# Automated Billing Cart using SSD based object detection

Sona Joy
*Dept. of Computer Science and Engineering (KTU)*
*Viswajyothi College of Engineering and Technology (KTU)*
Vazhakulam, India
sonajoy1998@gmail.com

Christy Maria George
*Dept. of Computer Science and Engineering (KTU)*
*Viswajyothi College of Engineering and Technology (KTU)*
Vazhakulam, India
christymariageorge@gmail.com

Maria Sajeev
*Dept. of Computer Science and Engineering (KTU)*
*Viswajyothi College of Engineering and Technology (KTU)*
Vazhakulam, India
mariasajeev1997@gmail.com

Pearl Jose
*Dept. of Computer Science and Engineering (KTU)*
*Viswajyothi College of Engineering and Technology (KTU)*
Vazhakulam, India
pearljose97@gmail.com

Nimmy George
*Assistant Professor ,Dept. of Computer Science and Engineering (KTU)*
*Viswajyothi College of Engineering and Technology (KTU)*
Vazhakulam, India
nimmy4ever@gmail.com

***Abstract*—Nowadays, most of the supermarkets are still using traditional shopping carts and barcode scanning methods. The main aim of this paper is to reduce the queue at the billing counter in a shopping complex. The customer can directly pay the amount at the billing counter and leave with the commodities he/she has bought. The use of barcodes and RFID tags are completely eliminated. The system has a feature to delete, update and count the scanned products to further optimize the shopping experience of the customer. Our recommended model consists of a camera, a load cell and an LCD display. Camera detects the object using Deep Learning methods. It also has a load cell attached to it. This load cell measures the weight of edible objects like fruits and vegetables. For stationary objects like pen, pencil,bottles etc object counting feature is added. The LCD display is used to display the particulars scanned and its quantity and helps the customer to know about the total cost of the purchased commodities. The hardware of this system consists of an Arduino platform and Xbee modules.**

***Index Terms*—Tensorflow, SSD**

## I. Introduction

In today's world ,everything is becoming automated.We tried to combine the latest advancements in machine learning like deep learning techniques to enhance the traditional shopping methods.Deep learning has many advantages including object counting[3],image caption generation.People likes shopping but waiting in a queue for a long time to get what they wanted is very irritating and time consuming.The restless waiting in front of a counter to scan each items are reduced as object detection and automated billing are done in the cart itself .Our aim is to produce a hassle free shopping experience that helps the customer to get what they purchased easily and quickly.

Machines are unlike humans who have the ability to learn by themselves. Machines learn from past experiences and examples. For this, artificial neural networks need to be trained. There are various methods for detection of objects like R-CNN(Region Based Convolutional Neural Network), YOLO(You Only Look Once)[1], SSD etc. In this paper, we use the SSD (Single Shot Detection) model for real-time object detection. This is because SSD is more advantageous than YOLO and R-CNN methods.

The system mainly consists of a camera,load cell,arduino,LCD display. For measuring the weight of weighable objects, we have used a load cell. This load cell uses the principle of Wheatstone Bridge. It is connected with a HX711 amplifier module[1]. This amplifier module is not required to be programmed externally.The scanned objects will be displayed using an LCD screen.

## II. Related Works

Early developments to ease shopping were concentrated on the autonomous movement of the cart and on identifying product location.With the latest advancements of technology in every sector ,object detection and object counting techniques can be used to enhance the shopping experience.The long queues and time wasted unnecessarily can be reduced by these deep learning techniques.

### A. Detection of object

Yolo[1] is a deep learning object detection algorithm which came out in May 2016 and it's so popular because it's really fast in comparison with the other algorithms. The main difference is that Yolo is able to detect the objects in only one pass while the other algorithms needed to scan the images many times.Yolo make use of a single convolutional network to predict the class probabilities and multiple bounding boxes.In this model it is trained to identify the small scale objects.There will be a framework which can be used to separate the picture.If the cell consists of any article then the framework cell will be positive.The YOLO here is implemented with the help of darknet.

### B. RFID Technology

RFID refers to Radio-frequency identification which makes use of electromagnetic fields to identify and track tags automatically that are attached to the objects.RFID reader scans the product and by using Wi-fi Module[2],the scanned RFID card numbers are transmitted to the billing counter. Using the database at the billing counter scanned RFID[5] numbers are matched and required information is retrieved including product name,price etc.The process of billing generation is done using a mobile application.

## III. Component Requirement

### A. Camera

A camera is used to capture the image of items that is to be added to the cart. For this, the camera is mounted on to the cart and the item is shown in front of the camera so that the image of the item can be obtained. This image can then be used to detect the commodity using the object detection technique that is SSD.

### B. Load Cell

A load cell is used to measure the weight of the product ,mostly fruits or vegetables. It is basically a force transducer which converts force to electric signal. A strain gauge load cell is used. It works on Wheatstone Bridge principle[1].The potential difference is proportional to the amount of force applied to the cell ,thus the amount of force can be calculated from the load cell's output. It has high accuracy and low cost.

### C. Arduino

Arduino is a company in Italy that designs and sells circuit boards that make microcontrollers easy to use. They call these circuit boards Arduinos and there are a lot of different types of Arduinos. The company Arduino open sources all of their hardware designs. There's also the Arduino software development environment, and this is what makes Arduino good for beginners. It allows a user to insert programs on it which can then relate to things in the real world. Arduino are made publicly available online by its developers.

### D. LCD Display

A LCD display can be used to display the images of the scanned item and also displays the total amount of the bill calculated[4]. It also provide three buttons for the user which includes RESET, NEXT, DELETE, FINISH. The RESET button can be used to clear the items in the cart, NEXT button can be used to scan the next object, DELETE button can be used if we want to remove any purchased good before billing[4], FINISH button can be used to evaluate the bill for the purchased goods.

## IV. METHODOLOGY

The customer is granted the freedom to choose any automated carts available. The user interface can be made ready for the customer by the owner. There is no need for customer's authorization. The system does not use any personal information from the customer's side. A UI is mounted on the cart with the screen facing the customer and with a camera on the rear end. The general procedure is as follows , the user is expected to walk around different sections, take the product and scan in front of the camera[7].The screen displays the image of the identified item , weight can be measured if needed. The identified product is added to the list of items with its predefined price. The total amount to be paid along with the bill will be displayed on the screen.

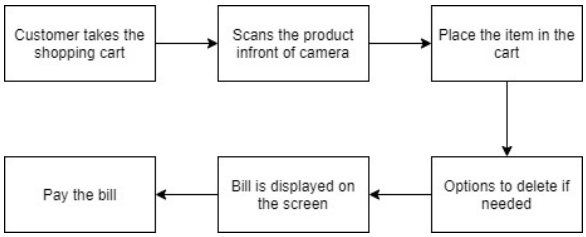


Fig. 1. Customer actions.

## V. THE PROPOSED APPROACH

### A. Object Detection using SSD

We used a single deep neural network based method for object detection, called Single Shot Multibox Detector or SSD in short. SSD shares similar techniques of the algorithm called YOLO. All the methods used before SSD for object detection were quite slow and also SSD has a greater advantage of real-time performance.

Images along with ground truth boxes for the objects in each image are required as input for training using SSD. A feed-forward CNN is used here. The feature maps extracted from the input contain important features of the image at different scales. A small convolution filter is used to obtain these feature maps and to multiply them so that the detection can be performed at multiple scales. This will help to produce accurate results even if the resolution of the image is low. Exactly one default box must be present for each ground truth box. To ensure this, the default boxes are matched with the ground truth boxes using jaccard overlap during training.Scores are

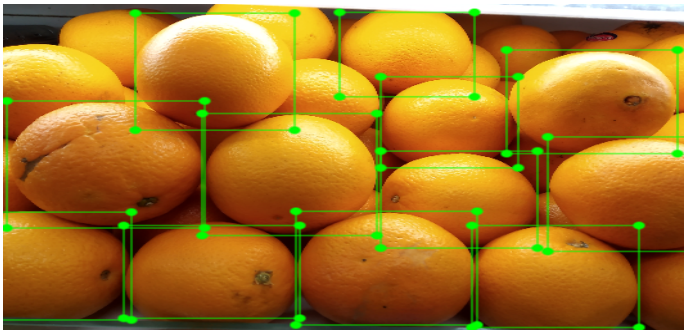

Fig. 2. Image with ground truth boxes.

generated during prediction time for the presence of bounding box corresponding to each object category and adjustments are also made accordingly.

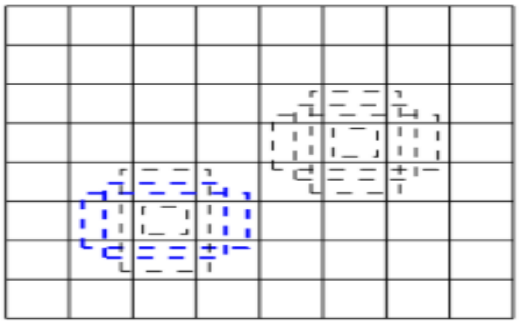

Fig. 3. SSD uses box anchors.

### B. Training of the model

The dataset we chose for training include apple,orange,pen etc. . Initially the dataset were jpg files. We draw bounding boxes for the objects in the image using label-img software. Resizing of the images is done to maintain the aspect ratio of the images and we created the new image with width and height of (512,512) respectively. We have splitted each of the dataset into two sets that is the training set and testing set based on the size of the files.Then these datasets are converted into XML files. These XML files contain the coordinates of the bounding boxes for each object. It also contains labels which are names of the object. Both of these are specified during labeling. The XML files of each dataset are then converted into CSV files which are then converted into tfrecords. Tfrecords contains a sequence of binary records and are used for training.

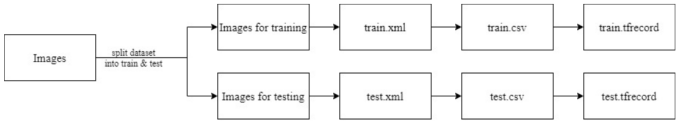


Fig. 4. Creation of dataset.

For making the computations easier, images are converted into numpy arrays by importing the numpy library of python. Plotting libraries like matplotlib and seaborn are imported for visualisation purposes. We used a tensorflow library for object detection. During training, checkpoint files are created automatically. Checkpoint files are useful in evaluating the model and contain snapshots taken at each step. The training of the model is completed with the creation of checkpoint files. Once the training is completed, it is important to run the test dataset. Evaluation is performed on the test dataset and the evaluation results can be summed up in the form of metrics. Tensorboard is also used in conjunction with TensorFlow for visualising the various aspects of our model.

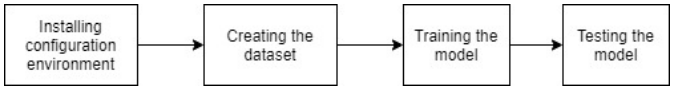


Fig. 5. Flowchart of Tensorflow Object Detection API.

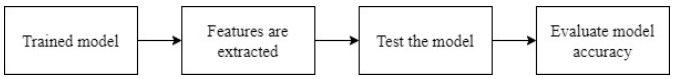


Fig. 6. Evaluation of model accuracy.

### C. Working of the system

The system mainly consists of a camera which is used to capture the real time image of the commodity. The commodity that is to be added to the cart is shown in front of the camera. The camera captures the video which is then read as image frames using the cv2 library of python. About 24 frames per second are captured by the camera. Foreground detection and background subtraction are performed. Some pixels remain the same in all the image frames for a defined time and are considered as static objects.

Using the ssd model, object detection is performed. The image of the detected commodity is displayed on the LCD screen attached to the cart. Tensorflow object detection api counts the number of objects in the image. The label of the detected commodity along with its total count will be added to the table displayed on the screen. For commodities like fruits and vegetables, the total cost can be calculated only by measuring their weights. So a load cell is attached to the cart to measure the weight of such commodities. After object detection, such items are placed on the load cell to calculate their weight. Once the weight is calculated and displayed on the screen, customers can take off the item from the load cell and can place it in the cart.

All the information regarding the product including its price is stored in the database. When the object is identified, its price is fetched from the database and the total bill will be calculated and displayed.

## VI. Conclusion

In this paper, we propose a system to modernize the shopping experience using deep learning. Image identification is used to identify and object counting techniques [3]are used

to count the particulars. It is also applicable to edible objects like fruits and vegetables. Barcodes and barcode readers are widely used in India.RFID tags are also used but they are not a preferred option for edible food items. There is also a scope of improvement, payment options, auto-follow and advanced security that can be added in the future.From the conventional method of bar code scanning and RFID tags, the cart will enable the customer to scan the items and get the total bill instantly. This would reduce the time wasted in front of the billing counter. The object detection used in the system expands customers the freedom to buy whatever they want and pay for it.

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