

Stochastic Modelling and Computational Sciences

IDENTIFYING AND SEGREGATING ITEMS BY USING IMAGE ANALYSIS AND DOBOT ROBOT

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ABSTRACT

In many manufacturing and assembly plants, workers often experience fatigue when performing repetitive tasks. As a result, their productivity tends to decrease over time, necessitating regular breaks for rest and refreshment. To address this challenge, integrating Dobot robotic systems into assembly lines can effectively analyze and manage tasks, minimizing idle time (commonly referred to as "refreshment time"). This innovation not only boosts production rates but also enhances overall productivity.

Keywords: DOF (Degrees of Freedom), DPDT (Double Pole Double Trough).

INTRODUCTION

In this project, the Dobot operates by capturing images through a camera and employs image processing techniques to detect specific colors within those images. Following the detection process, the processor takes appropriate actions, such as grasping and releasing objects at predetermined locations. This sequence of actions can be repeated seamlessly using a loop.

LITERATURE REVIEW:

Upon reviewing a multitude of research papers and delving into the history of robotic arms, it became evident that various methods have been employed to control their motions. These methods encompass remote control, human gestures, and the utilization of specialized applications like Inventor.

Notably, several YouTube videos have demonstrated the use of a Pixy 2.0 chip to accomplish similar tasks in conjunction with robots [1]. However, this project distinguishes itself by relying solely on a camera and computer for the automation process, eschewing the need for additional hardware or peripherals.

a) According to Manual Control:

In this type, the robotic arm was controlled with the help of various switches, levers, and knobs. The following are some research papers which are as hereunder:

Table No 1: According to Manual Control

Sr No	Research Paper Name	Remark
1	Design, Analysis, and Implementation of Robotic Arm – The Animator	In this paper, the robotic arm was controlled with the help of Double Pole Double Trough Switch (DPDT). It was made in order to co-ordinate with the robotic body [2]
2	Hydraulic Robotic Arm	In this type the robotic arm is controlled with the help of the levers and syringes [3]
3	Potentiometer Control based 5 DOF low payload Robotic Arm	In this project, the servo motors of the robotic arm were controlled with the help of Arduino UNO and potentiometer knobs [4]

b) According to Human Gesture:

In this type, the cameras were used for capturing the human gestures, and accordingly the robotic arm movements are controlled.

Stochastic Modelling and Computational Sciences

Table No 2: According to Human Gesture

Sr No	Research Paper Name	Remark
1	Controlling Robotic Arm using Kinect	The camera (Kinect) is used to capture the frames, thereafter, these frames are then processed by Arduino MEGA and thus controls the servo motors of the robotic arm [5]
2	Robotic Arm controlled by Arm movements	The robotic arm movements are usually controlled by the potentiometers, which are located at the human arm joints, while the gripper is controlled by a flex sensor [6]

c) According to Remote Control:

In this project, the robotic arm movements are controlled with the help of a remote control, and mobile application (Inventor Application).

Table No 3: According to Remote Control

Sr No	Research Paper Name	Remark
1	Wireless Mobile Robotic Arm	In this project, the robotic arm was controlled with the help of PS 2 Remote. This robotic arm has 4 wheels, thus makes it more portable as compared to other robotic arms [7].
2	Robotic Arm control with Arduino	In this project, the robotic arm movements are controlled with the help of inventor application. Here the communication takes place with the help of Bluetooth module which receives the signals from the mobile and then transfers it to the controller Arduino Nano and thus controls the robotic arm [8]

d) According to Application:

In this type, the various projects are usually made for specific applications, such as for pick and place applications, and working in hazardous environments.

Table No 4: According to the Application

Sr No	Research Paper Name	Remark
1	Design, Fabrication and Control of Articulated Robotic Arm	This project was usually made for educational purpose (pick and place application). This robotic arm has 6 DOF and is generally made up of acrylic and aluminum for making it light weight [9]
2	Design and Structural Analysis of Robotic Arm	This robotic arm was specifically designed for sheet metal pick and place application in small area. The multiple suction cups were used for firming the sheet metal in proper place [10].
3	Review on Design and Development of Robotic Arm	This robotic arm was generally made for performing pick-and-place tasks in hazardous environments. The servo motor motions of the robotic arm were usually controlled with the help of Arduino UNO [11].

Stochastic Modelling and Computational Sciences

METHODOLOGY

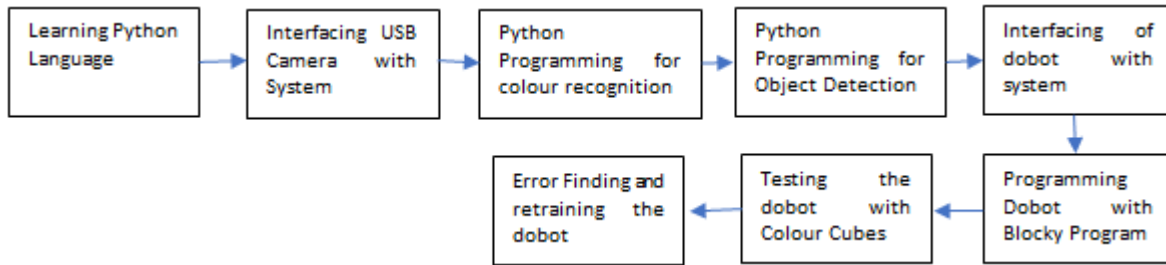


Fig 1: Flow Diagram of Methodology

At the outset, during the project's exploratory phase, extensive research papers shed light on the wealth of knowledge already accumulated in this field. Subsequently, the project advanced incrementally, commencing with the initial steps outlined above. These early stages encompassed the initial interfacing with the Dobot robotic system, followed by the development of a block-based programming code. This block-based code primarily leverages color recognition algorithms in its backend to discern the color of a placed object. Once the color determination is complete, the Dobot executes a predetermined sequence of movements, efficiently relocating the object to its designated location

RESULTS AND DISCUSSION:

a) Interfacing of Dobot:

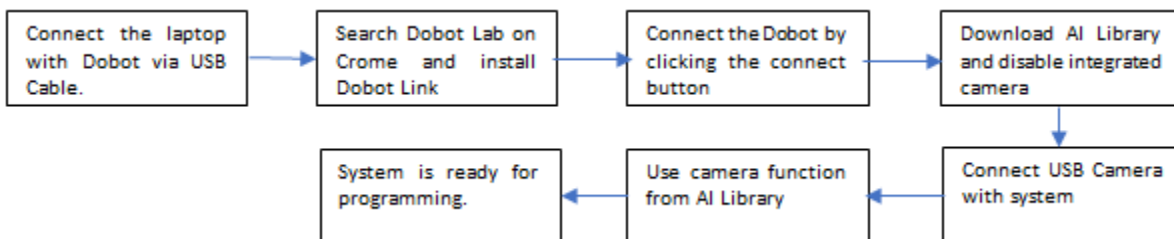


Fig 2: Flow Diagram of Interfacing of Dobot

Connect the dobot with the system, then browse dobot lab, and register in there. Then a link will pop up for installing dobot link, this enables the dobot to be access from any place, also it automatically detects the dobot if it is linked to system via USB cable. Thereafter, downloading the AI library enables the dobot for performing machine learning activities. Now the system is ready programming.

b) HSV Color Code:

HSV color space is mostly used by the computer systems, as this exactly mimics the colors, in the same manner as our human eyes.

1. Hue (H): It is a range of color stating from 0-179.
2. Saturation (S): This implies how much dark the color is, its ranges from 0-255.
3. Value (V): It provides the brightness for the color, it ranges from 0-255.

Converting the output from BGR to HSV

It is important because the camera captures the image in BGR format while the system understands the same in HSV format. This is because the HSV color space stores the different intensities light images one space, whereas BGR stores the information separately for each change in intensity of light or darkness.



Fig 4: HSV Color Code Result

c) Color Recognition:

In this context the camera is used for capturing the image, while this code grabs the raw images and identifies the color of the object through center pixel. Then shows the color of the same pixel on the left corner. For doing so this code uses the HSV code and its different hue values for identifying the color of the center pixel [12].



Fig 4: Color Recognition Result

d) Object Localization:

It is the process of identifying and creating the bounding boxes over the frame or image. Thus locating the objects in an image [13].

$$\begin{bmatrix} P_c \\ B_x \\ B_y \\ B_w \\ B_h \\ C_1 \\ C_2 \end{bmatrix}$$

Fig 5: Output Matrix

Here,

P_c = Probability of class

B_x, B_y, B_w, B_h = Co-ordinates of the center

C_1, C_2 = Classes

Stochastic Modelling and Computational Sciences

It is a difficult task for detecting 2 or more objects in an image, as this will create a confusion in creating the bonding boxes over the objects in an image, in this situation two or more bonding boxes are created over the image. In order to avoid this problem the intersection over union principle is which is as hereunder:

Intersection Over Union = Intersection Area

Union Area

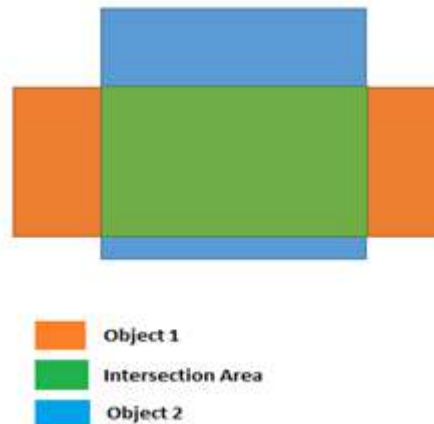


Fig 6: Intersection Over Union

Suppose if there are 2 bonding boxes which are created over one object. Then the area of the both the bonding boxes (Union Area) will be taken by the neural network algorithm. Thereafter, the common area will be taken by the neural network algorithm (Intersection Area). Then after the a division of both the values, will set a mean value. This mean value acts as a confidence level for those 02 bonding boxes which were appeared over a single object. This will enable bonding box to appear whose confidence level way higher than the mean value. This, is how the neural network algorithm allows the of one bonding box over one image. Thus, the remaining bonding boxes whose value is below the mean value are not appear over the single object. In this way the Intersection Over Union restricts the creation of the bonding boxes over one object [14].

e) Object Detection:

It is a technique of teaching the computer system, to detect the objects in an image or videos, with the help of intense learning and machine learning algorithm, in the similar manner what naturally comes in a human mind [15]



Fig 7: Object Detection

Stochastic Modelling and Computational Sciences

Code:

In this code the caffe model is used for detecting the objects, it usually detects 21 different objects like mobile, television, bike, bicycle and other. In this code the confidence level is 40%, it enables the creation of bonding boxes if their confidence level is above 40%. Also it will create (7 x 1) matrix for each detected object and the same is as under [16]

[0 classes confidence upper_left_x upper_left_y lower_left_x lower_left_y]

Where,

Classes: Different objects

Confidence: Confidence of detecting correct object

Upper_left_x, y & Lower_left_x, y : Co-ordinates of bonding boxes in an image

f) Blocky Programming:

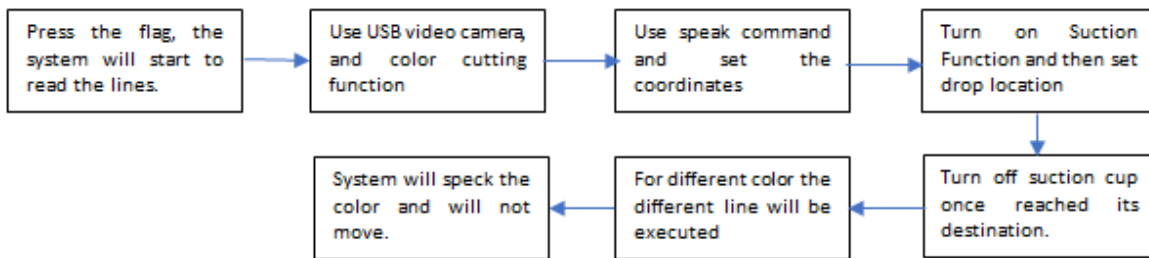


Fig 8: Flow Diagram of Blocky Programming

When the flag is pressed, the system starts to execute the lines, one by one. Then the USB camera turns ON and grabs the images in the image. Then the program detects the objects in the image. The speak command the system interacts with the user in the set language, and also speaks the color which is recognized. Once the set color is recognized, then the program lines of the particular color gets executed. Accordingly, the dobot moves in the through the set coordinates as per program. When the dobot reaches its pick up location, suction function turns on, and picks the object from pick up location. Further, when the dobot reaches its destination then after the suction function turns off, and the object gets placed at the respective location. If the another color is detected the program runs the another set of lines, and collects the different color object from the same location but delivers the object to different location (As mentioned in the Program).

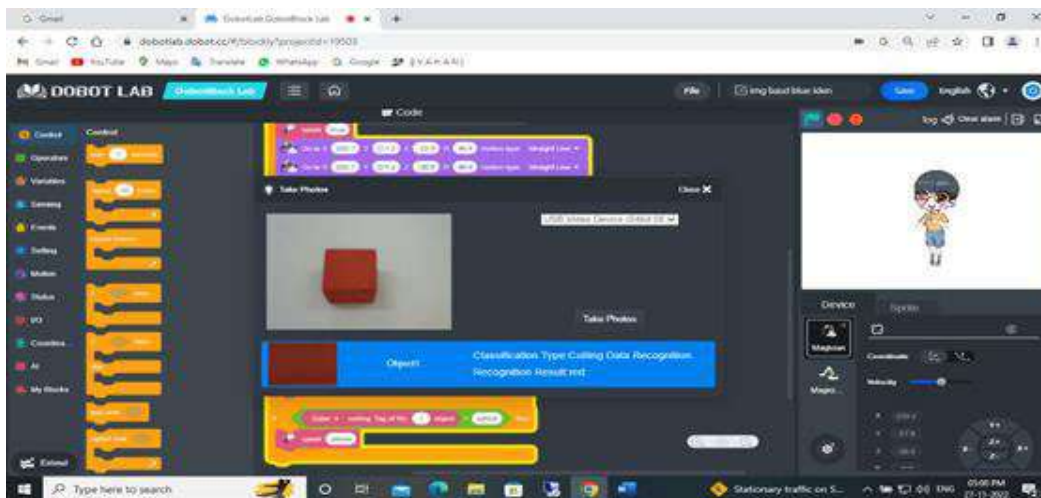


Fig 9: Color Recognition by Blocky Program

Future Scope:

a) Neural Network:

It is a method in Artificial Intelligence that teaches the computers to process the data in the way that naturally comes in the human brain [17]

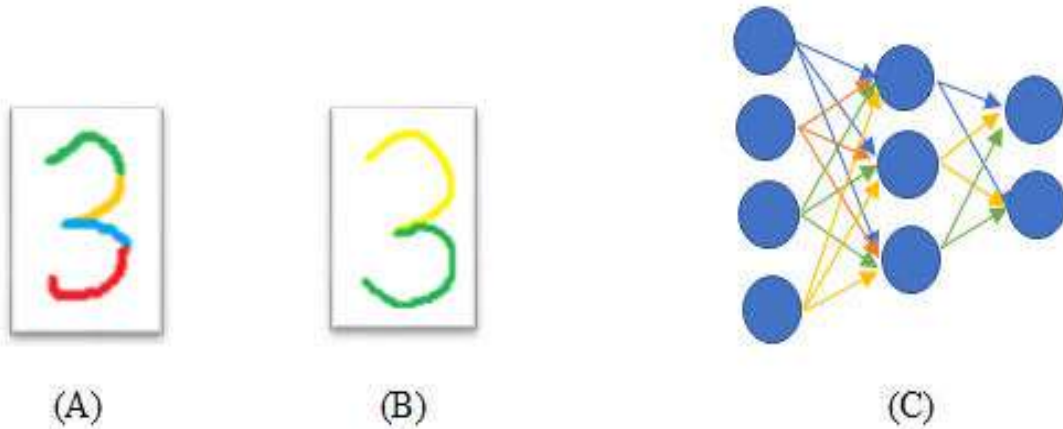


Fig 10: (A) Small Pieces (B) Pattern Forming (C) Neural Network

It usually divides the image into number of pixels, and the different layers inside the neural network combines the different pixels into patterns and those patterns then forms a final pattern in the output layer, and then declares the result [18].

b) Coding in Colab:



Fig 11: Coding in Colab

By using this program, the custom object detection can be carried out. It requires more than 100-130 images for training and testing the dataset. All the images must be labeled with bonding boxes, these bonding boxes will create the text files containing the pixels values for creating the bonding boxes. Once the training and testing data gets prepared. After then execute the same to the drive.

Thereafter, the execution the will make the changes inside the darknet53.conv.74 file. This will then create a yolo file in the google drive, after fetching the training data inside the respective file for the custom classes.

By infusing this file inside the object detection program will make the make the program to detect the custom objects. But this program requires more time if more layers are needed to be added inside the yolo file, also processing power required will also be high to run the program [19].

```

cd /content/drive/My Drive/yolo
/content/drive/My Drive/yolo
!python custom_data/creating-files-data-and-name.py
!python custom_data/creating-train-and-test-txt-files.py
!darknet/darknet detector train custom_data/labelled_data.data darknet/cfg/yolov3_custom.cfg custom_weight/darknet53.conv.74 -dont_show

CUDA status Error: file: ./src/dark_cuda.c: ( ) : 1106: 38 : build time: Mar  4 2022 - 15:00:53
CUDA Error: no CUDA-capable device is detected
Darknet error location: ./src/dark_cuda.c, check_error, line #69
CUDA Error: no CUDA-capable device is detected: Bad file descriptor

!darknet/darknet
usage: darknet/darknet <function>

```

Fig 12: Error in generating of train yolov3 file

c) Application:

The robot can be used for the following applications, and the same is as hereunder: [20]

1. Measurement:

This project can be modified, for checking the spark plug gaps in production line. The same can be done by setting the specified measurement limits at the input.

2. Counting:

This project can be upgraded for counting the number of pieces in the package. Thereby removing the affected pieces from the production line.

3. Location:

This project can be improved, by changing the color cutting function to shape cutting function, in the this project and thus we can locate the different shaped objects in a particular spot, and can remove those objects from the production line.

4. Medical:

This project can also be used in medical applications, such in a process of Stereoelectroencephalography procedure. Wherein the surgeon marks the trajectory points on the patient head virtually. While a robotic arm (Neuromate) is been used for performing the task of just showcasing the trajectory points accurately on the patient head [21].

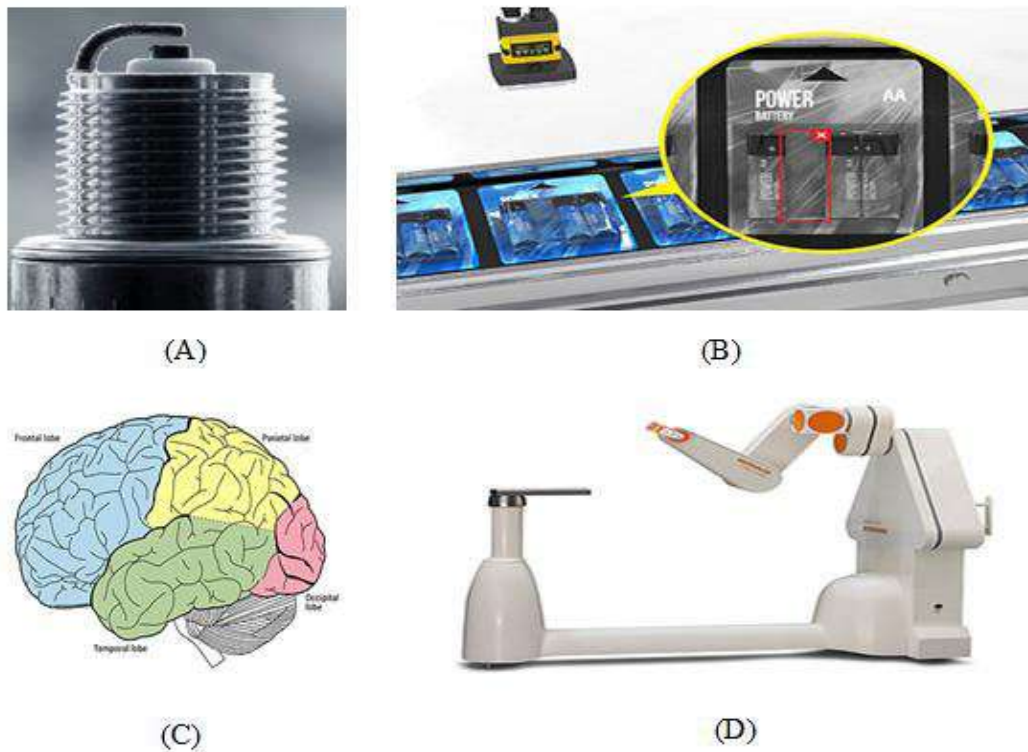


Fig 13: (A) Spark Plug (B) Counting of Objects (C) Brain Lobes (D) Neuromate [22] [23] [24] [25]

CONCLUSION

In this project, blocky programming was mainly used for controlling the dobot movements, but the rest of the program generally depicts the block program back-end process. The color recognition python program (Color cutting function) is generally runs in the background, which recognizes the color and fetches the information to the controller. Once the color is recognized, then after the particular set of program lines (containing motion instruction) are executed as per the recognized color. Then this controller (System), instructs the stepper and servo motors of dobot. This causes the dobot to move which makes the dobot for picking up the color cube from a specific location, and then places the color cube at the another location.

In this project, only color cutting algorithm was used for detecting the different colors. However, in future the same program can be even used for the detecting the different shapes, just by changing the color cutting function to shape cutting function. This function will enable the dobot to detect the objects of different shapes. Thus will help in detecting the irregular sized objects in production line

This project was generally prepared for helping the quality engineers for reducing their task of quality checking especially identifying the incorrect items and segregating the items from the assembly lines, and thus obtaining consistent output throughout the process.

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Stochastic Modelling and Computational Sciences

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