ROBOTICS AND ITS APPLICATIONS (CSE 3011)

J COMPONENT REPORT

OBJECT SORTING BASED ON COLOUR DETECTION ON CONVEYOR BELT

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1. Abstract:

We have proposed a project to separate the objects from a set according to their colour. This can be useful to categorise the objects which move on a conveyer belt. The proposed method of categorization is based on colour of the object.

Shading and shape is one of the most significant highlights of a picture or object. If shading in a live video or in a computerized picture can be identified and processed, at that point the consequences of this recognition can be utilized in different modern applications. In this project Image handling tool compartment is utilized for recognition of a specific shading and colour in a given object. Picture Processing Toolbox gives wide assortment of referenced calculations, strategies and applications for picture handling, perception and division. Image Processing is most regularly utilized stage for execution of a picture based calculation. A picture can be spoken to utilizing many shading models like dim scale, RGB, HSV, CMYK and so forth. Here RGB model is utilized to distinguish the hues in a picture. RGB model is a shading model in which red, green and blue lights are included in different approaches to create wide scope of hues. Shading and size is the most well-known element to recognize objects, arranging, perceiving and following the parts. Picture preparing catches a two- dimensional picture as the contribution of a framework and creating an adjusted picture. Picture handling is a kind of sign allotment, which yields as a picture or gives qualities related with that picture.

Picture handling fundamentally incorporates 3 stages :

(a) Importing the picture with a camera

(b) Observing and controlling the picture which incorporates information pressure and picture improvement and finally

(c) Output can be decision or action that depends on picture examination. The Image preparing methods are modest and are less tedious.

2. Problem Analysis:

The automatic sorting system has been reported to be complex and a global problem. This is because of the inability of sorting machines to incorporate flexibility in their design concept. The fundamental point of this task is to improve how various items produced in industries are sorted upon production. Items are put on a solitary conveyor for their appropriate circulation in an irregular arrangement which are sometimes sorted using human resources or by using machines containing IR/Ultraviolet sensors to detect the items. These techniques are not much reliable as they do not provide much accuracy and efficient results as well as are time consuming.

Therefore, we need an object tracking process for a conveyor system which is accurate and fast enough to support a real-time environment.

To improve this procedure, images caught by the web camera can be prepared with picture handling strategies utilizing programming like MATLAB. This picture handling procedure and shading location strategies are applied for the taken picture and the correct yield is acquired in this undertaking. It points in sorting the articles by shading and shape, which is going ahead the transport by picking and setting the items in its particular characterized place, In this way disposing of the convoluted work done by human, accomplishing exactness and speed in the work.

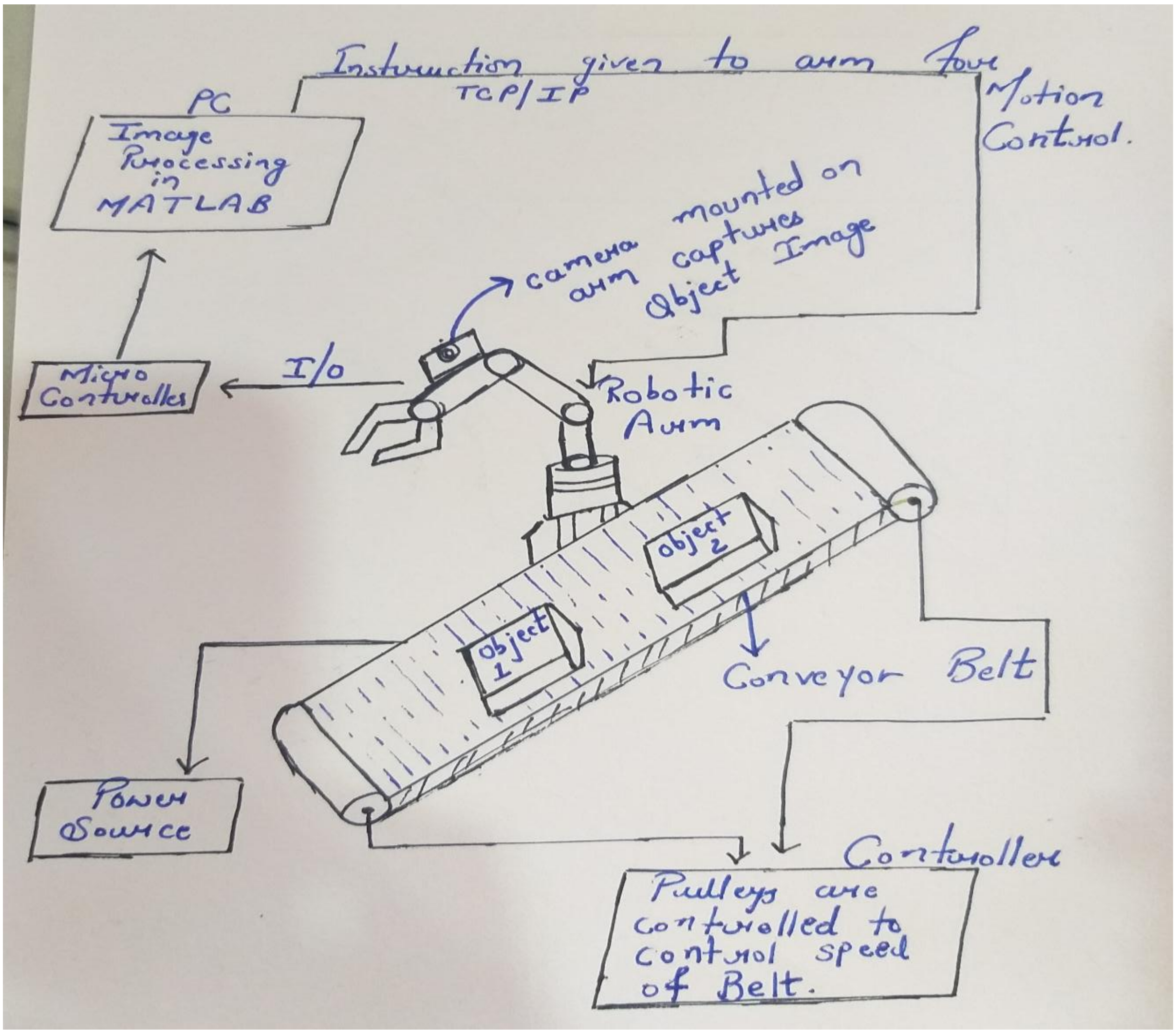
3. Existing system:

Robot conveyor tracking is a task in which a robot follows and obtains objects on a conveyor belt. Currently, a system exists where the object sorting using a robot has been tested. The developed automated sorting machine is able to incorporate flexibility and separate species of non-ferrous metal objects and at the same time move objects automatically to the basket as defined by the regulation of the Programmable Logic Controllers (PLC) with a capacitive proximity sensor to detect a value range of objects. The result obtained shows that plastic, wood, and steel were sorted into their respective and correct position with an average, sorting, time of 9.903 s, 14.072 s and 18.648 s respectively. The proposed developed model could be adopted at any institution or industries, whose practices are based on mechatronics engineering systems. But it has several drawbacks. Prior to obtaining an object from an automation line, this robot needs information about the object, such as its position, orientation, velocity, size, etc. It uses ultrasonic sensors and infrared ray sensors to gather the information about the object on the conveyor belt. It has several steps such as obtaining an image, recognizing objects, and extracting information for object position and orientation. The elongated process makes the task time consuming and cumbersome. Also the life of the this robot is short-lived and has failed to attract much attention.

4. Proposed system:

The object tracking process for a conveyor system should be fast enough to support a real-time environment. This is a project to sort hued and diverse molded items with an automated arm. We have a mechanical arm which picks distinctive hued 3D squares and sorts them setting in various boxes or holders. The recognition of the specific shading and shape is finished by a light power to recurrence converter technique. The mechanical arm is constrained by a microcontroller based framework which is controlled by DC servo motors. This robot is utilized for picking up the article from one spot and spot that particular objects in required boxes based upon its shading. Some mechanical works are hazardous for people. This robot is predominantly utilized to lessen the hazardous procedure and devouring time and stay away from such works. It is comprised of microcontroller, DC servo motor and shading sensor. The arm's end, reflector, is fit for picking and discharging both wet and dry items. PC vision is completed with help of Open CV and the automated arm, which is motored by microcontroller. Various calculations work in microcontroller, empowers the automated arm to either sort the articles dependent on shortcoming like missing drill openings, ill-advised shape or some different flaws. The mechanical arm utilized in this venture work is utilized to sort the item proceeding onward moving circle. Contingent on shortcomings identified into foreordained classes.

5. Robot Architecture:

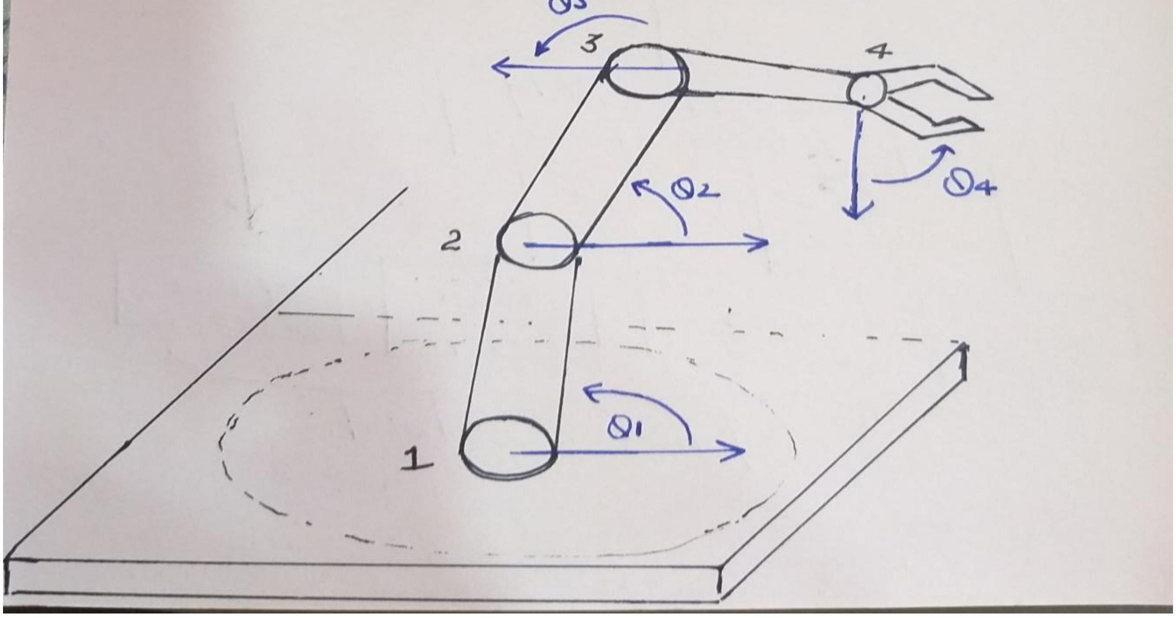


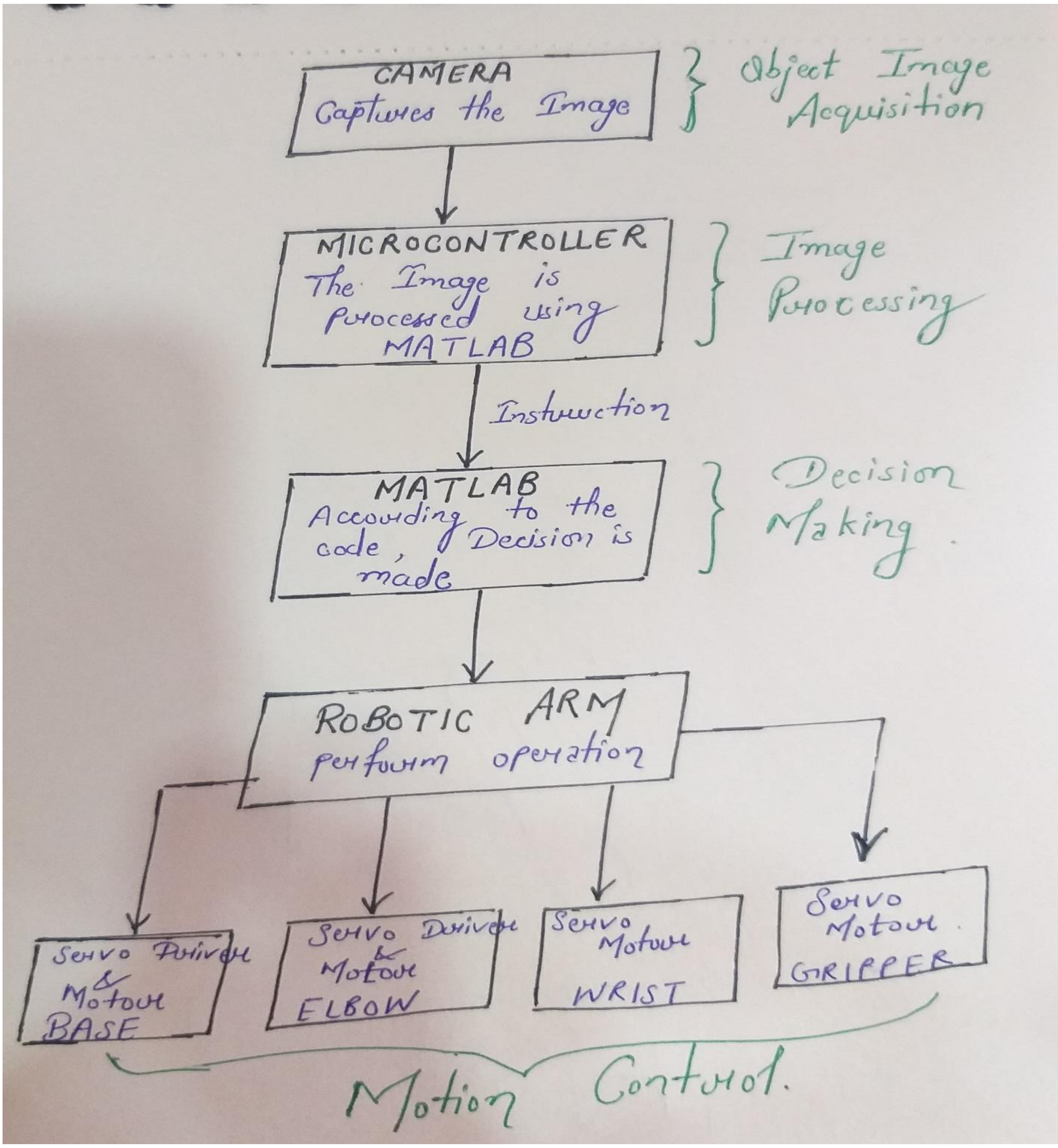
1. Servo Motor at Base
($\theta_1 \rightarrow$ Degree of Rotation of Base and Pole)

2. Servo Motor at Shoulder.
($\theta_2 \rightarrow$ Degree of Rotation of Shoulder)

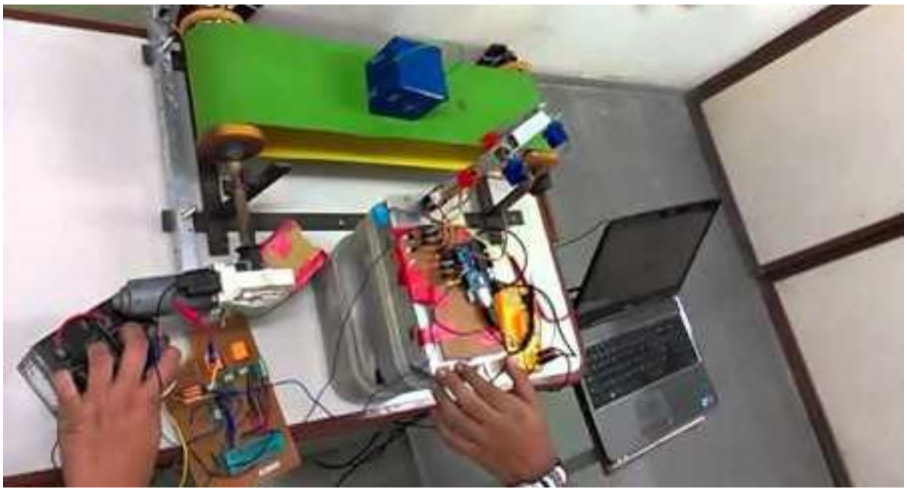
3. Servo Motor at Elbow.
($\theta_3 \rightarrow$ Degree of Rotation of Elbow)

4. Servo Motor at Wrist.
($\theta_4 \rightarrow$ Degree of rotation of Wrist).





MECHANICAL ROBOTIC ARM PERFORMS PICK AND PLACE ACCORDING TO THE GIVEN I/O INSTRUCTION.



PROJECT HARDWARE SETUP

The whole system follows a series of actions that can be divided into four blocks:

- Image Acquisition
- Image Processing
- Decision Making
- Motion Control.

It receives image with a computer-based camera or digital video camera. This device captures the image and sends it to the Image Processing toolbox to convert it into RGB scale.

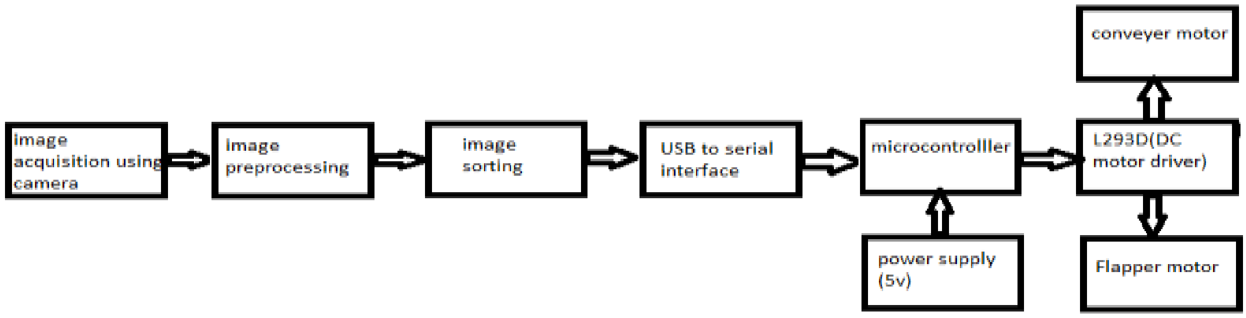
After this it is sent to the processor for further processing.

We have a robotic arm which picks different colored cubes and sorts them placing in different boxes or containers. The detection of the particular color is done by a light intensity to frequency converter method. The robotic arm is controlled by a microcontroller based system which controls DC servo motors. This robot is used to pick the object from one place and place that objects in required boxes with respect to its color. It is build by microcontroller, DC motor and color sensor.

Computer vision is carried out with assistance of Open CV and the robotic arm, which is motored by microcontroller. Different algorithms build in microcontroller, enables the robotic arm to either sort the objects based on Color. The robotic arm used in this project work is used to sort the object moving on moving conveyor belt. It can be improved by using different advanced color sensors and microcontrollers.

6. Work Flow:

- ## Block Diagram:



- ## Image acquisition:

Image acquisition in image processing can be extensively characterized as the activity of recovering an image from some source, generally a hardware based source, so it very well may be gone through whatever procedures need to happen. Performing image acquisition in image processing is always the initial phase in the work process succession because without a image, no processing is possible. The image that is gained is totally natural and is the consequence of whatever equipment was utilized to create it, which can be significant in certain fields to have a consistent baseline from which to work. To begin with the item on the conveyer, image is captured by the camera and is sent to the MATLAB workspace. The input image got from the webcam can't be directly given for processing.

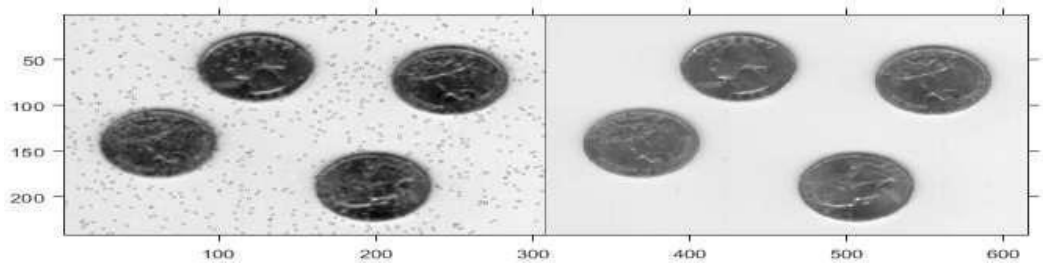
- ## Image pre-processing

Pre-processing is applied on images at the most minimal degree of abstraction and its aim is to diminish undesired distortion and improve the image data which is valuable and significant for further processing. It is generally important and required for improving the performance of image processing techniques like image transform, segmentation, feature extraction and fault detection. Image pre-processing refers to tasks done before a key processing step, such as

1) Filtering 2) colour transforms

- ## Filtering:

Noise reduction assumes a significant job as the pre-preparing strategy in image segmentation. Digital images are inclined to different sorts of noise. Noise is the aftereffect of errors in the image acquisition process that results in pixel values that don't reflect the true intensities of the real scene. There are a several ways that noise can be brought into a image, depending upon how the image is made. For instance: If the image is examined from a photo made on film, the film grain is a source of noise. Noise can likewise be the result of damage to the film, or be introduced by the scanner itself.



- ## Color transformation

In image preprocessing, color transformation is most important. In color transformation, the color image is converted into grayscale image and further it is converted into the binary image
i.e. in black and white image.

- ## Image sorting

After the preprocessing the image data is sent to microcontroller. Program run on image and the desired output sent to sorting mechanism. The sorting mechanism consists of a flapper motor and a conveyor assembly. According to the size and color, the flapper motors with help of linear actuator places the objects in their specified place.

7. Hardware and Software Requirements:

- ## Conveyer Belt

It is a mechanically moving belt, usually made of polyester, used to transport the material. It contains two or more pulleys with a continuous loop of conveyor belt - It rotates about them. The drive pulley covers the drive, the idler pulley is powerless.

- ## The camera

Webcam Intex IT 306WC is used for taking pictures of objects. Matlab uses these images for colour recognition. Items are sorted based on that colour. With a simple clip-on mechanism, we can connect it to a laptop. It is a 8 MP camera; It offers sharp, crisp image quality with 3280 * 2460 image resolution.

- ## Matlab

The system describes visual sensor systems used in the field of robotics for object recognition and tracking. Program design Object detection and capture via PC-based camera using Matlab software. It describes the image capture processing technique, after the introduction of the actual robot application to track objects using the computer's serial COM port. The whole system follows the object can be divided into four blocks: object acquisition, image processing, decision making, and motion control. Receive With a computer-based camera or digital video camera. This device captures the image and sends it to the processor for further processing. Computer. Image processing includes converting RGB colour images to greyscale images, setting thresholds, and setting the cut-off value to remove noise from the binary image. Decision making is done with the help of the software program

- ## The driving unit

The driving unit has a motor connected to the laptop for feedback. The DC motor is a closed loop mechanism that uses feedback to Control its speed and endpoint. The signal that indicates the location of the command for the input output shaft of its control.
We used a 12-Volt DC gear motor to drive the pulley. Polymer bars are used for coupling between the motor and the shaft pulley.

- ## Controller

We are using the **atmega16** microcontroller for our sorting system. It is the brain of our system. It has 40 ports. Each port can display Different types of tasks according to coding.

- ## Mechanical arm

It is used to perform the pick and place operation here. Once the system makes decision it gives instruction to the mechanical arm to the object into particular box.

- ## Electricity Supply

We are using a self-made power supply. The power supply we carry can take 240 volts and convert it into 5 volts and 7 volts.

8. Code

The code has 3 files linked to each other which are collectively used for detecting the color of the image scanned.
The three files are named respectively :

- colorDetectHSV(fileName, hsvVal, tol)
- getHSVColorFromDirectory(dirName)
- selectPixelsAndGetHSV(RGB, Area)

1) colorDetectionHSV file:

```
function colorDetectHSV(fileName, hsvVal, tol)
RGB = imread(fileName);
HSV = rgb2hsv(RGB);
diffH = abs(HSV(:,:,1) - hsvVal(1));
[M,N,t] = size(RGB);
I1 = zeros(M,N); I2 = zeros(M,N); I3 = zeros(M,N);
T1 = tol(1);
I1( find(diffH < T1) ) = 1;
if (length(tol)>1)
   diffS = abs(HSV(:,:,2) - hsvVal(2));
   T2 = tol(2);
   I2( find(diffS < T2) ) = 1;
   if (length(tol)>2)
      difV = HSV(:,:,3) - hsvVal(3);
      T3 = tol(3);
      I3( find(diffS < T3) ) = 1;
      I = I1.*I2.*I3;
   else
      I = I1.*I2;
   end
else
   I = I1;
End
subplot(1,2,1),imshow(RGB); title('Original Image'); subplot(1,2,2),imshow(I,[]);
title('Detected Areas');
```

2) getHSVColorFromDirectory File:

```
function hsvAll = getHSVColorFromDirectory(dirName)

D = dir(dirName);

length(D)

hsvAll = [];

for (i=3:length(D)) % for each file in the directory:

   if (strcmpi(D(i).name(end-3:end), '.jpg')==1) % if current file IS JPG:

      RGB = imread([dirName '/' D(i).name]);

      HSV = selectPixelsAndGetHSV(RGB, 5);

      hsvAll = [hsvAll;HSV];

   end

end
```

3) selectPixelsAndGetHSV File:

```
function hsvMean = selectPixelsAndGetHSV(RGB, Area)

clf;

warning off;

imshow(RGB); hold on;

HSV = rgb2hsv(RGB);

HSV2 = HSV;

numOfSelectedPixels = 0;

right_not_pressed = 1;

BUTTON = 1;
```

```
while (BUTTON~=3)
    numOfSelectedPixels = numOfSelectedPixels + 1;
    [X,Y,BUTTON] = GINPUT(1);
    hsvTemp2 = HSV(Y-(Area-1)/2:Y+(Area-1)/2, X-(Area-1)/2:X+(Area-1)/2, :);
   HSV2(Y-round((Area-1)/2):Y+round((Area-1)/2), X-round((Area-1)/2):X+round((Area-
1)/2), :) = 0;
    hsvTemp = zeros(3,1);
    [K,L,M] = size(hsvTemp2);
    for (i=1:K)
        for (j=1:L)
            hsvTemp(1) = hsvTemp(1) + hsvTemp2(i,j,1);
            hsvTemp(2) = hsvTemp(2) + hsvTemp2(i,j,2);
            hsvTemp(3) = hsvTemp(3) + hsvTemp2(i,j,3);
        end
    end
    hsvTemp = hsvTemp / (K*L);
    hsv(numOfSelectedPixels,:) = hsvTemp;
    hsvMean = median(hsv,1);
    line([X-(Area-1)/2 X+(Area-1)/2] , [Y-(Area-1)/2 Y-(Area-1)/2]);
    line([X+(Area-1)/2 X+(Area-1)/2] , [Y-(Area-1)/2 Y+(Area-1)/2]);
    line([X+(Area-1)/2 X-(Area-1)/2] , [Y+(Area-1)/2 Y+(Area-1)/2]);
    line([X-(Area-1)/2 X-(Area-1)/2] , [Y+(Area-1)/2 Y-(Area-1)/2]);
end
[N, t] = size(hsv);
hsvMean = median(hsv);
```

9. Implementation:

Phase I Object Placement: This is the first part of the system to sort all objects, placed on the conveyor belt. Items of Different sizes and colors should be placed on the conveyor belt. After placing an object on the conveyor belt, start the conveyor for more Processing.

Phase II Image capture: Once an object is placed on the belt, the belt takes a fixed position. The camera used in this case will be overhead and it takes a snapshot of the object for sorting purpose. A real-time image of an object is captured with the help of the camera. The image should be of good quality and send to PC with Matlab software.

Phase III Image Processing: The camera captured image is being transferred to a PC that contains various image processing algorithms which are applied to it.

<u>Key words related to image processing</u>:

- **Pixel:** Pixels are the building blocks of an image. In other words, Pixel is the smallest image you can find on your screen.
- **RGB image:** An image is made up of three basic colours red, green and Blue. Hence itis called RGB image.
- **Binary image:** An image consisting mainly of black and white pixels.
- **Gray Scale Image:** Contains the intensity value ranges from minimal to maximum and between different shades of gray. Generally, this range is between 0 and 255.

First, the image captured by the camera is sent to the PC via a microcontroller, the RGB image is created. It changes to RGB values to Gray Scale Value. This gray level image is converted to binary image using threshold. The simplest method is **threshold**

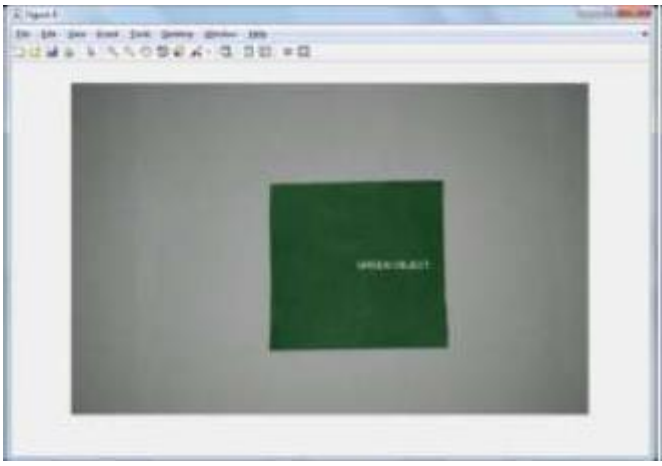
Image separation.

From the scale image, the threshold can be used to create a binary image. Threshold converts each pixel into an image with the black pixel. This converted image is saved as a new image and sorted by object colour using a binary image partition.

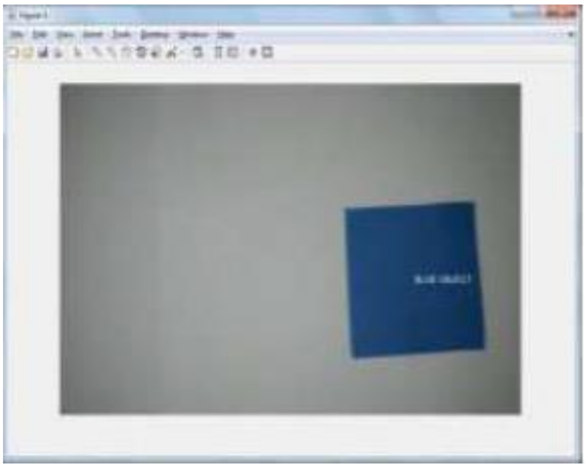
Phase IV Instructions to L293D(DC motor): Once the object is found, the PC sends the command on the dc motor through the microcontroller Conveyor. The motor covers and rotates in a circular motion. By rotating the belt, the object is moved from the camera and purchased in front of flapper. This way the DC motor helps move the sorting object.

10. Result and Analysis:

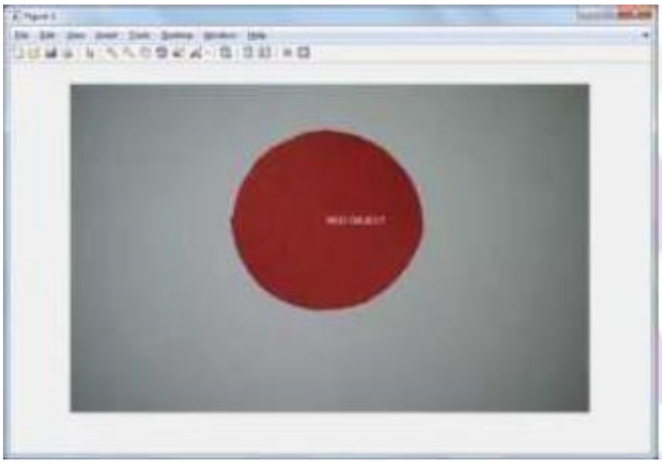
- ### Screenshots:



Detection of Green Colour



Detection of Blue Colour



Detection of Red Colour

- ### Advantages:

1) In small and large scale industries.
2) Time saving by avoiding manual method.
3) Failure rate is low with long life.
4) The speed of operation is high.
5) High productivity.

- ### Applications:

1) The medical and alcohol industry.
2) Food industry.
3) In agricultural machineries.
4) In the application of robotics.

▪ Conclusion

According to this review paper, we conclude that using the image processing application we can easily sort different colour objects like red, blue, green. Using this system time, the amount of time needed to sort items from one to another is reduced compared to the traditional Partition system. It also helps in reducing labour costs, time and energy. It is very useful for small and medium sized enterprises. It Improves accuracy.

▪ Future Scope

- The system is working with open loop. A better resolution can be achieved if closed loop control is incorporated.
- The system responses are a little bit slower than expected. It can be improved by using a more advanced Image processing algorithm such as Convolutional Neural Networks etc. and a better microcontroller.
- A better resolution camera can be incorporated for better image acquisition.

11. References:

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2) Aishwarya RaoDept. of Electronics and Communication Engineering,Vidyavardhaka

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5) Karthik V DesaiDept. of Electronics and Communication Engineering,Vidyavardhaka College of Engineering,Mysore, Karnataka, India
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