

Robotic Jaw for Object Sorting using Raspberry pi

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Abstract : Robots are nowadays most often used which gives the same result each time as opposed to the human. The object sorting robot which is costless, fastest, and most valuable in terms of saving money and labor. To sort a bulk of object in quick time also the weight is greater than what a human can carry. By implementing project we are trying to reduce human labor by making the work automatic by using robotic arm, thus making work simple and consuming time. The speed and the accuracy of the sorting processes is increased. The cost is considerably reduced.

We are making use of the robotic arm which is capable of detecting and placing in specified object. The robotic arm detects the pre-defined object and segregates them based on the RGB color. The aim of the system is to detect the object based on color and sort them accordingly.

Keywords: Robotic jaw for object sorting, Robotic jaw, color detection, object sorting, color detection with raspberry pi

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I. Introduction

In today's scenario, the robot with high accuracy, high output, and no error is in demand, the precise work or repetitive work is better done with robots, for the robot the sensor or camera is common sense for the machine like image processing to detect and identify an object and its characteristics which helps to perform a required task. A robotic arm can decide the object based on color like Red, Green and Blue using camera and image processing in Raspberry pi.[5]

To determine real time and highly accurate characteristics of small objects in a fast flowing stream would open new directions for industrial sorting processes. The present paper relates to an apparatus and method for classifying in and sorting small-sized objects. In today's scenario, the robot with high accuracy, high output, and no error is in demand, the precise work or repetitive work is best done by robots, for the robot the sensor or camera is common sense for the machine-like image processing to detect and identify an object and its characteristic which helps to perform a required task. A Robotic arm can decide the object based on color like Red, Green, and Blue is using cameras and image processing in raspberry pi. The main aim of the project is to make robot that has the capability to pick a pre-specified object and place it in separate divisions based on color. Raspberry Pi has found its way in many useful implementations in robotic systems. The python code has been formulated for creating a robotic arm with image processing and to adjust servo motor position manually[5]. For the industrial purpose, the robotic arm can help to separate the object based on color with a good frequency.

A webcam is a video camera that feeds its image in real time to a computer network.[7] Unlike an IP camera (which uses a direct connection using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable or similar cable. Digital Image processing, means to convert an image into digital form. Image processing involves conversion of RGB colored image into gray scale images, setting threshold levels to remove noise from the binary image.

A robotic arm is a type of mechanical arm usually programmable having similar functions to a human arm.[8] The robotic technology provides human-like dexterity in a variety of environments. Additionally, the robots turn out a more consistent product at a significantly cheaper cost than can humans. Robots can do a lot of work more efficiently than human beings because they are so fast and precise. They also have significantly reduced worker injuries, including repetitive stress injuries and more significant mishaps that can do major harm. Robots can work around the clock with a minimum of human supervision. A robotic arm is a type of mechanical arm usually programmable having similar functions to a human arm. The arm maybe a part of mechanism or part of a complex robot. The robotic hand can be designed to perform any desired task such as gripping, spinning, etc.

The ultrasonic sensor is used for measuring distance by using ultrasonic waves.[6] The sensor head emits an ultrasonic wave at a frequency too high for humans to hear and receives the wave reflected back from the target object. Ultrasonic sensors measure distance to the target by measuring the time between the emission and reception.

II. Literature Review

In this section , we will look at several similar systems that are been researched and implemented by other researchers for further understanding on their methods and techniques , refer to the reverence page at the end of this report to search or text or even websites published.

In 2017, Asra Anjum *et.al.* [1] has proposed the system in which object sorting process was done manually. However, this method has some disadvantages such as increase in the cost of the product, slow performance, and inaccuracy due to the human mistake. Existing sorting methods use set of inductive, capacitive and optical sensors to differentiate color. They measure color, based on RGB color model. A large percentage of the visible spectrum can be created using these three colors but the disadvantages of this kind of system is sensor sensitivity range or effect of environmental conditions. In some existing systems of sorting, objects are placed on conveyor belt and according to movement of belt, objects get sorted. The main drawback is only detection and tracking of green object is done and only green colored objects are being sorted.

In 2018, Hemalatha *et.at.* [2] have made a robot capable of surveillance and also with an alternate application in detecting and following a pre specified object. The robotic arm is controlled by a microcontroller based system which controls the DC servo motors. The recognition and detection has been done using open CV library. Raspberry pi is more useful in real time projects. The main aim of project is to make a mobile robot capable of following a pre specified object and also can be used as a surveillance robot. Raspberry pi has found its way in major in number of useful applications in robotic systems.The main drawback is use microcontroller was being used. A microcontroller that can run one program at a time ,over & over again.

In 2015, Trinesh T M *et.at.*[3] have endeavored mechanical moving distinctive sorts of automated arms are being created. These arms are too excessive and complex because of the many-sided quality and the manufacture process. The vast majority of the automated arms are intended to handle rehashed occupations. In configuration of the mechanical are diverse parameters are to be taken consideration. The configuration of mechanical structure with enough quality, ideal weight, burden bearing limit, pace of development and kinematics are critical parameters. In electronic outline the detail of the engines, drives, sensors, control components are to be considered. In the product side the re configurability, client interface and execution and similarity are to be considered. In straightforward term, the reference sources underscore on couple of angles like sorting of diverse shaded articles should be possible by utilizing camera, yet here in this task deals with sorting of both different colored objects and different length and size objects with the help of advanced color sensor TCS34725FN.

The objects with different color can be identified by using advanced color sensor & object with different size also can be identified by array matrix..All the objects are picked and placed by pick and place robot with efficient manner.The time and cost of invesment is very low as compared to other robot.The both color and size of the object can be identified.Main drawback of the system is that objects with different size can be identified by array matrix.

In 2017, Yayati Dandekar *et.at*[4] have proposed the system to make use of a microcontroller ,5 servo motors, a gripper mechanism, an ultrasonic sensor and openCV for color sensing of the object and a mechanical arm assembly to support this components .The assembly is fully custom made and hence much cost effective.

The arm should be able to sense the predefined colored object from the given set of the objects. Gripper should be able to grip the particular object by using the coordinates. The arm should be able to pick and place the object on the particular box according its color. Arduino is a microcontroller motherboard. A microcontroller that can run one program at a time ,over & over again.

III. Research Methodology

Following is the architecture for the project. The color detection of the object and image processing is done using Raspberry pi. The ultrasonic sensor calculates the distance using its transmitter and receiver. The web camera senses the object and gives the results to the pi. After taking the results from the raspberry pi and the sensor, the robotic arm moves accordingly and picks and sorts the objects in their pre specified position.

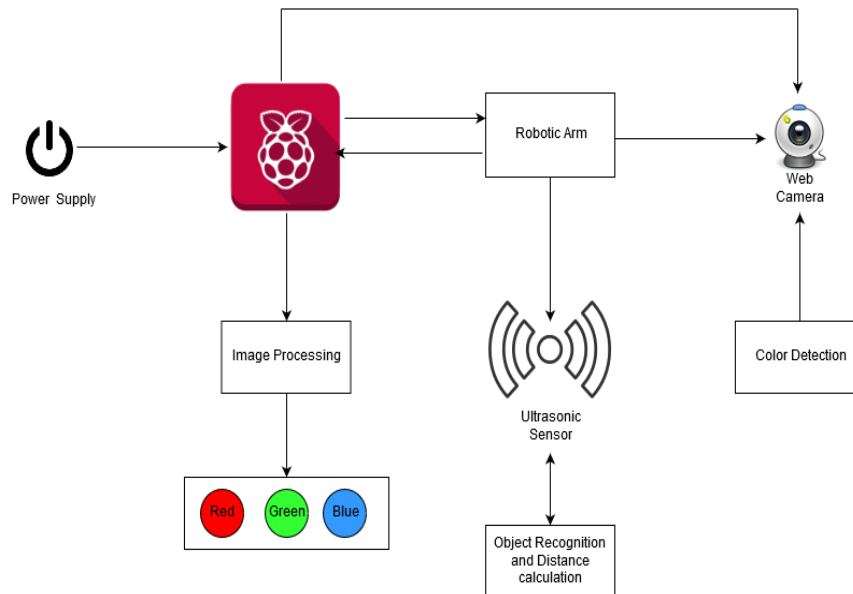


Fig.1. System Architecture

The proposed system is divided into following phases:

A. Phase 1:

In this phase color detection of object using Raspberry pi with the help of USB camera is done. Installation of Open CV library for image detection is done. Run `bash install-opencv.sh` command on the terminal to download OpenCV from the official site. Installing OpenCV may take a long time due to the packages to be installed and the compilation process. Numpy library is installed using `sudo pip install numpy`.

In order to perform runtime operations, the device's web camera is used. To capture a video, we need to create a VideoCapture object. Its argument can either be the device index or the name of a video file. Device index is just the number to specify which camera to be used. Normally one camera will be connected, so we pass value as 0. This can be selected by passing 1 and so on. After that capture frame-by-frame. The infinite loop is used so that the web camera captures the frames of every instance. After capturing the live stream frame by frame, we convert each frame in BGR color space to HSV color space. There are more than 150 color-space conversion methods available in OpenCV. But we are considering two which are most widely used, BGR to Gray and BGR to HSV. For color conversion, we use the function `cv2.cvtColor(img, cv2.COLOR_BGR2HSV)`. We can use this for extracting a colored object. The range of each color is specified in their specified range. Masking technique is being used basically creating some specific region of the image following certain rules. Mask is a filter. A mask is being created that comprises of an object in different colors.

Whenever an object comes in front of the camera, the object is detected according to Red, Green, Blue colors. This happens with the help of image processing.

B. Phase 2:

In this phase, the working of Robotic arm is done to move the arm front and back, with the help of Raspberry pi. Raspberry pi will instruct the Robotic arm to move and pick the object and put in its specified position. It is programmed in such a way that the ultrasonic sensor is attached to the robot on its top. The sensor will sense the object, and calculates the distance of the object placed. Ultrasonic sensor is an instrument that measures the distance of an object using ultrasonic sound waves. It uses a transducer to send and receive ultrasonic pulses that relay back information about an objects proximity. High frequency sound waves reflect from the obstacle to produce distinct echo patterns. This sensor is reliable in any lighting environment and can be used inside or outside. Ultrasonic sensors can handle collision avoidance for the robot and being moved often, as long as it isn't too fast. It consists of one or more ultrasonic transmitters, a receiver and a control circuit. The transmitters will emit a high frequency ultrasonic sound, which bounce off any nearby solid object. Some of that ultrasonic noise is reflected back and detected by the receiver on the sensor. The return signal is then processed by the control circuit to calculate the time difference between the signal being transmitted and that being received. This time can be used to calculate the distance between the sensor and the reflecting object.

When the robotic jaw senses the object with this ultrasonic sensor, it moves near to the object and the jaw opens. Once the jaws are opened, it picks the object and takes to the desired position. With the time it takes for the signal to travel to the object and back again, we can calculate the distance using the following formula :

$$Speed = \frac{Distance}{Time}$$

C. Phase 3:

All the hardware and software will be ready to do the whole working. When three colored balls are placed in front of the Robotic arm, the camera will detect the colors red, green and blue and the sensor will calculate the distance. Based on that the robot will move forward to pick the balls and after picking, it will go to the specified location to place it. In this way the sorting of different colors can be done.

IV. Result and Analysis

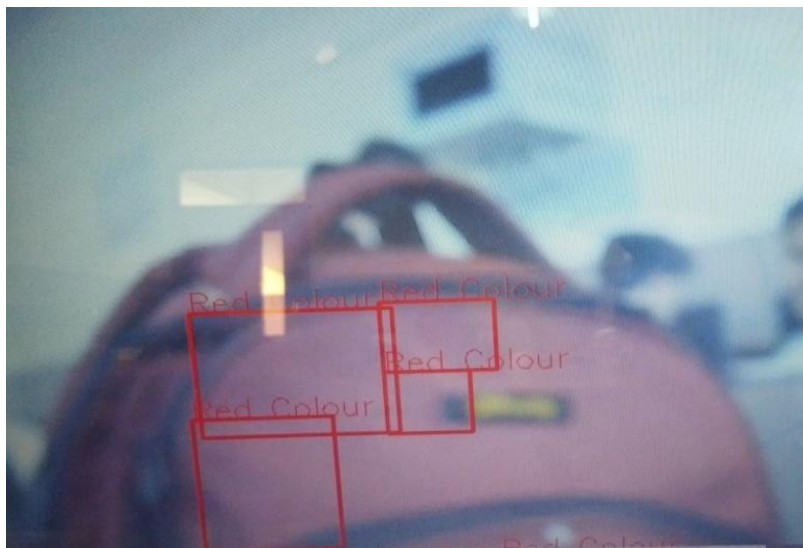


Fig.2. (a) Snapshot of Color Detection



Fig.2. (b) Snapshot of Color Detection

The Raspberry pi is connected to the laptop with a USB cable. A free and open source application called Putty is used to run Raspberry pi on laptop. The pi is connected to USB camera. Open CV (Open Source Computer Vision Library) is installed on Raspberry pi for image processing. Whenever an object is placed in front of the camera, the camera detects color of the object as written in the code. Here, in the code, we have mentioned red, blue, yellow, white and black colors. Whenever these colors are detected by the camera it is shown on the screen. Morphological operator, dilation is used on the image generated by the camera. Hence, color detection is done with the help of image processing.

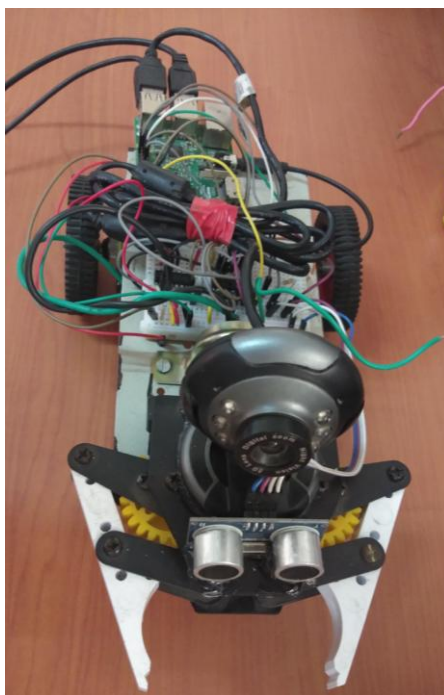


Fig.2. (c) Robotic Jaw

This is the model of the robotic jaw connected with raspberry pi and USB camera. The robotic jaw senses the object with the help of ultrasonic sensor. It detects the object as well as the color of the object and accordingly moves near to the object to do its sorting. The jaw, after detecting the color, picks up the object and takes it to the specified position. The distance for every color object is pre specified in the code.

V. Conclusion and Future Scope

This proposed system gives better results when compared to the earlier existing systems. Identification of colored object by the robotic arm can be controlled automatically for industrial purpose. The arm can segregate among three colors to pick and place it accordingly. This system has been effectively designed to handle the required task. It can identify the specific color of the object and pick it and place it in a specified area as the user wants with the help of RGB values by detecting the color of the object.

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