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# Touchless System for Fruits Sorting and Packaging in Shops

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***Abstract:*** *The time required to discover the product and ready with inside the lengthy queue for checkout of the shops is a common problem in our everyday lives. The automatic shop is the answer proposed to such problems. These shops are significant for each financial and social development because it reduces the efforts of guide operation and is time-saving. This system is a need of an hour these days since Covid-19 denies us to make direct contact with fruits or vegetables. Now-a-days deep learning gives evolution with brilliant performance in object detection. This paper gives solution as, robotics based totally automatic shop which uses deep learning to classify the products which helps to save our efforts and time. The Mobile-Net is used to detection of fruits on 2 classes with 85% accuracy in detection. Robotics combined with virtual technology inclusive of picture detection, cloud and analytics, makes the structures correct and supplies more modern efficiencies.*

***Key Word****: Image Detection, Deep learning, Robotics, COVID-19*

## I. Introduction

The customer satisfaction is a key to achievement of any business. Along with customer satisfaction, customer safety is also important during this pandemic time. The proposed system helps in store automatic and ensures zero contact of customers with the products. The conventional strategies to sell products and take its charges included less precision, more time consuming and loss caused by damage to respective product. To do away with this, we've added the Touchless system for fruit sorting and shipping with inside the stores. To avoid this direct contact of fruits with consumer, this robot hand proposed will select out the favored fruit in ordered quantity. The robotic hand or this human Touchless system which is crafted using deep learning modules will run according to the sales person and satisfy all the needs of customers. This will reduce the time consumed by manual interference and will increase the precision. The touchless system proposed promotes sustainability.

## II. Literature Survey

Author Dr.A. Brintha Therese [1] proposed the concept to create a Robotic arm with real time image processing techniques. The system can either be automated or operated manually. The software implementation is done using python and the hardware implementation is done using raspberry pi module. The methodology follows detection of the pre-defined object by the robotic arm and then segregating on bases of color (RGB). The program written includes controlling the robotic arm and identifying the object.

Author Mohd Ashiq Kamaril [2] proposed the development of wireless mobile development arm. The pick and place operations are controlled by Wireless PS2 controller. The Arduino Mega Platform is used for the development of this project. To know the performance of the system some key parameters such as load, speed, distance is studied. The main objective of this idea is to pick and place hazardous objects fast and easily without the user actually touching it.

Author S. Premkumar [3] proposed an experiment which mainly aims to achieve collaboration between the gripper mechanism and vaccum sucker mechanism. By combining these two mechanisms the simple pick and place action is achieved. The resultant robotic arm can perform various actions like gripping, lifting, releasing. The proposed system is user friendly and can majorly used in glass handling mechanisms.

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Author M. Cianctietti [4] proposed an interesting robotic arm. This idea was inspired by the octopus's arm and its complex behavior. In this experiment the key features studied were the patterns of movements like elongation, bending, reaching, etc.

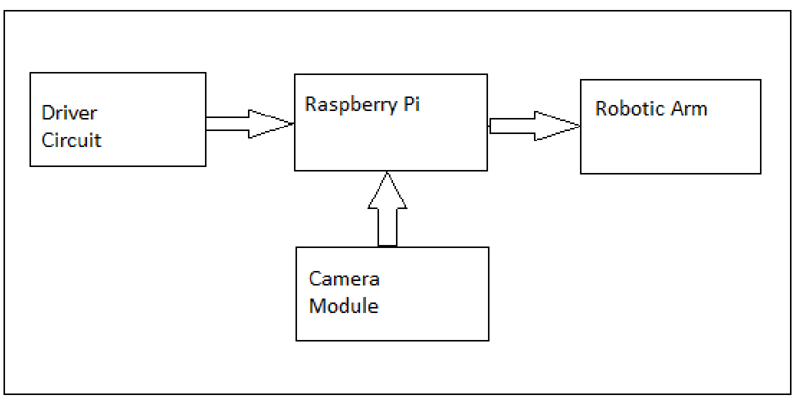
Prof. S. N. Teli [5] proposed a paper which aims to design a pneumatic robotic arm. This arm basically pics the objects which are cylindrical in shape. This system is totally controlled manually. The Robotic arm can be controlled via direction control valves. The arm rotation movement is achieved by using helical slot mechanism, this study shows there is scope to improve the detection accuracy of objects and make automation in robotics.

## III. Proposed Methodology

The proposed system consists of a robotic arm attached with a camera module. The system captures the image and then processes data as per the pre-trained model on which it is trained and identifies whether the object is desired or not. The pre-trained model is trained using customized training data and test data based on the images of the desired fruits. This system can detect desired fruit in real time. The object is picked only if it matches with the desired object. The pre-trained model used is ssd-mobilenet (Single Shot Detector). The hardware implementation is done using raspberry pi module. In order to understand and execute this project we have divided this project into two parts software and hardware part.

As shown in Figure (1), the Raspberry Pi is connected to the Robotic arm consisting of servo motors using the jumper wires. The image is captured using the camera module and then given as input the pre-trained module via raspberry pi module. The captured image is identified by the pre-trained model and then decision is made whether to pick the object or not. If the input images match with the desired object, then it is picked using Robotic arm. The driver circuit provides power supply to the system.

**Figure No 1:** Block Diagram.




The hardware implementation is achieved using Raspberry pi module and robotic arm. To drive this system external power supply is provided. To implement object detection using the raspberry pi module we need to download the raspberry os. The first we got the static ip address of the raspberry pi module. In the raspberry pi os we downloaded the required packages. The robotic arm selected consists of 4 servo motors which allows the movement of the arm easily. Once the final object detection code is executed successfully, we combined the code of object detection and code to control pick and place action using 4 servo motors.

**System Specifications:**

For the implementation of object detection technique deep learning modules are used as they provide better efficiency as well as accuracy. For the software implementation we used the python language as it is easy to understand. The pre-trained model used is SSD-Mobilenet (Single Shot Detection). The process of object detection is carried by using TensorFlow library. We chose this library as it is open-source frame work and consists of many

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inbuilt packages and to implement TensorFlow using raspberry pi we used TensorFlow-lite. For better efficiency and accuracy, we used custom data to train the model. For the hardware implementation we used the raspberry pi and robotic arm with 4 servo motors.

**Figure No 2:** SSD-Mobilenet Architecture

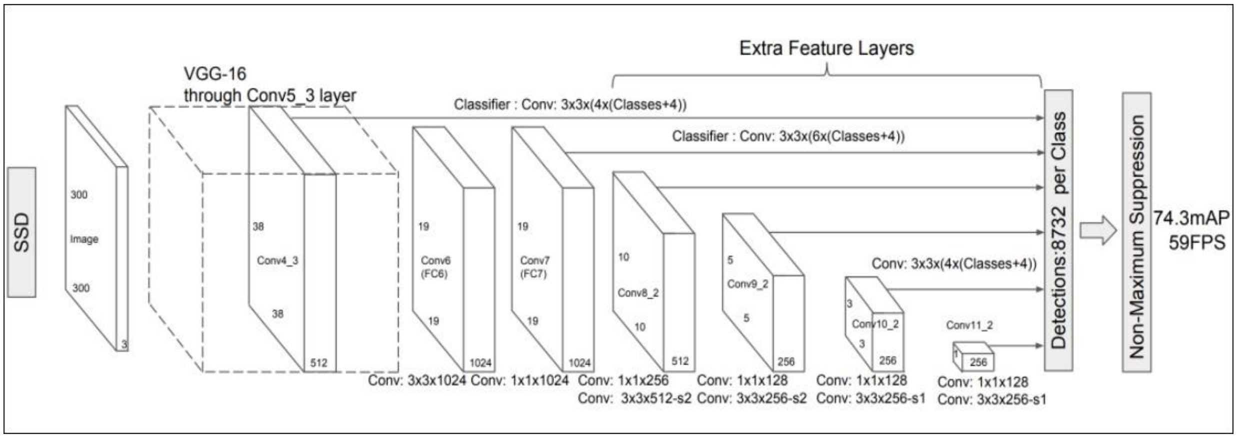


Figure (2) above represents the architecture of ssd-mobilenet model. An image is given as input to the model. The VGG-16 is used in initial step to extract feature maps. The next six convolutional layers perform the classification object detection task. This model detects 8732 objects per class. This means it creates 8732 bounding boxes per class. As a result, multiple bounding boxes may detect the same object. To overcome this issue the non-maximum suppression method is used. This helps to detect single object using single bounding box.

The implementation is achieved in few steps. Firstly, we need to create a new environment in anaconda. Then we installed all the needed packages with respective to their dependencies. Many pre-trained models are available depending upon the requirement we selected the SSD-Mobilenet (Single Shot Detector) model. This model is quite faster and also gives good accuracy. After downloading the pre-trained model and the required packages test the installation. Once everything is installed and running perfectly next step involves downloading and labelling the required images. More the images more the accurate the model is trained. After the labelling the images and their respective xml files are generated. Then this data is divided into training data and test data. 80% data is training data while 20% is test data. The xml files are then converted into csv files Then to train the model using custom data tf-records are generated using respective csv files. Then train the model with customized data. Once the model is trained then make changes in files and file-path in the main object detection code. Then to run the object detection in raspberry os convert the trained model into TensorFlow-lite model. Then finally run the object detection code.

## IV. Results

We have successfully identified and picked the desired object in real time.

1) Data labelling.

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**Figure No 3:** Data Labelling

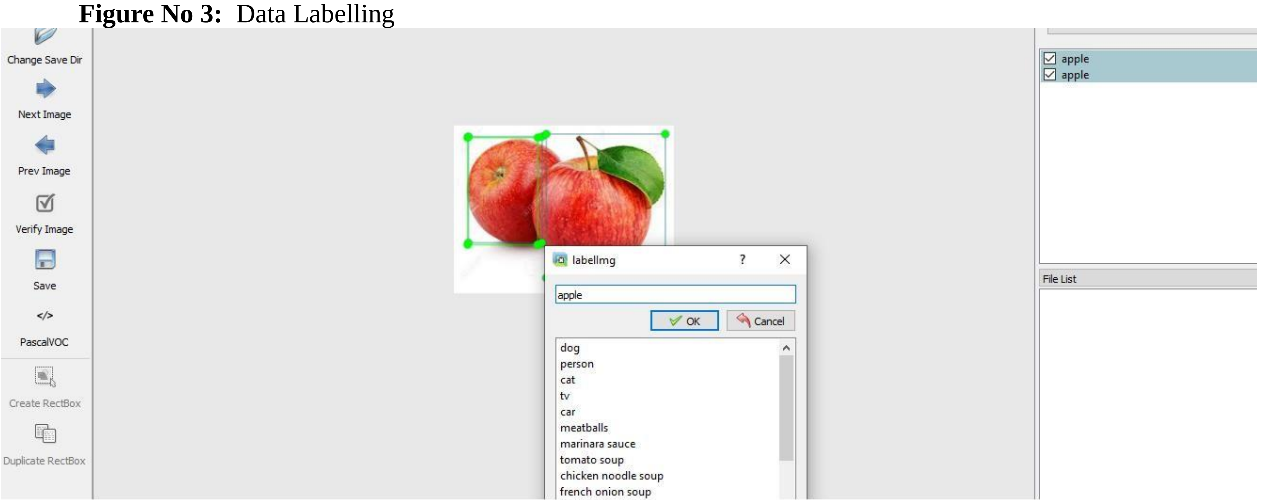


Figure (3) shows the process of image labelling. The tool used to label image is LabelImg using python. After labelling the data the corresponding xml files are created.
In the table Figure(4) the file name and its corresponding values for height,width,class,etc. is given.The xmin, ymin, xmax and ymax values represents the details of the bounding boxes created during the image labelling process. The class column represents the label class of the image. Height and width of the corresponding image is aslo mentioned.

**Figure No 4:** Data labelling in XML

| filename | width | height | class | xmin | ymin | xmax | ymax |
|---|---|---|---|---|---|---|---|
| 2Q__(1).j| | 257 | 196 | apple | 17 | 13 | 103 | 137 |
| 2Q__(1).j| | 257 | 196 | apple | 108 | 10 | 247 | 178 |
| 2Q__(2).j| | 298 | 169 | apple | 5 | 11 | 145 | 169 |
| 2Q__(2).j| | 298 | 169 | apple | 149 | 26 | 294 | 169 |
| 2Q__(3).j| | 214 | 236 | apple | 5 | 6 | 210 | 236 |
| 2Q__(4).j| | 225 | 225 | apple | 7 | 3 | 222 | 224 |
| 2Q__(5).j| | 217 | 232 | apple | 8 | 3 | 204 | 198 |
| 2Q__(6).j| | 221 | 229 | apple | 13 | 17 | 153 | 204 |
| 2Q__.jpg | 225 | 225 | apple | 26 | 62 | 194 | 206 |
| 9k_(1).jpg | 221 | 228 | apple | 24 | 24 | 198 | 202 |
| 9k_(2).jpg | 208 | 242 | apple | 13 | 58 | 195 | 233 |
| 9k_.jpg | 240 | 210 | apple | 26 | 5 | 213 | 190 |
| images - 2 | 240 | 210 | apple | 26 | 13 | 211 | 197 |
| images - 2 | 265 | 190 | apple | 143 | 29 | 239 | 166 |
| images - 2 | 227 | 222 | apple | 7 | 21 | 220 | 205 |

2) Training and testing data.

**Figure No 5:** Result of the object detection code.

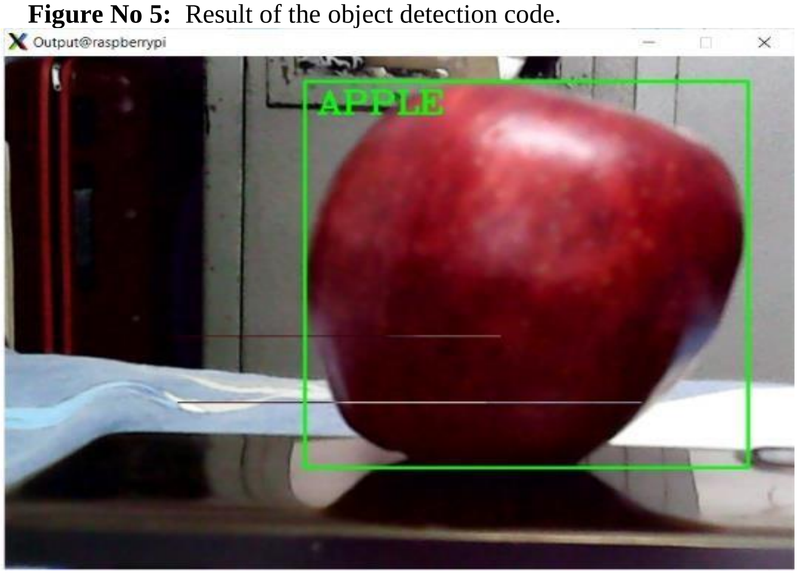


Figure (5) Result of the object detection code

The Figure (5) above represents the result of the object detection code. The image of the apple in front of the camera module is detected. The detected object is displayed along with the label. The model is trained with the custom dataset. Hence, we have implemented the software implementation in the real time.

3) Hardware.

**Figure No 6:** Hardware implementation.

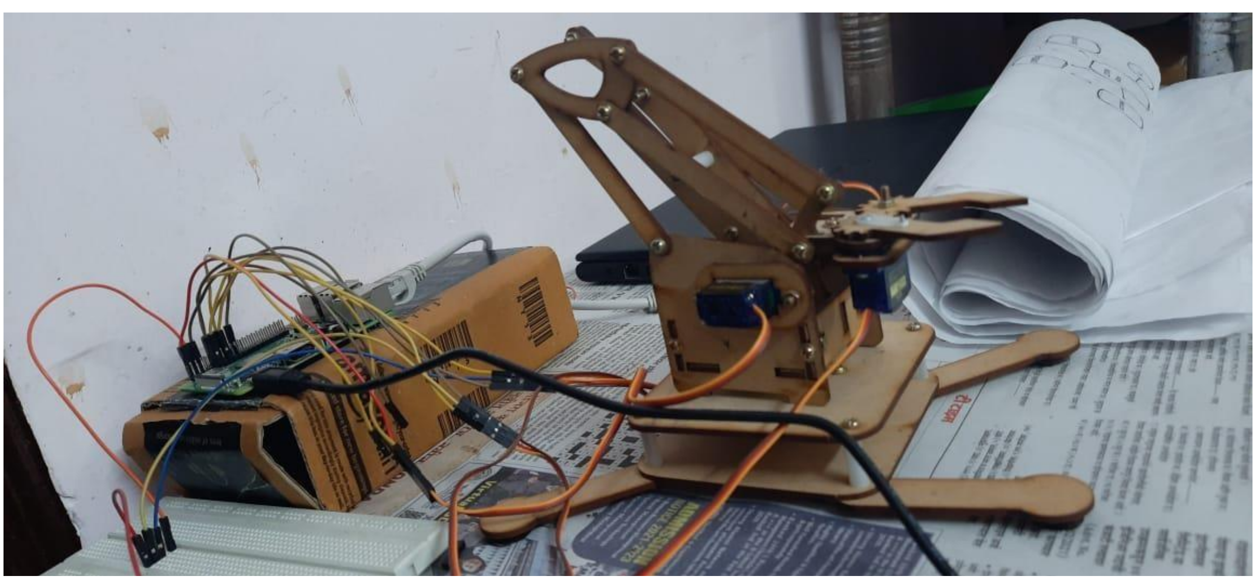

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**Figure No 7:** Robotic Arm

The above Figure (6) shows the hardware implementation of the proposed system.
The Figure (7) shows the robotic arm used in the system.
This robotic arm consists of 4 servo motors that allow free movement of the arm.
We have successfully implemented the hardware implementation of the proposed system in real time.

## Discussions:

Selection of the pre-trained model based on the following table.

**Table no 1:** Comparison of model

| Model Name | Speed (ms) | Coco (mAP ) |
|---|---|---|
| CentreNet HourGlass | 70 | 41.9 |
| SSD-Mobilenet v1 | 48 | 29.1 |
| Faster R-CNN Resnet v1 | 53 | 29.3 |

As shown in the above table the CentreNet model has the higher mean average precision but the time required to detect the object is more. The mean average precision of SSD-Mobilenet v1 and Faster R-CNN Resnet v1 is nearly same but there is difference between speed of the models. The ssd-mobilenet model is quite faster and also provides good accuracy. Hence, we have selected the SSD model.

The proposed system is efficient and this can be defined using some parameters as follows:

- Precision.

This machine work at a level of accuracy, human assembly can never match. This precision ensures better performance for the final product while reducing the number of defective products coming off the line.

- Cost savings.

Reduced labor work and bringing automation to the store. Although the upfront cost of a can be a few thousand rupees, the device quickly pays for itself.

It would raise the overall level of efficiency, which makes them a cost-effective solution.

- Time efficient

It performs or functions in the best possible manner with the least waste of time and effort.

- Longer working hours.

People need to have breaks as they get distracted and after some time attention drops and pace slows. With a robot it can work 24/7, and keeps running at 100%.

The proposed system has some flaws like:

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- Job loss is by far the most significant opposition frequently brought against the use of robots.
- High initial investments.

## V. Conclusion

The proposed solution gives better results when compared to the earlier existing systems such as efficient image capture and better object detection. Identification of object by the robotic arm can be controlled automatically for industrial purpose. The arm can detect object, pick and place it accordingly. The SSD model gives accuracy of 85% for the 2- class detection. The co-ordination in the robotic arm may improve using high speed motors and PLD tunned controller. The advancement in the proposed system can help in store automation.

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