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Automated Object Sorting Using Raspberry Pi

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Abstract : *Automation, although had led into the development in terms of sophistication of human efforts in bringing out mass production of more precisely manufactured goods; yet it in some ways it needs to be modified to be a smarter intelligent system. Usually sorting of objects is carried out manually using human labor. Recognizing a particular object and placing it in the required position is a tiring work especially in the field of industry where in one has to sort a bulk of objects in quick time and also the weight is greater than what a human can carry. In this paper we discuss about sorting the objects based on their shape and color. Here we use Raspberry pi, which is an open sourced Linux based board and it is interfaced with camera module. Firstly we catch up the images of objects which are required to be sorted out by using the camera. By applying the basic principles of digital image processing we compare the color components of the acquired image and differentiate the objects. This entire sequence of steps of results in our desired output of sorting out objects automatically.*

Keywords: *Conveyor belt, Drivers, IR sensors, Raspberry pi, Stepper motor, USB camera*

I. Introduction

In manufacturing industries, there arises a need to sort objects. The objects may be of similar or different types. The system should be able to detect the objects and then differentiate the objects from each other based on their properties. Objects may have different shapes or different colours. The objects may be of same shape and same colour but different texture. Thus, different objects and different conditions require different type of processing. Our aim is to classify objects using different image processing algorithms on the parameters like colour, shape, texture[1]. The input image will be processed for detecting the colour components.

This automated system does not requires any special human vigilance and thus reduces the probability of man made errors. The outputs of the system are completely reliable which can be further linked with huge working systems.

II. Color Sorting Techniques And Usages

In the present context we are using two color models.
1)RGB color model
2)CMYK color model

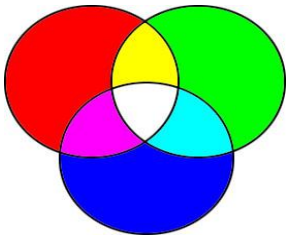
2.1 RGB Color Model

RGB color model is an additive color model in which red green and blue light are added together in various ways to reproduce the broad array of colors[3]. The main purpose of the RGB color model is for the sensing, representation and display of images in electronic systems such as televisions and computers though it has also been used in conventional photography. While using the image processing software like Photoshop you can see that these RGB colors are added with the help of numerical value, which is between 0 to 255. With RGB, mixing of red and green equally gives yellow, mixing of green and blue creates cyan and the mixing of red and blue creates magenta. When all the three colors, red, green and blue are mixed equally they produces white light. Hence it is called Additive color model. Another RGB model based example is human eye itself and scanners. The basic advantage of RGB model is; it is useful for full color editing because it has wide range of colors. But at the same time this model is said to device dependent. It means the way colors displayed on the screen depends on the hardware used to display it.

2.1.1 Calculations

The RGB color model is used for specifying colors. This model specifies the intensity of red, green, and blue on a scale of 0 to 255, with 0 (zero) indicating the minimum intensity. The settings of the three colors are converted to a single integer value by using this formula

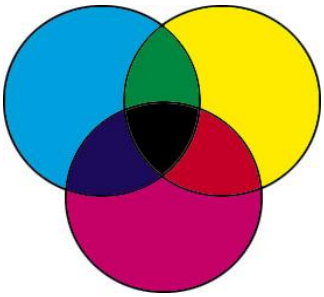
: RGB value= Red + (Green*256) + (Blue*256*256)----(1)



1) RGB color model

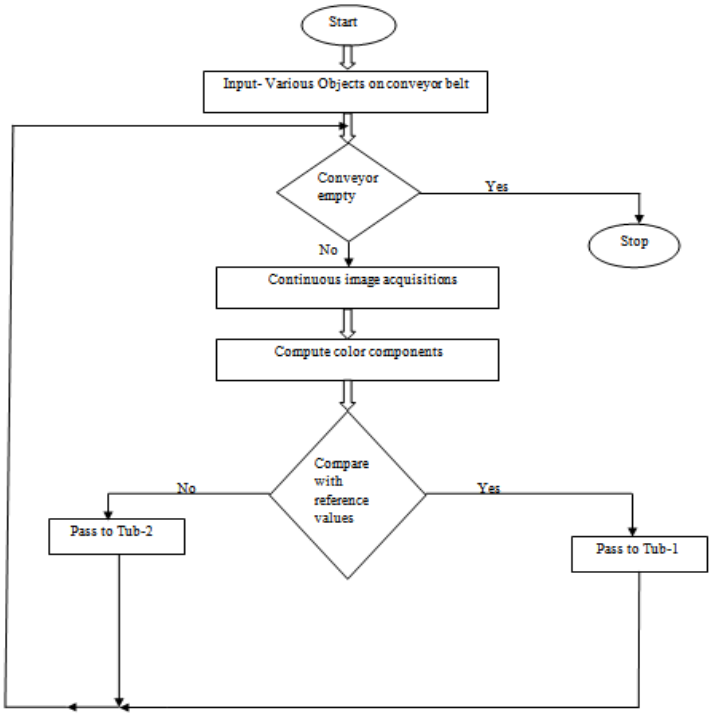
2.2 CMYK Color Model

The CMYK color model is a subtractive color model, used in color printing, and is also used to describe the printing process itself. CMYK refers to the four inks used in some color printing: CYAN, MAGENTA, YELLOW, and KEY(BLACK). The "k" in CMYK stands for key because in four color printing, cyan, magenta and yellow printing plates are carefully keyed, or aligned, with the key of the black key plate. K is used as "key", which was possibly chosen because black is often used as outline. Since black is a full presence of color, you will have to subtract the levels of cyan, magenta and yellow to produce the lighter colors. This can be explained in different way. When light falls on the green surface or green ink. It absorbs (subtracts) all the colors from light except green. Hence the model is called subtractive model. Print production is based on this model. It is useful to have proper understanding of the color models. The monitors as well as scanner works on RGB principle. While scanning we can adjust the software to produce desired result. CMYK is for print industry. It cannot produce the color range of RGB hence after finishing the work on computer in RGB mode when you convert it into CMYK for printing some tonal changes can be occurred. In spite of its limitation CMYK model is considered as best model available for printing because it can produce properly finished output.



2) CMYK color model

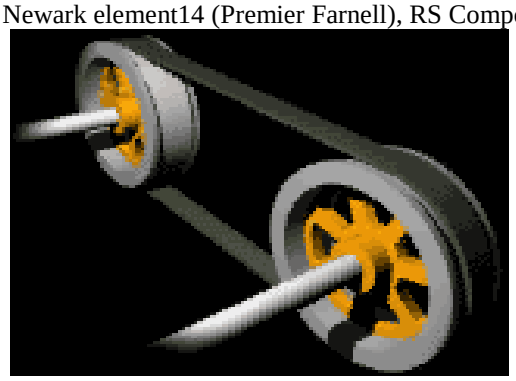
2.3 Flowchart for the model



Step 1:- At first the process is started with the inputs as various objects which are to be sorted.
Step 2:- Conveyor belt is checked whether objects are present or not. If conveyor belt is empty then the process will be stopped and if it is not empty process is continued.
Step 3:- Continuous images of the objects are taken.
Step 4:- The color components in each image are calculated.
Step 5:- These values are compared with the reference values.
Step 6:- If values are matched then the objects are passed to tub-1 and remaining to tub-2.

III. Hardware Utilised

3)Raspberry pi
The Raspberry Pi is a series of credit card–sized single-board computers developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The original Raspberry Pi and Raspberry Pi 2 are manufactured in several board configurations through licensed manufacturing agreements with Newark element14 (Premier Farnell), RS Components and Egoman.

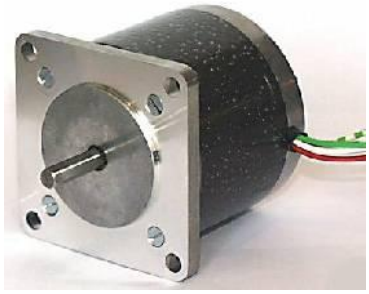


4) Conveyor Belt
A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward.

5) USB to VGA adapter
In this project this USB to VGA convertor is required to connect the Raspberry pi with the monitor. With this we can connect to monitor for programming the Raspberry pi.

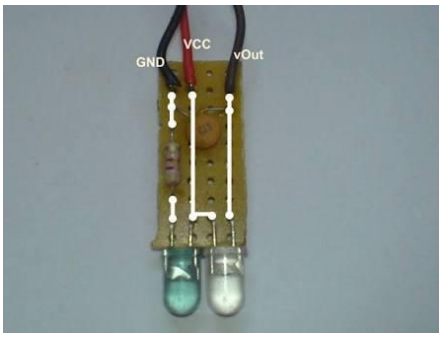
6) USB Camera

USB camera's or imaging camera's that use UBB 2.0 or 3.0 technology to transfer image data. USB camera's are designed to easily interface with dedicated computer systems by using same USB technology that is found on most computers. The accessibility of USB technology in computer systems as well as the 480Mb/s transfer rate of USB 2.0 makes USB camera's ideal for many imaging applications.



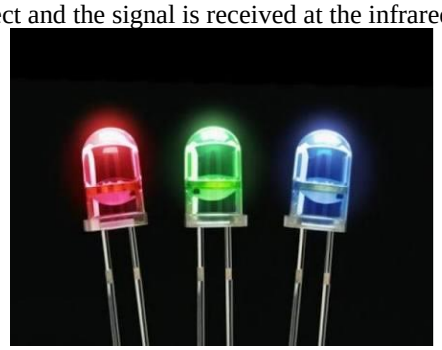
7) Stepper motor

A stepper is a DC electric motor that divides a full rotation into number of equal steps. The motor's position can then be commended to move and hold at one of these steps without any feedback sensor, as long as the motor is carefully sized to the application in respect to torque and speed.



8) IR Sensors

These IR sensors are used to detect the presence of objects on conveyor belt in this project. The basic concept of an Infrared sensor which is used as obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver.



9) LED's

In this project LED's are used as indicators for the color objects which are being sorted. LED's are just tiny light bulbs that fit easily into an electrical circuit. But unlike ordinary incandescent bulbs, they don't have a filament that will burn out and they don't get especially hot.

IV. Raspberry Pi

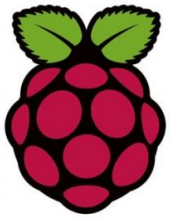
4.1 Evolution Of Raspberry Pi

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.

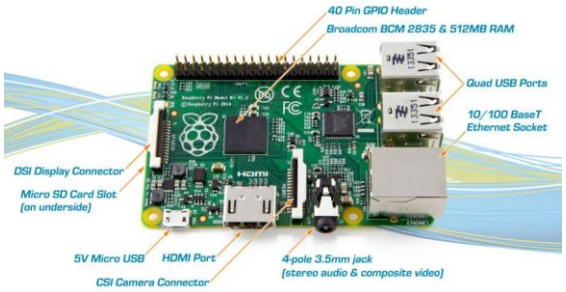
4.2 Models In Raspberry Pi

- MODEL A
- MODEL A+
- MODEL B
- MODEL B+

Model B+ has been used in the present context due to it's comparable advantages over others.



10) Raspberry pi logo



11) Model B+

4.3 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

4.4 Advantages Of Raspberry Pi

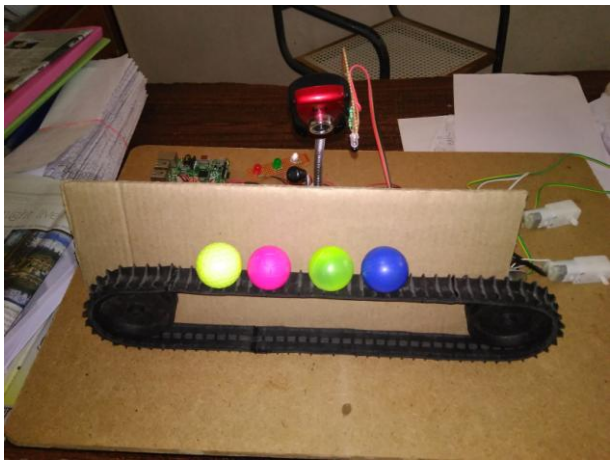
- More Energy Efficiency.
- Improved Power Management: Manage More Devices from Your Pi!
- Bigger and Better projects via an Expanded GPIO Header (40 pins vs. 26)

- Increased connectivity - 2 Extra USB ports (making a total of 4) and a new 4-pole connector replace the existing analogue and composite video port on the Model B.
- Cheaper to produce.
- Smaller in size.
- Less Power Required.
- Has a simple server that can handle light internal or web traffic.
- Tools are free unlike Microsoft system.
- Can open every application without internet.
- Can be used a low cost developing platform.
- Can be used as a trouble shooting tool.

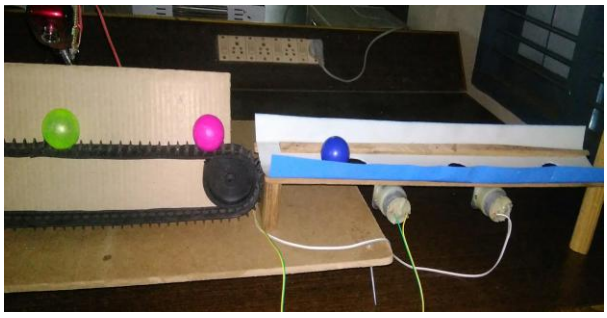
V. Results And Conclusion

The objects are sorted out based upon the calculated color characteristics[2]. We have used a Linux based board called raspberry pi, interfaced with USB camera to capture the images of the objects and store them. The stored images will be processed for calculating their color characteristics by using fundamental digital image processing techniques. The results will the pre-known values in the case of it's use in any industrial processes.

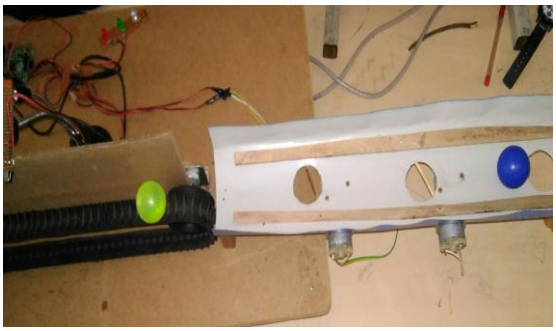
12) Conveyor belt, Raspberry pi and camera interfaced together



13) During color details extraction



14)For blue color



15) First two paths are closed indicating that object is neither red nor green.

16) For red first path is closed indicating that object is not green.

The entire working process can be summarized as below:-

- Switch ON the power supply for Raspberry pi which in turn drives the conveyor belt, motors and USB camera.
- If objects which are to be sorted out are placed on conveyor belt IR sensors will detect them and converts the camera from video mode to image capturing mode.
- Thus obtained imaged will be processed and color computed.
- Motors are driven according to the result of major color component in the image.
- Hence the objects are sorted out automatically basing upon their color characteristics.

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