Billing System for Groceries with Object Recognition

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Abstract— Object recognition systems can have some very useful applications. This system can be used with minimum human involvement. This system can be very helpful for developing an automated billing system. For edible products like vegetables and fruits, bar-codes and RFID tags cannot be used as they have to be stuck on each of the items and the weight of each item must be individually measured. The proposed system consists of a camera which detects the commodity using Deep Learning techniques. In this article, the machine learning algorithm is applied to the detection of groceries, and some progress has been made in this direction. A real time application for automated billing is developed in which customer can bill his purchase using a Graphical User Interface on a computer screen integrated with a camera. The system is also developed for simultaneous detection of multiple objects offering advantage over barcode-based billing system. By using modern object detection techniques, we can increase the accuracy of the application as for application like billing system, accuracy of recognition is very crucial for correct billing.

Keywords: OpenCV, Object Detection, Machine Learning, TensorFlow, CNN (Convolutional Neural Network), epochs, vgg16

I. INTRODUCTION

Many grocery supermarkets like Big Bazaar, Easy Day uses barcodes for billing and invoice generation. Check-out counters uses bar-code readers in such stores but the space between the sensor and the object should be nearly zero when the reader is applied. In the modern era, the people have more income to spend and lesser time to spare, so they generally choose supermarkets for grocery and other shopping rather than local shops. During the peak hours in supermarkets, the queue for billing at the checkout counter is quiet long. In weekends, customers are forced to stand in the queue for almost an hour. This is more than the time required by them to shop. Therefore, we are introducing Self Scan Billing system which help customer to save their precious time. Computer vision-based systems could be developed and deployed for such an automated billing application where minimum human interference and lesser wait time is required leading to customer satisfaction. We can use Object Detection to separate between different products and we can connect these systems with a weighing machine for determining the weight. Once the product is identified, it can be added to the bill. Efficient ML algorithms are there for faster recognition of an object. Faster checkout at stores means more customer satisfaction. Object detection is the only main required technology for this project. Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class in digital images. A real time application for automated billing is developed in which customer can bill his purchase using a Graphical User Interface on a computer screen linked to a camera. The world is moving towards an era of automation and human capital is a great asset and we have to use it in more intellectual works rather than manual, monotonous works.

II. LITERATURE SURVEY

Efforts to develop self-checkout system involve using lots of sensors to identify which item has been picked from the shelves as in case with Amazon's product Amazon Go. Amazon said it is using a combination of artificial intelligence, computer vision and data extracted from multiple sensors to ensure customers are only charged for the stuff they pick up. These system does not give results effectively applied for groceries as they cannot be individually kept in a shelf. Another research that has been made in this field is that of self-checkout trolley which will detect items placed inside trolley. The Automated Shopping Trolley which integrates a Raspberry Pie Embedded Chip with one Bar code Scanners, four gear motor and a Battery kit. More the number of customers more hardware they must use. This idea can work for large retail stores but most of the supermarket which cannot afford large amount of trolleys embedded with sensors and raspberry chip will not adopt this considering it's high cost. Some of the products which already exist but with lot of electronic tools and sensors are:

1) Amazon Go
2) Walmart Scan and Go
3) MoltIn

The widely used barcode scanning does not adhere with the grocery items where you cannot stick barcode to the grocery products. The conventional canning as in RFID tags does not fit in, it can be difficult to scan products with non-traditional shapes and of various textures. Few researches have been made for generating bill using object detection algorithms like sift algorithm but TensorFlow fits well when accuracy is considered and provide better results than other algorithm. Scanning groceries with Object detection will overcome the disadvantages and, in less cost, as compared to the present self-checkout system. The system will require a weighing machine, a camera installed monitor system.

III. RESEARCH METHODOLOGY

Manual entry in the computer system has always been a very tedious and error-prone process. It wastes a significant time of supermarket employees. Billing counters of stores are perfect examples of this. By applying new and ever better technology, this wastage of time can be saved. TensorFlow is one of the best machine learning platforms used to classify an image. TensorFlow with Python is extremely powerful to apply operations on an image.

Using TensorFlow highly accurate object detecting model can be developed. The new and better version of TensorFlow detects trained objects quicker than ever. Having a highly rich dataset always helps. A good dataset increases the accuracy of the model. One of the reasons to use TensorFlow is that it doesn't require a very high configuration system. TensorFlow has achieved fault-tolerance to a significant level. In TensorFlow, we model all data as tensors. Tensors naturally represent the inputs to and results of the common mathematical operations in many machine learning algorithms. TensorFlow can automatically determine placements that achieve close to optimal performance on a given set of devices, thus freeing users from this concern. TensorFlow supports advanced machine learning algorithms that contain conditional and iterative control flow. The final experiment result shows the much-improved object recognition rate. The mathematical model of the network is executed in python with Tensorflow.

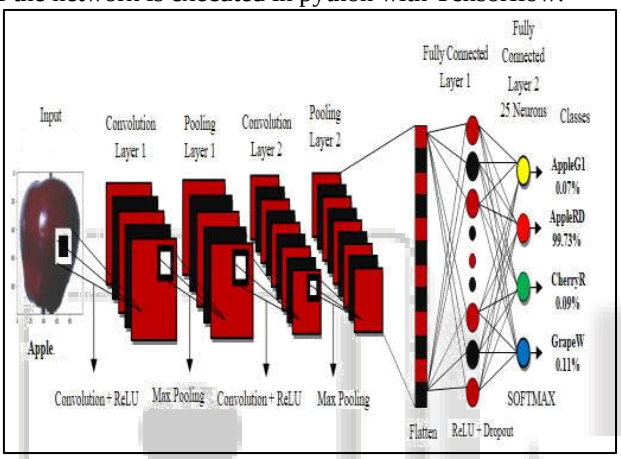

Fig. 1: Training Model

Training model used is vgg16. VGG16 is a convolutional neural network model proposed by K. Simonyan and A. Zisserman[8]. It makes the improvement by replacing large kernel-sized filters with multiple 3×3 kernel-sized filters one after another. VGG16 was trained for weeks using NVIDIA Titan Black GPU's. The image goes through a stack of convolutional layers, where the filters were used with a very small receptive field: 3×3 convolutional layers. These are described in the figure above. Three Fully-Connected layers are succeeded by a stack of convolutional layers which has a different depth in different architectures. The final layer is the soft-max layer. The configuration of the fully connected layers is the same in all networks. This model was chosen because it improves classification accuracy.

IV. DATASET

For training and testing, all the images were selected from the fruits-360 dataset which is publicly available for use on Github and Kaggle. The dataset contains 82213 different fruit images of 120 categories. The fruit images were reaped by recording the fruits while they are revolved by a motor and then producing frames. A white color is used behind the fruits as a background. Due to the disparity in the lighting a flood fill type algorithm was developed which extract the fruit from the background. After removing the background all the fruits were scaled down to 256×256 pixels of standard RGB fruit images.

From the fruits-360 dataset, we picked 8,567 images from 17 different categories. Among them to create the training set of images, we have used 6,583 images (0.8 of Dataset) and the rest 1,984 images used for testing the model. The network is trained for 50 epochs with a batch size of 128 and verbose =1.

V. EXPERIMENTAL RESULTS

For this project, we have applied a convolutional neural network on the fruits-360 dataset in order to find the better classification performance of the network. For determining the overall classification accuracies, we have taken 50 epochs with a mini batch size of 128 and calculated the accuracies on the test and training set. The accuracies were obtained using TensorFlow library in python.

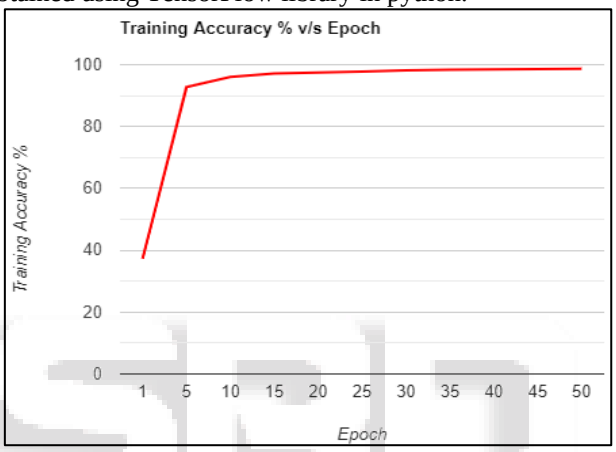

Fig. 2: Training Accuracy curves for different epoch

The highest classification accuracy on the test images was found 98.63% on 50th Epoch. Initially, accuracy came very on first few Epochs. As Epochs increased, training accuracy also increased. In the last few epochs, training accuracy increased but not with significant amount. But, over-fitting of the model always helps in increasing the accuracy, so we did it.

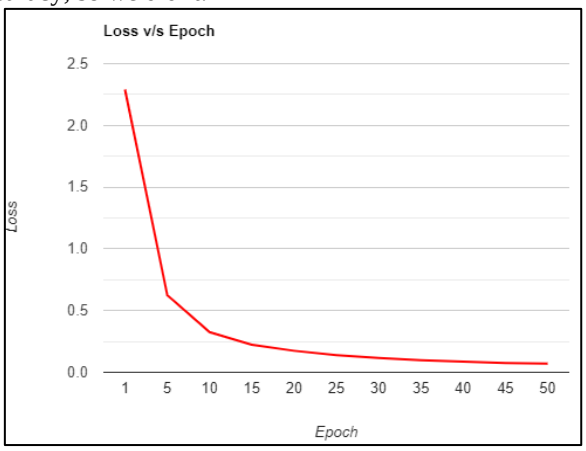

Fig. 3: Loss curves for different epoch

Loss while training the data was inversely proportional to the number of epochs. During the first epoch we saw significant loss of data. But, as the number of epochs becomes more loss dropped consistently. At the last Epoch loss was very low and can be regarded as negligible.

VI. PROCESS

The Software we have developed is for Groceries stores. Here, customer scans the product using a system with a camera. Application will recognize the product scanned. The price of recognized product is searched in database. By adding the quantity and receiving the price from database, the product is added to the bill. Customer repeats the process till they scan every product selected. Finally, bill is handed over to the customer.

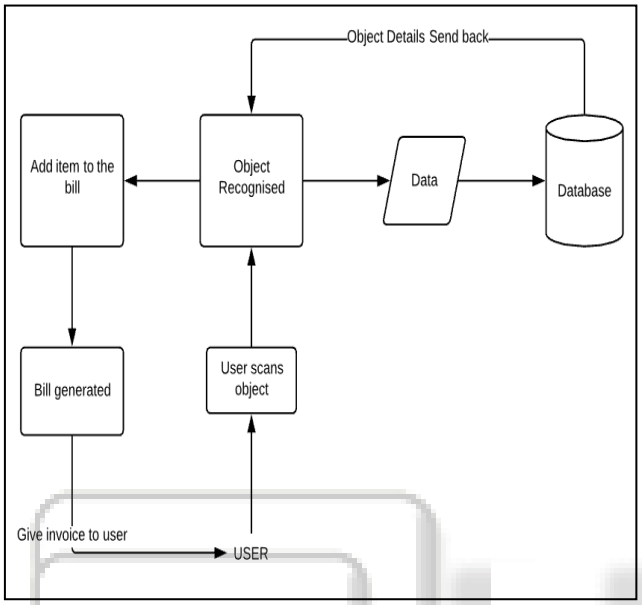

Fig. 4: Data Flow Diagram

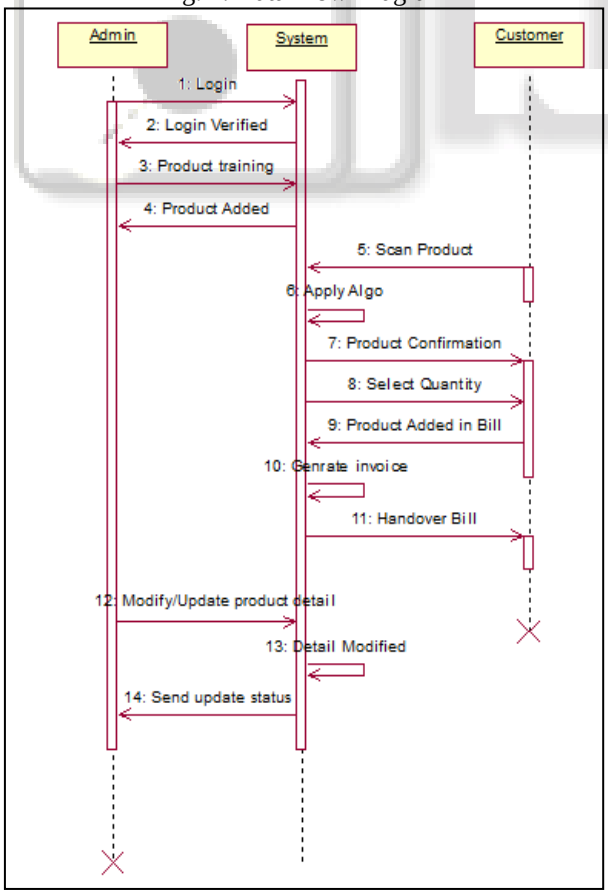

Fig. 5: Sequence Diagram

VII. CONCLUSION

This paper explores a products recognition classifier based on CNN algorithm. The accuracy and loss curves were generated by using various combinations of hidden layers using fruits-360 dataset. The model achieved the train accuracy of 98.63% and testing accuracy of 99.94%. We have successfully applied this model to form a software which can generate bill of Groceries items. In the future, our plan is to add more and more products in the dataset to expand our recognition domain.

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