape and find square in the red mask then put red square in front the frame, as shown in Figure 6.

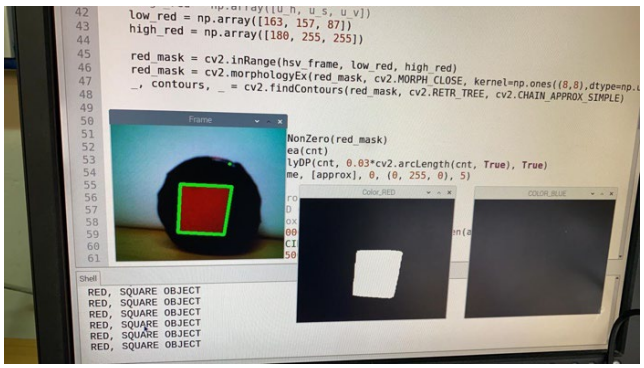

Figure 6. Counting pixel and contour for red square

Also do for triangle shape with red color and then run the program find triangle shape in red mask as shown in Figure 7.

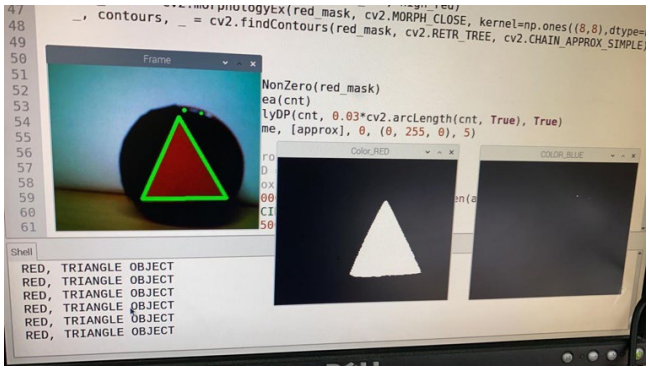

Figure 7. Counting pixel and contour for red triangle

After completion for red color with three shapes, now we do the same thing for blue color. Start with circle shape write program for blue in the python and find the trackbars value. Then run program and put blue circle in the frame to get the circle in the blue mask, as shown in Figure 8.

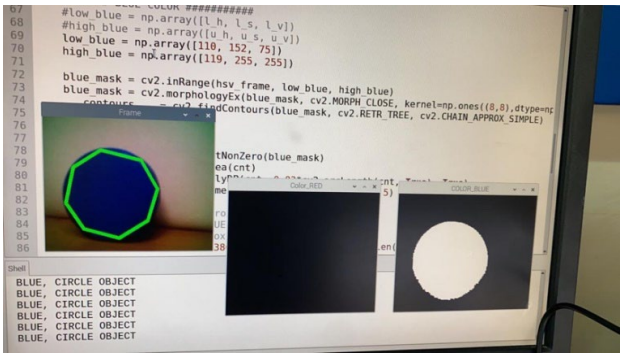

Figure 8. Counting pixel and contour for blue circle

Then do for square shape, write the trackbars value what you get before and run program, then put blue square in front the camera to get square in the blue mask, as shown in the Figure 9.

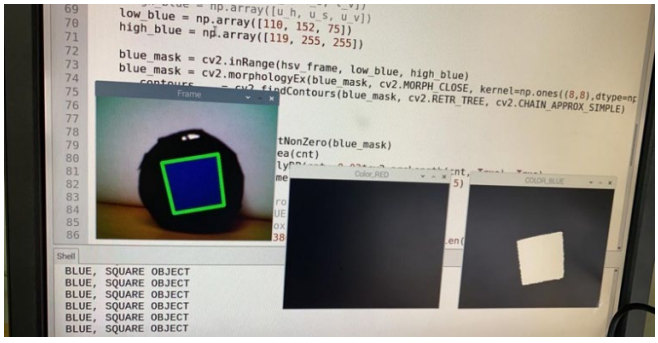

Figure 9. Counting pixel and contour for blue square

Then do for triangle shape, run program, then put blue triangle in front of the camera to get the triangle in the blue mask, as shown in the Figure 10.

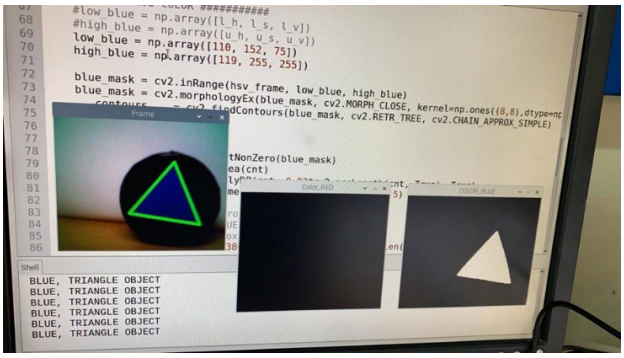

Figure 10. counting pixel and contour for blue triangle

At the last do the test for green color for three shape also. first do for circle shape with green color. Then run the program and put the green circle in front the frame to get the circle shape in the green mask. as shown in the Figure 11.

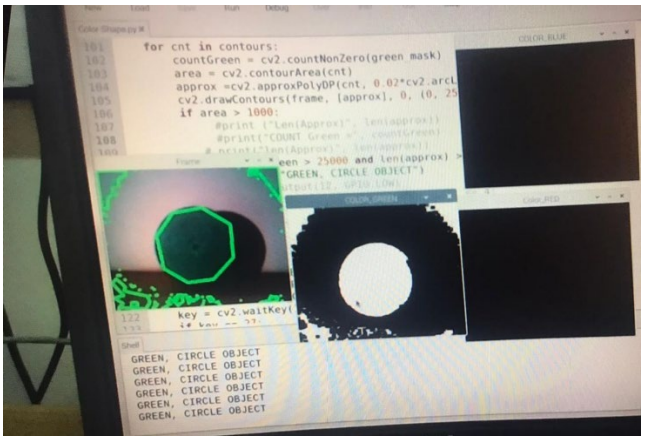

Figure 11. counting pixel and contour for green circle

Then do for square shape, write the trackbars value what you get before and run program, then put green square in front the camera to get square in the green mask Figure 12.

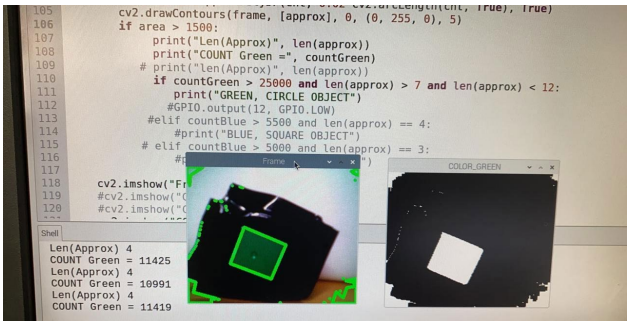

Figure 12. counting pixel and contour for green square

Finally, do for triangle shape in green color, put the triangle shape in front the frame after running the program and the triangle shape will be shown in the green mask. As shown the Figure 13.

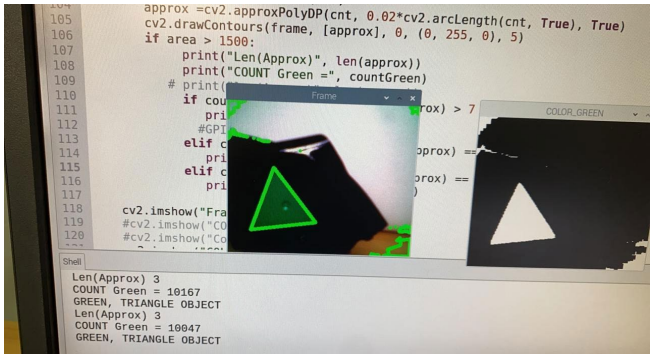

Figure 13. counting pixel and contour for green triangle

Discussion

The python programming language is used to identify the low and high HSV values for different color and shapes. The machine sorts out 3 shapes (square, circle, and Triangle) 3 colors (Blue, green and red). The machine defects a red circle when the contours is greater than 7 and less than 12 at 15,000 pixel, and Blue Square at when the contours are 4 at 5500 pixels, Green triangle at when the contours are 3 at 9000 pixels. Table 1 summary of the Low and High HSV values for red, blue and green and Table 2 shows the contours and pixel counts for different shape and colour.

Table 1: HSV Values for different color

Color of the Object	Low HSV Values	High HSV Values
Red	**Low Hue: 163** **Low Saturation:157** **Low Value:87**	**High Hue:180** **High Saturation:255** **High Value:255**
Blue	**Low Hue:110** **Low Saturation:152** **Low Value:75**	**High Hue:119** **High Saturation:255** **High Value:255**
Green	**Low Hue:25** **Low Saturation:52** **Low Value:72**	**High Hue:102** **High Saturation:255** **High Value:255**

Table 2: The contours and pixel counts for different shape and color

Object		**Contours**	**Pixel**
Colour	**Shape**		
Red	Circle	Greater than 7 and less than 12	15,000
Red	Square	4	5000
Red	Triangle	3	4000
Blue	Circle	Greater than 7 and less than 12	13,800
Blue	Square	4	5500
Blue	Triangle	3	5000
Green	Circle	Greater than 7 and less than 12	25000
Green	Square	4	11600
Green	Triangle	3	9000

Selection of colors is done by using masks. These masks are created based on the HSV values of each color. Each color have Low HSV values (low Hue, low Saturation and Low Value) and High HSV values (High Hue, High Saturation and High Value). These HSV values are shown in Table 4.1. The Low HSV values of the Red mask are (Low Hue: 163, Low Saturation:157 and Low Value:87) and the High HSV values are (High Hue:180, High Saturation:255 and High Value:255). The Figure 14 show the selection of the Red object.

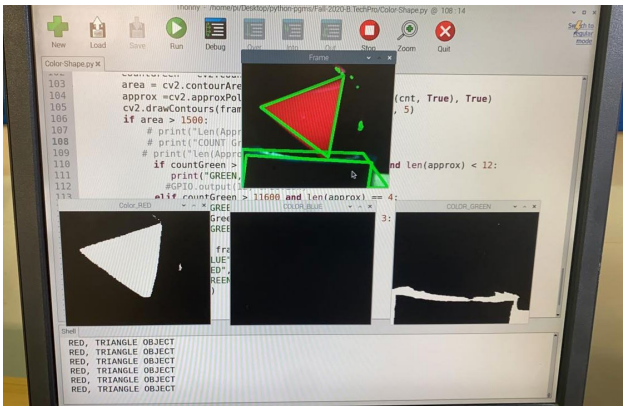

Figure 14. Red object selection

The Low HSV values of the Blue mask are (Low Hue:110, Low Saturation:152 and Low Value:75) and the High HSV values are (High Hue:119, High Saturation:255 and High Value:255). The Figure 15 show the selection of the Blue object.

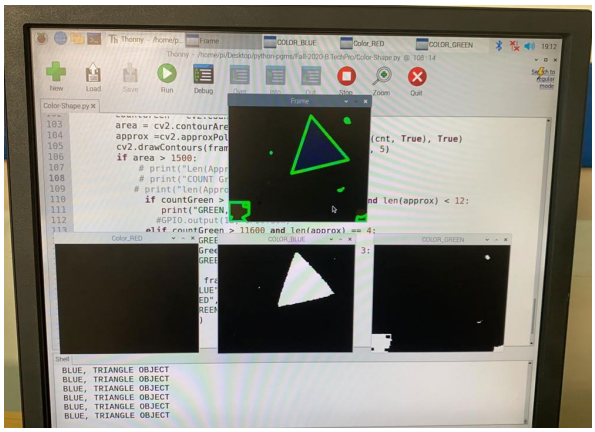

Figure 15. Blue object selection

The Low HSV values of the Green mask are (Low Hue:25, Low Saturation:52 and Low Value:72) and the High HSV values are (High Hue:102, High Saturation:255 and High Value:255). The Figure 16 show the selection of the Green object.

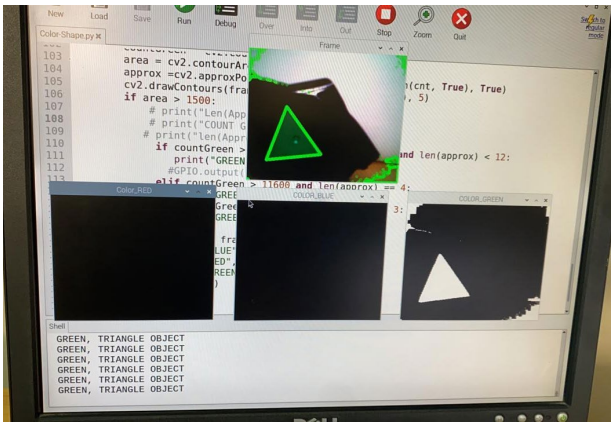

Figure 16. Green object selection

Conclusion

In this paper we have concluded that "Raspberry Pi based image processing for automated Object sorting using shape and color" project was able to successfully overcome the drawbacks of previous approaches and can be implemented for a lot of applications for industrial purposes. We have proposed an automated object sorting system based on shape and color using raspberry pi 3 to make the system more efficient and easier to use and camera to sort of the object which will help industries to increase the speed of object sorting. It also reduces the cost and effort and reduces the time spent in sorting the objects without any human mistakes.

References

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