VEGETABLE DETECTION USING TENSORFLOW OBJECT DETECTION API

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**Vegetable Detection Using TensorFlow** ", submitted by *Kawser Ahmed* and *Mahedi Hasan Niloy* to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on *08-JULY-2020*.

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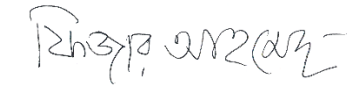

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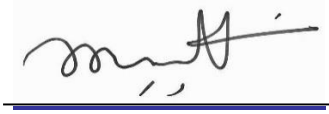

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Professor Dr. Md Ismail Jabiullah, Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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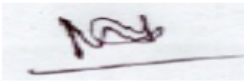

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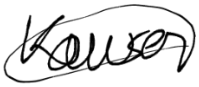

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ABSTRACT

At present, object detection is one of the popular platforms in whole the world. Because of uses automation technology in most of the sectors, object detection is most important to know the accurate object of machine. Realizing this concept, we made this project. This project will be detected seven different types of vegetable those are available in our county. It is implemented by using of TensorFlow object detection API that is making used of OpenCV. This API makes easy to detect our selected objects by using a pretrained object detection model. A pretrained model simply means that it has been trained on another dataset. The model we have used in our project that is ssd_mobilenet_v2_coco. There are 2100 images in seven separate kind of vegetable used in our project. Using these datasets in our proposed model we are getting up to 99% accuracy based on types of vegetable

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Being an agricultural country, the huge amount of people produces different kind of vegetable. The most essential part of everyday meal is vegetable. Recognizing different kind vegetable is a recurrent task in supermarket. It is also important to determine its price. The object of the project is identification of vegetable based on tensor flow with aim of solve this kind of problem. First, we use a big number of image dataset which include seven type of very popular vegetables. Vegetable sample like biter gourd, papaya, multitude, lady finger, cucumber, cauliflower etc. are consider in the project. Traders have warehouse where different type of vegetable are stored. The sorting process is done by manually which cost more time and also money. At the end the sorting is not so accurate. To solve the problem automated system can help. So first of all, learn the machine about the different type of vegetable so that it can be identify. Identification is the very root level task in Agriculture and botany industry. Up to now there are almost 50-100 type of vegetable available in Bangladesh [18]. It is very difficult to know all the species of vegetable. Our project can identify at least 7 type of vegetable.

There is some challenge in vegetable identification, the background of image sometimes being complex. There are a similarity between different type of vegetable. So, it not only based on single feature like color, shape, size etc. Sometime same species vegetables will be different because of viewpoint, color, size, shape etc.

The idea is based on Martin Gorner's Hand-written digit recognition using Tensor Flow. A similar procedure is following for this work. The idea is to use convolution neural network (CNN) and Tensor Flow [1]. The convolutional neural network is the efficient identification and classification method developed recent years. This network avoid complex preprocessing any image [3]. People directly input original image without any

processing. Tensor Flow is the second generation of artificial intelligence system developed by Google which support convolution neural network (CNN), recurrent neural network (RNN) and other depth of the neural network model that can be used in speech recognition, image identification and so on many machine learning fields [15].

In this project we used CNN with tensor flow on the vegetable image contain dataset. CNN a method that train our model based on train data. We have 1275 train data and 235 test data in total. Traditional Neural network model needs at least 1000 data to give a pretty much accuracy of any model.

1.2 Motivation

One day I visited to a local shop to buy some vegetable and other stuff. Some of foreigner also came here to buy some product. But there is no labeling on the local vegetable. So, it is hard to find out for them. They look so helpless. I came back from shop and discuss these with my friend after some days he joined me with our final year thesis. He also shares his opinion. He told that his father a local businessman work with local vegetable. From whole Bangladesh different kind of vegetable are stored their store room. At this time all the packaging and loading work done by analog procedure which is time consuming and more costly. If we build a system which is shorted the vegetable, this will be also used in super shop. As our honorable prime minister declare the vison 2021 and we are an agriculture country why not we bring 4^{th} industrial revolution in our agriculture sector. We decide that our first task will be learn the machine about our local vegetable. How far there are some research project on identification of fruits, birds and some products has done so far. There is no proper Bangladeshi vegetable identification research. This research will show how Machine learning methods help to identify Bangladeshi vegetable automatically.

1.3 Rationale of the Study

Agriculture has a large number of contributions on Bangladesh GDP. Vegetable is one of the largest parts of our agriculture. As we are targeting 2021 to become a digital Bangladesh but our agriculture sector is not much digital compare to another sector. This cause less contributes to our national GDP. AI, Machine learning, Computer Vision so far used in find out the different kind of disease but very few works done with identification of vegetable [14]. It is very first step to being automated in this sector. Without know vegetable or other agriculture products machine cannot done anything. This wok helps to short out these problems.

1.4 Research Questions

Throughout the research we try to find out following question concerning Machine learning impact on identification of vegetable.

1. Does machine learning technique effective to identification?
2. How does “Identification” relate to agriculture automation?
3. Which procedure is more efficient?
4. Does different type of technique is varying identification accuracy?
5. What kind of effect we saw if AI, Machine Learning come into agriculture scenario?

1.5 Expected Output

The purpose of the study to learn machine with different kind vegetable so that they find out the products like people with more accuracy. However, the following specific outcomes have been expected from this paper:

2 Finding out the vegetable by help of the machine learning technique.

3 Investigating how machine learning help to solve agriculture sector problem.

4 Finding effective solution of analog shorting problem and help people who don't know the different kind of vegetable.

5 Implement a machine learning technique to find out vegetable automatically.

1.6 Project Management and Finance

At present there are no need financial issues. And the project management is very easy. This project just will be added in automation system. And it can be used in smartphone application. Just it can be needed to update. When it will be available the financial benefit will get the authority because it will make our life easy.

1.7 Report Layout

This report is split in six separate chapters to present the study. There are some sections under each of the chapter which make this paper easy to understand. Chapter 1: Introduction, is the very first chapter. This will help a reader to know what we will truly explore throughout the research. This chapter shows the motivation behind the work, research question, expected outcome. This chapter has 7 sub sections. Chapter 2: Background shows the root of the research. In this chapter existing literature findings were discussed related to present study. We also discuss different between related work and present work. This section divided into 5 subsections. Chapter 3: Research Methodology shows the method of work. This section consists of Research subject, data collection. How data is pre-processed and after processing data what is the statistical measurement. This section divided into 5 subsections. Chapter 4: Experimental Results and Discussion, is shows the model results, setup and result analysis. This chapter divided into 3 subsections. Chapter 5: Impact on Society, Environment and Sustainability is all about the impact of the study in environment, how its helps society and its sustainability. This chapter has 4 subsections. Chapter 6: Summary, Conclusion, Recommendation and Implication for Future Research is the last chapter of this study. In this chapter we discuss about the ending of the study, summary, our limitation and what we want to done with this project in future is discuss in this chapter. This chapter is including 3 sub sections. References and Appendices are including in the end of the paper that will be helpful in order to study the paper more effectively.

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CHAPTER 2
BACKGROUND

2.1 Terminologies

Object detection is a new trend in artificial intelligence. It gives machine intellectual knowledge. It is related to image processing and computer vision. It is a part of machine learning. TensorFlow offers multiple levels of abstraction. Build and train models by using high level Keras API, which makes getting started with TensorFlow and machine learning easy.

2.2 Related Works

Identification and classification are not a new thing in agriculture sector, so huge work done on it. With respect to produce classification problem, Veggie vision (1996) was the very first attempt of a Supermarket Produce recognition system uses color, texture and density [2]. Though this work done quite a long time ago so that no advanced technique used. The reported accuracy of this model was 95% [16], but to achieve this accuracy it uses top four response. The dataset was used in this model have more classes [7].

About 2 years ago in 2018 Om Patil, Prof. (Dr.) Vijay Gaikwad Developed a model which classified different type of vegetable like Carrot, Onion, Cucumber and Tomatoes [6]. This model is based on Tensor Flow. They use Inception-v3 which implemented using Tensor Flow tools. The classifier model divided in four different part [12]. Firstly, they collect image of carrot, onion, cucumber, tomatoes. They use both google image and capture home vegetable image. After capture image the next step is labeling the image. After label image, the file format is converted to .xml. The next step is training the model. They use tensor flow CPU to train the model [13]. To find the classification of the vegetable they made an android app. After capture any vegetable image the model compares between Learnt image and Capture image. Finally, the app shows the classified data. This is the total workflow of this model.

In 2017 Japanese Automobile industries named Makoto's Koike started a machine which sort out cucumber [11]. Makoto used simple Tensor Flow code Deep MNIST for experts with minor modification of convolution, pooling and last layers. Changing the network design to adapt with pixel format [15].

X. E. Pantazi et al made a one class classifier to detect leaf disease by image processing. Their model classified disease with around 95% accuracy [8]. Juncheng Ma et al proposed a deep learning technique to detect cucumber disease.

2.3 Comparative Analysis and Summary

There are huge number of projects based on object detection. But vegetable detection is rare. Some projects are detecting animals, some are leaf, some are detection traffic signal, some are smoke.

The title 'Classification of Vegetables using TensorFlow" is using four items [9]. Those are carrot, cucumber, onion and tomato [6]. It is related to our topics. But in our project, we are using seven items. They used inception-v3 model where we used ssd_mobilenet_v2_coco model [10]. They used 1200 images but we used 2100 images in our project. So, in our project the accuracy and the number of items is more than this paper.

2.4 Scope of the Problem

It is the scope of the following paper's problem. We will solve these issues. And we are following different projects. In our project we are also trying to use different model. By using different model, we can see that the model we are using in our project it is giving accurate result. The advantage of using this model is, it is easy to train. It takes low time and give high accuracy.

2.5 Challenges

There is some challenge in vegetable identification, the background of image sometimes being complex. There is a similarity between different type of vegetable. So, it not only based on single feature like color, shape, size etc. Sometime same species vegetables will be different because of viewpoint, color, size, shape etc.

CHAPTER 3
METHODOLOGY

3.1 Research Subject and Instrumentation

The name of our research subject is machine learning. Using machine learning tools, we are detecting object. Object detection is a popular research area which use different machine learning algorithm and API. In our project we are detecting vegetable. Preliminary we are detecting seven types of vegetable. They are

1. Bitter gourd
2. Brinjal
3. Cauliflower
4. Cucumber
5. Lady finger
6. Multitude
7. Papaya.

To detect those objects, we had needed to use some instrumentation. By using these instrumentations, we completed our project. The instrumentations are

- Devices:
    i. Smartphone
    ii. Laptop
- Software:
    i. Anaconda 3
    ii. TensorFlow GPU v1.15
    iii. LabelImg
    iv. Google Colab
- Model:
    i. TensorFlow
    ii. Ssd_mobilenet_v2. coco

- Packages:
    i. Protobuf
    ii. Pillow
    iii. Lxml
    iv. Cython
    v. Contextlib2
    vi. Jupyter
    vii. Matplotlib
    viii. Pandas
    ix. Opencv- python

3.2 Data Collection Procedure

Data is the most import things of our project. The more data we will train the accuracy of result will be more. And the quality of data will be good then the train will be good. There are two way to collect data for our project. They are

- Capture Image: The most of the data are being collect by capturing on our smartphone. There are three sources to collect our data. They are
    a. From Direct Farmer's Field
    b. From Market
    c. From House
- Download Image: And some data we are collected from internet.

We went to direct farmer's field to collect our data. There we talked with farmer and listen to their sadness and happiness that will help to research in future. Then we went to different market to collect data. After returning home we capture more picture of our selected vegetable. And in the last we collect some data from internet. We downloaded some data from google image.

3.3 Statistical Analysis

First of all, we plan to build a model that detect every type of vegetable in our country. But it is very tough job for us. Finally, we collect 2100 of vegetable image which contains 7 class. To build our dataset more efficient we preprocessed our data until it removes irrelevant, inconsistence data. After processed we have finally got 700 data. Every class has same number of data that means 100 data for each class. The total train data is 560, every class has 80 data. Test data is per class has 20 that means total 140 test image.

3.4 Applied Mechanism

For our final output it longer 11 steps to train up the model with our dataset. These steps are:

- Collecting Images and Label.
- Setting up the environment.
- Install required Packages.
- Preprocessing data
- Download Tensor flow model.
- Collecting TF Records.
- Download Pre trained model
- Configuring Training pipeline
- Tensor board
- Training the model
- Export the model

Collecting Image and Label:

We collect the image from field by using smartphone camera. And for labeling we use python LabelImg tools.

Setting up the environment:

We use Google Colab notebook for our primary environment. To set up environment it takes some steps.

- Create a new Notebook.
- From top left menu: Go to Runtime then Change runtime type, select GPU from hardware accelerator.
- Mount Google Drive to Colab notebook.

After training starts, checkpoints, logs and other important files will be automatically created. But after disconnect the kernel these files are deleted if there are no backup in google drive. Kernel disconnect if computer sleeps or after using 12 hours of Colab GPU.

Install Required Package:

Google Colab has most of the package like Python, Pandas, Tensor flow etc. are pre-installed. But Some of the package are note installed and these are installed by running.

Preprocessing Image:

We need two csv files for the .xml files in each 'train labels' and 'test labels'. These 2 folders contain train and test image file xml. The same folder name where the xmls are located is matched. The image must be in .jpg format.

The working directory at this point:

object_detection/ > data> images> annotations> train labels> test labels> label_map.pbtxt>test_labels.csv>train_label

Table: 3.1. Train Data in CSV File

	filename	width	height	class	xmin	ymin	xmax	ymax
0	bitterGourd_100.jpg	800	600	bittergourd	554	135	661	233
1	bitterGourd_100.jpg	800	600	bittergourd	237	350	353	462
2	bitterGourd_100.jpg	800	600	bittergourd	369	126	468	224
3	bitterGourd_100.jpg	800	600	bittergourd	154	184	245	265
4	bitterGourd_101.jpg	800	600	bittergourd	338	194	546	316
...	...	...	...	...	...	...	...	...
801	papaya_95.jpg	800	600	papaya	226	80	627	544
802	papaya_96.jpg	800	600	papaya	250	177	638	591
803	papaya_97.jpg	800	600	papaya	135	107	560	549
804	papaya_98.jpg	800	600	papaya	145	94	591	525
805	papaya_99.jpg	800	600	papaya	168	130	617	543

806 rows × 8 columns

Table: 3.2. Test Data in CSV File

	filename	width	height	class	xmin	ymin	xmax	ymax
0	bitterGourd_1.jpg	800	600	bittergourd	54	181	339	439
1	bitterGourd_1.jpg	800	600	bittergourd	570	267	800	473
2	bitterGourd_1.jpg	800	600	bittergourd	377	408	544	593
3	bitterGourd_1.jpg	800	600	bittergourd	453	1	617	165
4	bitterGourd_11.jpg	800	600	bittergourd	63	44	685	286
...	...	...	...	...	...	...	...	...
180	papaya_5.jpg	800	600	papaya	173	247	529	600
181	papaya_6.jpg	800	600	papaya	127	177	518	587
182	papaya_7.jpg	800	600	papaya	145	152	618	564
183	papaya_8.jpg	800	600	papaya	12	116	506	589
184	papaya_9.jpg	800	600	papaya	161	201	544	579

185 rows × 8 columns

Download Tensor flow model:

Tensor flow model contains the object detection API. This API are mainly used to detect the vegetables. This model is downloaded from official repo.

Collecting TF Records:

Tensor flow model accept the data as TF Records. It is a binary file that even runs fast in low memory usages. It contains all the image and labels in one file. To work with this, we have to make sure some point:

- The CSV file name is matched train_labels.csv and test_lables.csv
- Object detection is the current root directory.

Download Pre train model:

Pre train model means it train with another dataset. This model is consisting of thousand and millions of image data. Such as COCO is a dataset which has 80 Class and 333000 image which contains 1.5 million objects. Train a model is long time of matter, it contains some days. So, if there are online pre train model why not we use it? We test the download model with our dataset to watch if it is work or not.

Configuring the Training Pipeline:

It is the last step before our model started to train.

Tensor board:

It is a place where we can see the whole process that happen during train the model. We can monitor loss, maP, AR from it.

Training:

It is the part which have some line of code to write.

- model_main.py which runs the training process.
- pipeline_config_path to config the model
- model_dir= path to training

Export the trained Model:

Training model save after every 600 second up to 5 checkpoints. After that new model is created and old is deleted. It accesses from these directories:

- ✓ pipeline_config_path
- ✓ output_directory
- ✓ trained_checkpoint_prefix

After complete those 11 steps, we can find our train model which gives us maximum 99%.

3.5 Implementation Requirements

To implement this project there are some requirement. Without these requirements it is so hard to implement this project. The major implementation requirements are

- Device and Software
    1. Python v3.5
    2. TensorFlow GPU v1.5
    3. Graphics Card on Device
- Knowledge
    1. Python Programming
    2. Basics of Machine Learning
    3. Basics of neural Networks

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

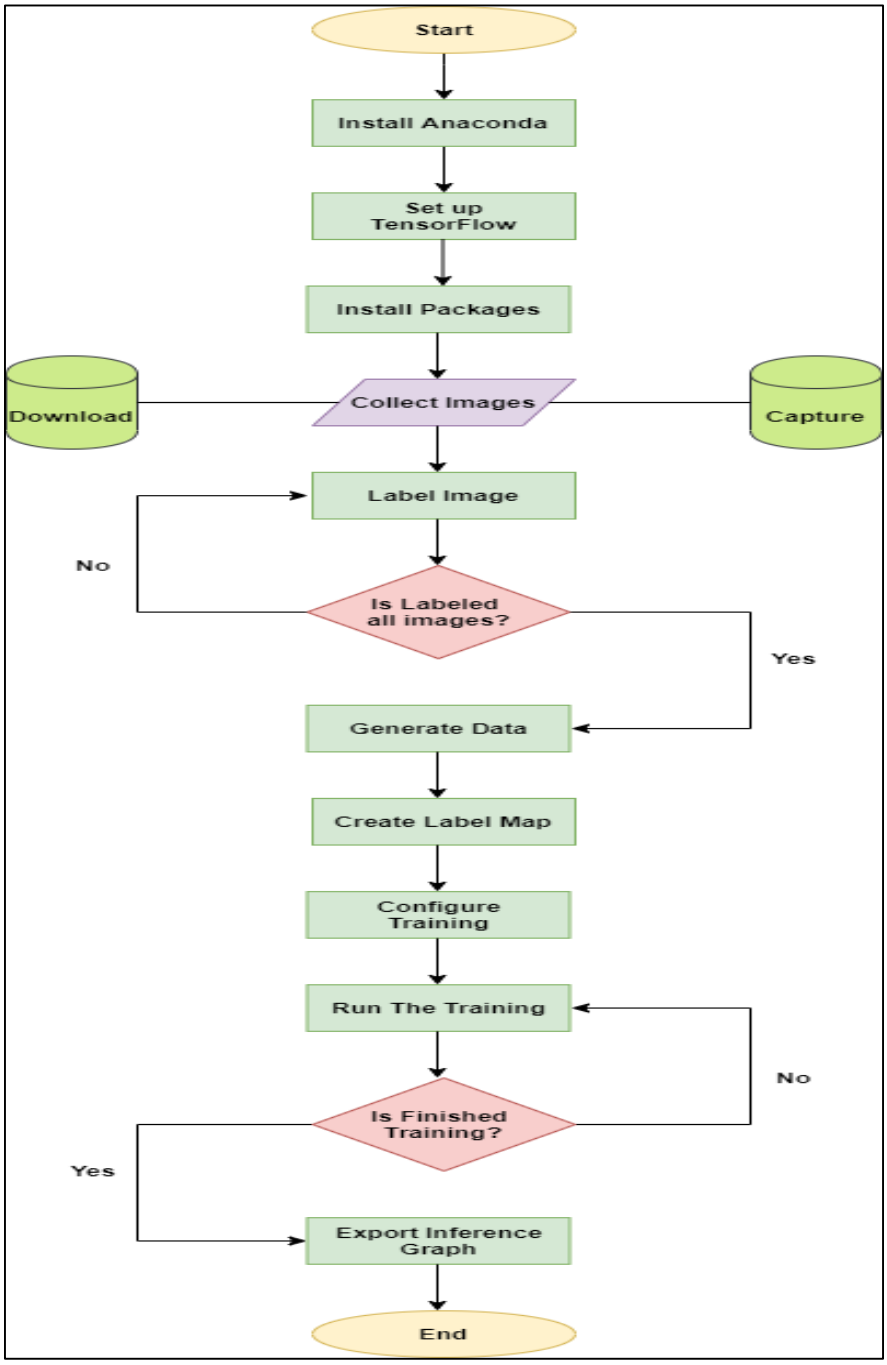

Figure: 4.1. Experimental Diagram

4.2 Experimental Results

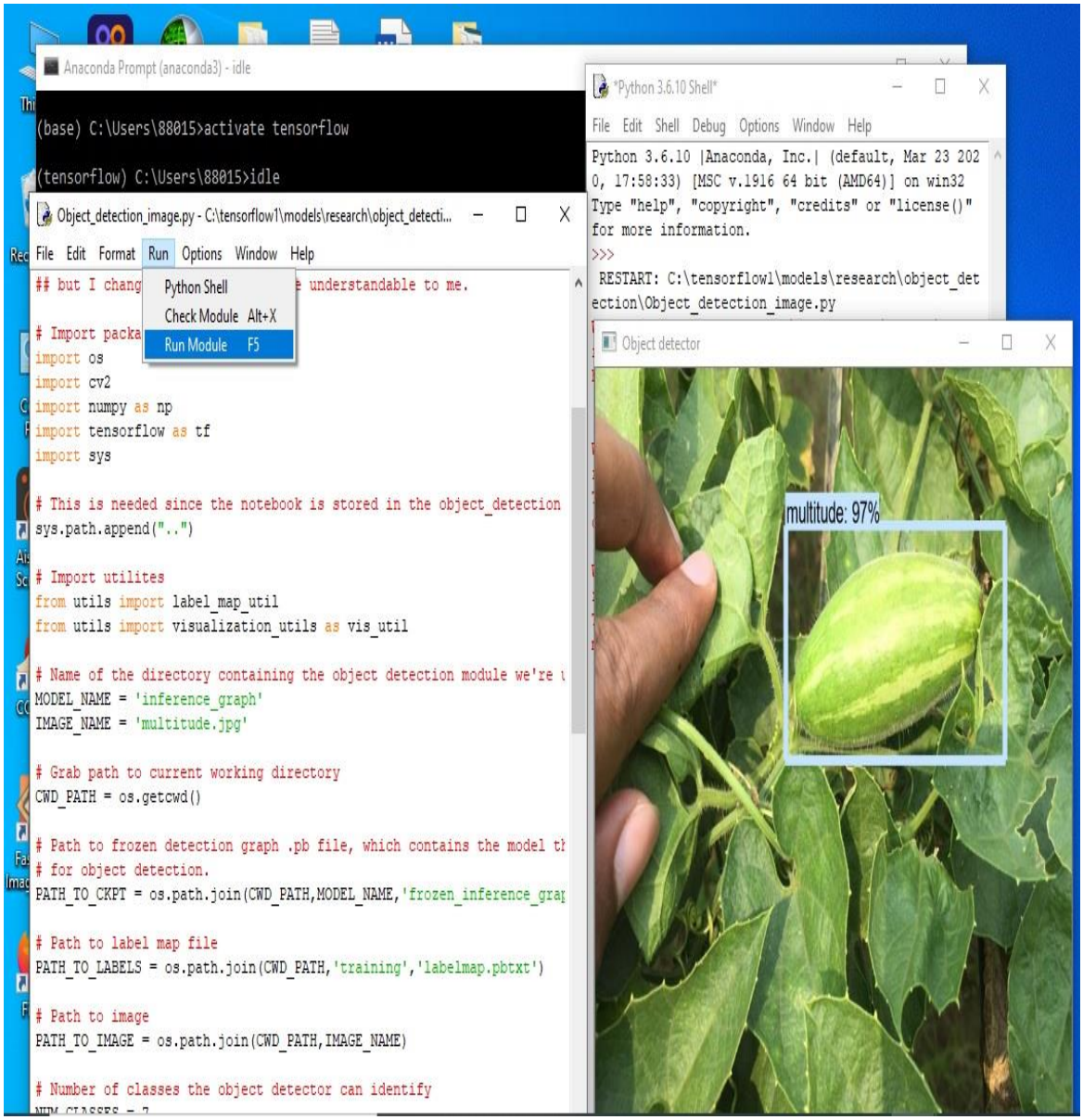

Figure: 4.2. Image Detecting Procedure

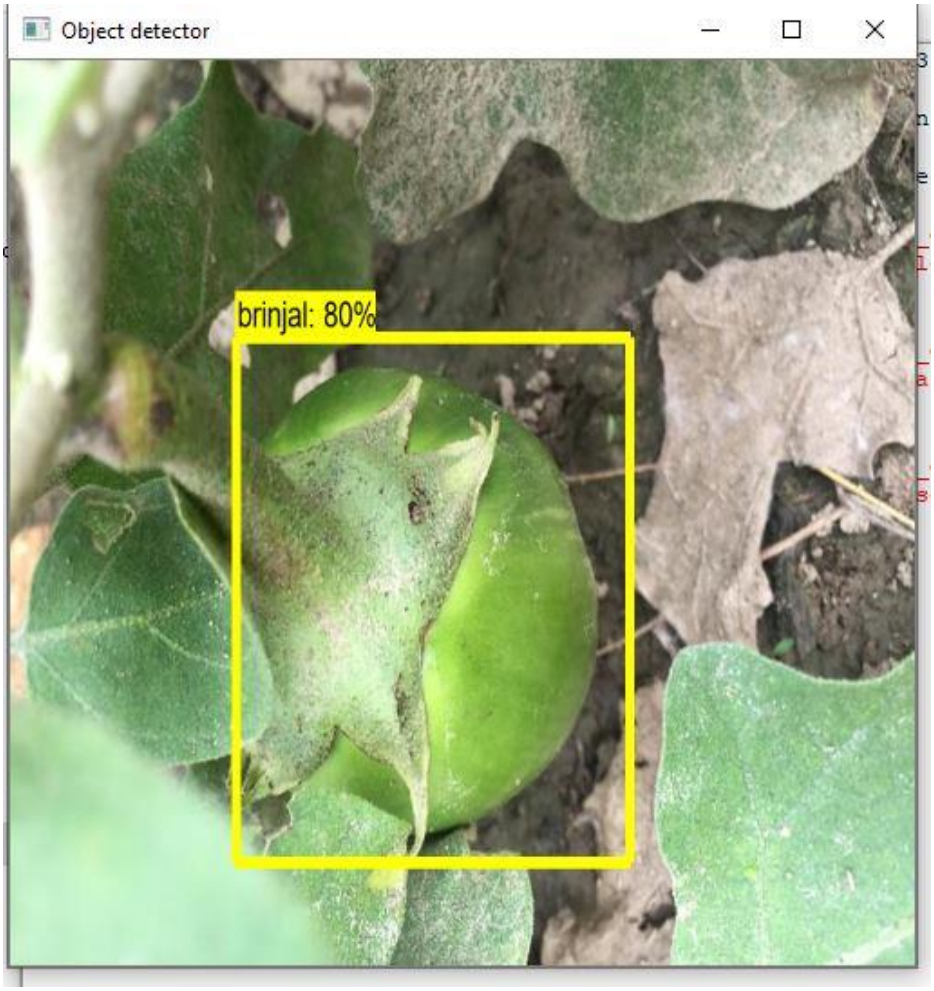

Figure: 4.3 Brinjal Detecting

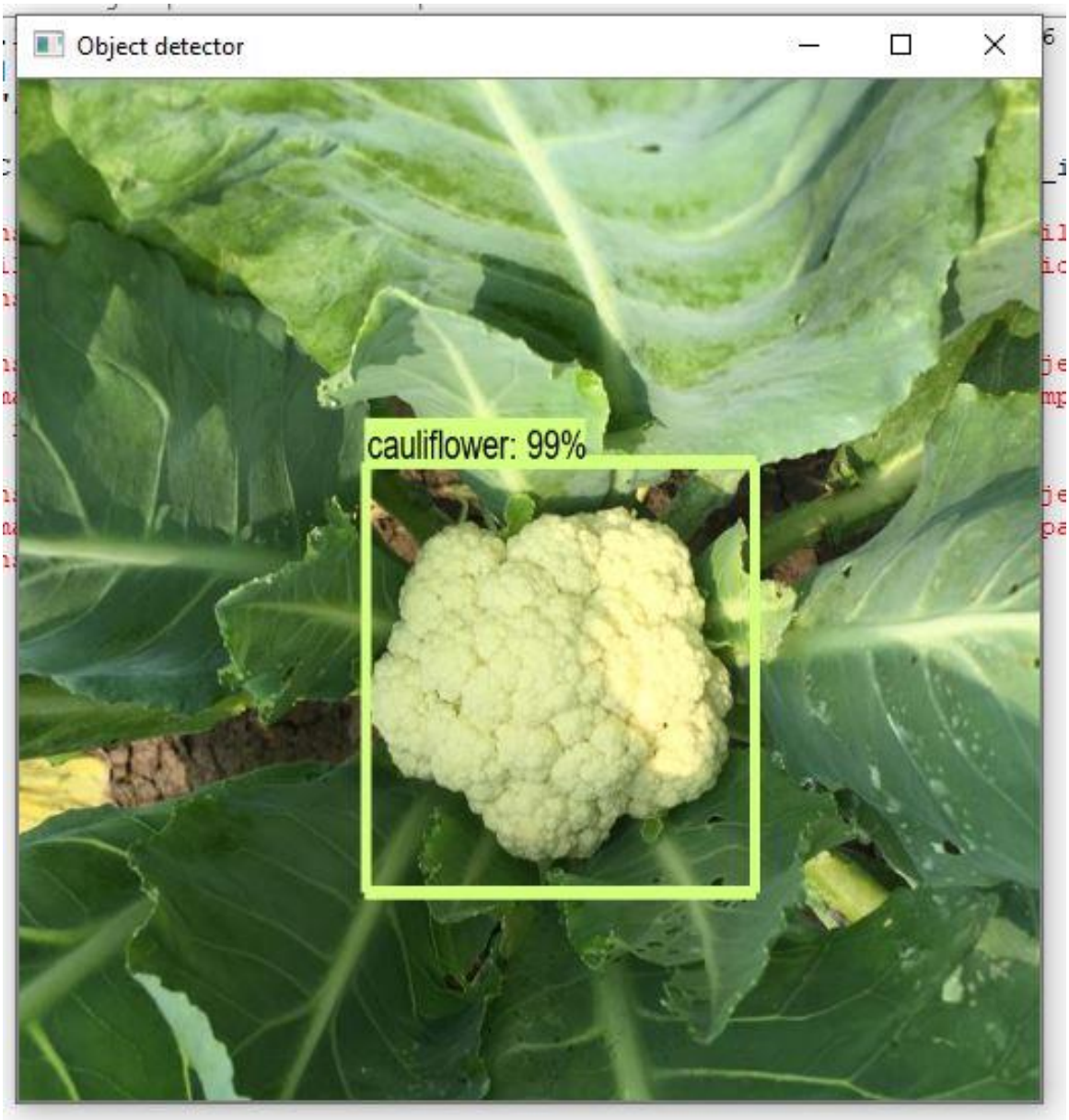

Figure: 4.4 Cauliflower Detecting

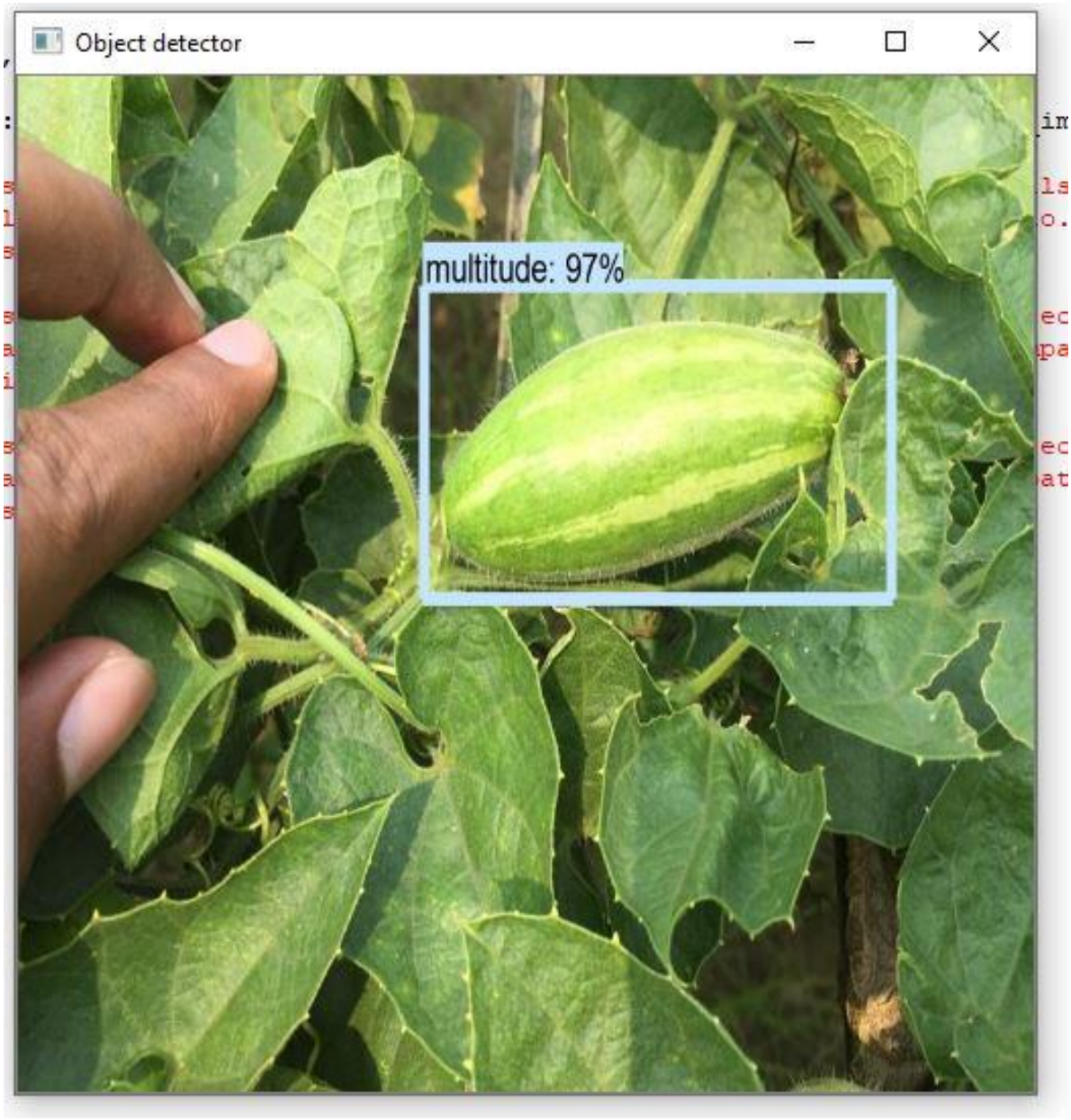

Figure: 4.5 Multitude Detecting

Figure: 4.6. Papaya Detecting

Figure: 4.7. Lady Finger Detecting

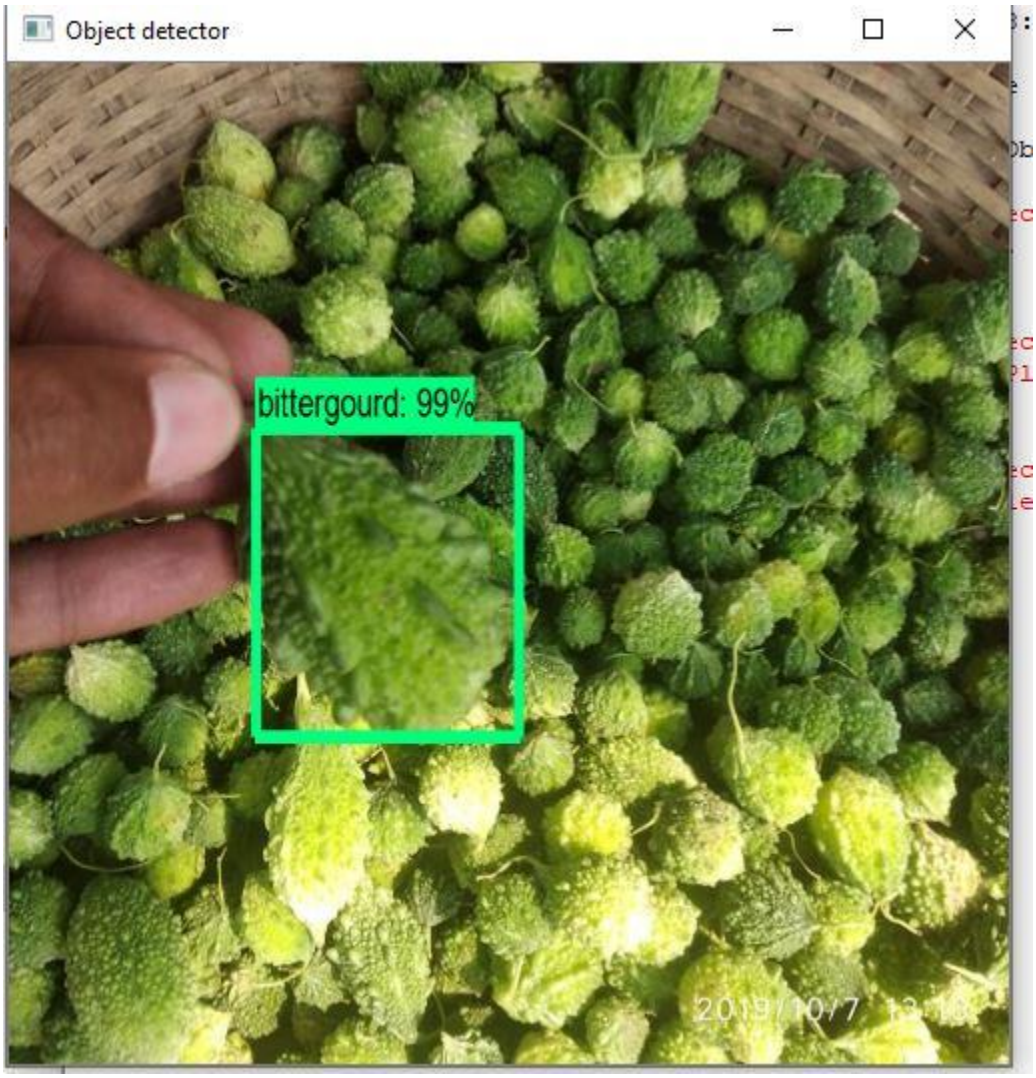

Figure: 4.8. Bitter gourd Detecting

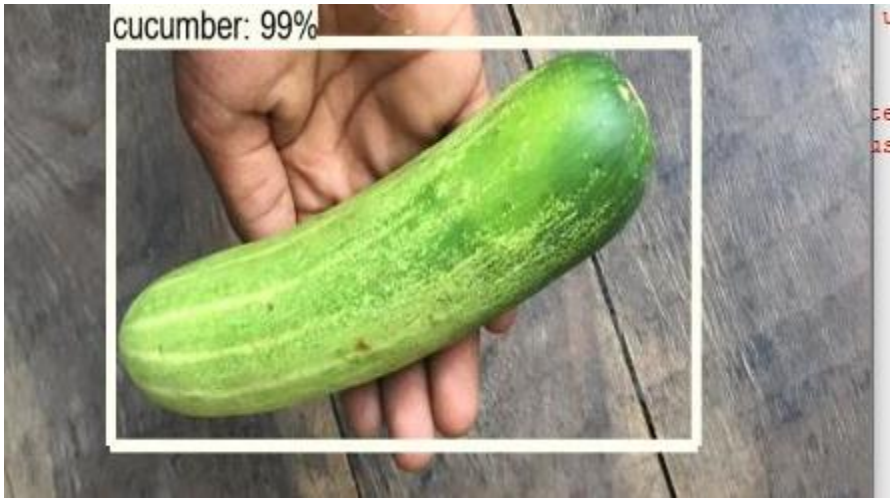

Figure: 4.9. Cucumber Detecting

4.3 Analysis & Discussion

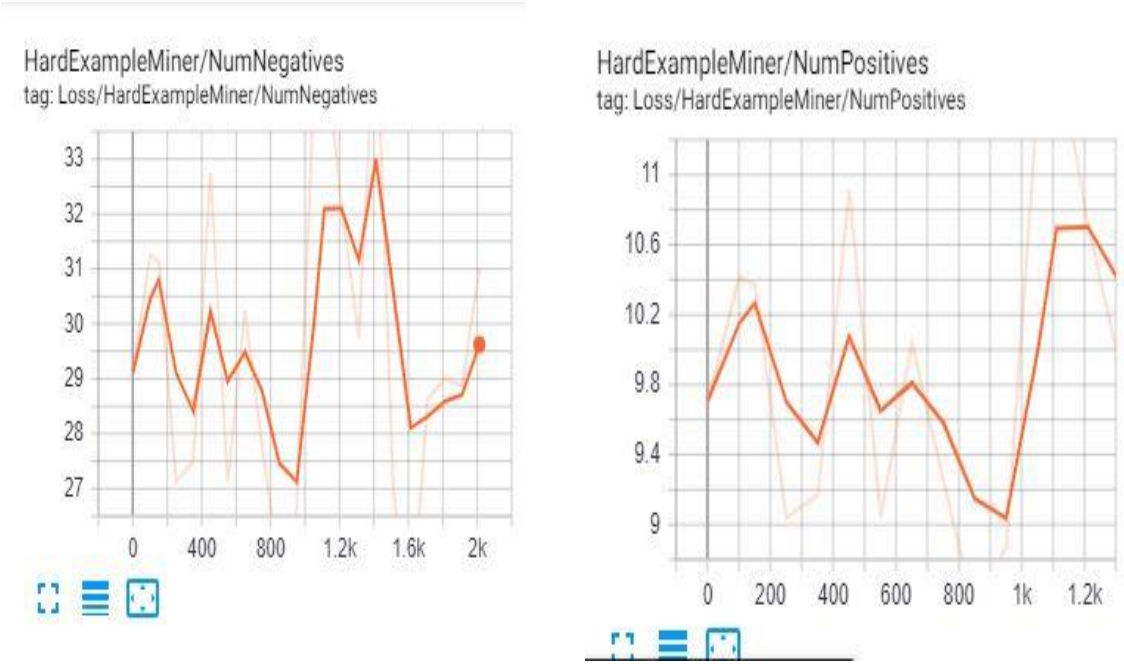

Figure: 4.10. Hard Example Miner

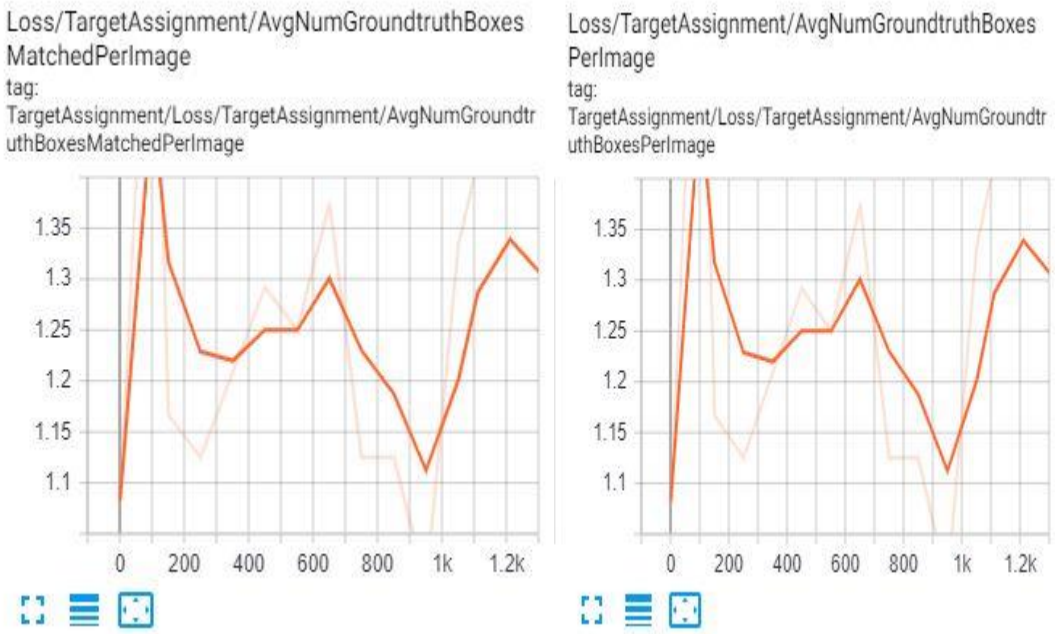

Figure: 4.11. Target Assignment

Figure: 4.12. Average Number Ignored Anchors Per Image

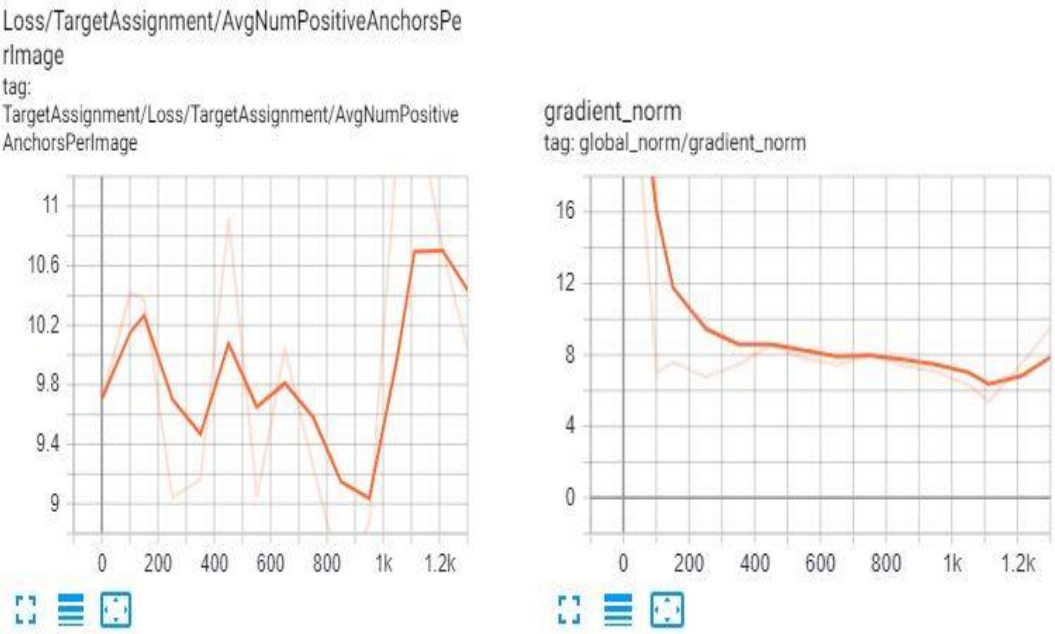

Figure: 4.13. Gradient Normalization

CHAPTER 5
ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

The project we have done which is normally used in automation system. If it is being used properly, then it can be good impact on society. It will make our life easy. Suppose we go to market but don't know the product name, it will help. Using this technology, we can also help people from different side. Suppose we want to know the amount of nutrition of some vegetable, if we can detect the object then it will suggest all the nutrition. In any super shop we can use this technology by robot. Robot will be able to shop if we can teach him. So, it will be good impact on society.

5.2 Impact on Environment

Physically it will not impact on environment. It is just a software; it will not be harmful for nature and our environment. But it can be help to nature and our environment. Using this technology such like it can help to our life style then it can help to produce it. If we can detect the vegetable then we can get all information of this product. That can help to cultivate, that can help to get nutrition.

5.3 Ethical Aspects

There are no problems from ethical aspects. It is not doing cheat or harmful for others. It just helping to produce more services and makes people's life style.

Moor defines computer ethics as a research area that deals with the analysis of the social impact that computer technology causes. Computer ethics is a branch of information ethics that has been built on the foundation of information ethic.

5.4 Sustainability Plan

The sustainability of this project is outstanding good. Because we know that we are going to enter in new technology that all are being automation. Everything is being easy, coming in out hand. People wants everything is being easier. If the technology can be implemented properly then we can produce service easily.

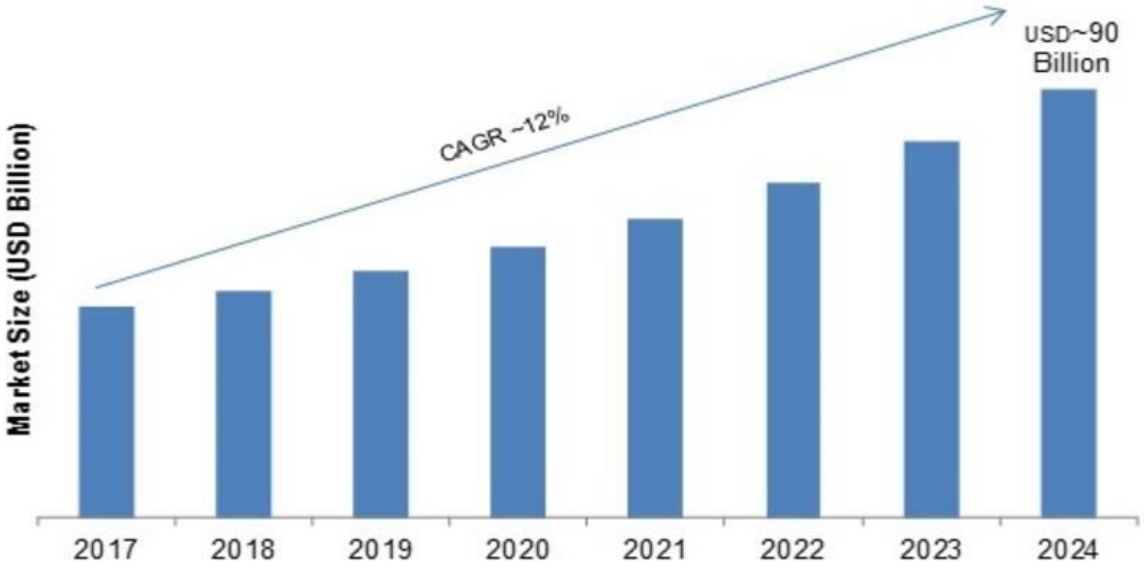

Figure 5.1: Market Size of Automation

From the above statistics we can assume that how the sustainability of this project. We can see from the report we can see the market size of automation is increasing that will reach in 2024 up to $90 Billion USD [18].

CHAPTER 6
SUMMARY

6.1 Summary of the Study

The main target of this project was detecting vegetable. We belief that if we can detect any vegetable we can use this technology in different way. It will helpful in different sector. Primarily, we used seven different types of vegetable in this project. Those are Bitter gourd, Brinjal, Cauliflower, Cucumber, Ladyfinger, Multitude and Papaya.

We used TensorFlow Object Detection API to detect those objects. Besides there are also some library and dependencies which already described above in this report. We used for trailing seven hundred images. There were five hundred and sixty train data and one hundred and forty test date. After train our model we get up to 99% accuracy from test data.

6.2 Conclusions

Our project based on Deep Learning and using this technology detect multiple objects. TensorFlow, a deep learning object detection API which based programming model, as well as single machine and distributed implementations of this programming model. There are seven hundred images of seven different items of vegetable. After training our model, we get up to 99% accuracy.

We will increase the dataset and items for better performance and acceptance in future work. And we believe that our project can make the advantage of the computer science in the field of agriculture and food industry.

6.3 Implication for Further Study

There are many options for future implication. Next our target cover most of the items adding. Then we will create an application. By using this application users from globally can detect any vegetable. There we will add also some features. We can use this application in super shop for identifications and get details of this object. This technology we can use to cultivate vegetable. If we can detect an object and we can add details about it. So, it will be helpful for any kinds of people and any kinds of objective.

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