BANGLADESHI FRESH-ROTTEN FRUIT & VEGETABLE DETECTION USING DEEP LEARNING DEPLOYMENT IN EFFECTIVE APPLICATION

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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/internship titled **"Bangladeshi Fresh-Rotten Fruit and Vegetable Detection Using Deep Learning Deployment in Effective Application"**, submitted by Md. Abrar Hamim, ID: 183-15-11821 and Jeba Tahseen , ID: 183-15-11834 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 13th September 2022.

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We hereby declare that, this project has been done by us under the supervision of **Nasrin Akter, Lecturer, 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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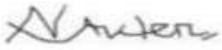

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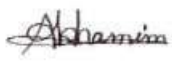

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ABSTRACT

Growing fruit and vegetables has long been a component of Bangladeshi agricultural methods. Today's rapidly changing our farming techniques for cultivate fruits and vegetables. Because our country's farmers now grow all fruits and vegetables all year round. Winter fruits and vegetables are not just available in the winter, as it was in past times. For this reason, Fruits and vegetables frequently rotten. We started this study project in order to prevent this rotting fruit, vegetable. Our methodology in the most current developments in deep learning and computer vision is to identify if a fruit or vegetable is fresh or rotten. Artificial intelligence and machine learning are widely used. After that, we built a device directly here. An intelligent, quick, and perceptive technology can differentiate between fresh and spoiled fruits and vegetables. We utilize the Python CNN algorithm here to categorize rotting and clean fruit as well as fresh and rotten vegetables. We also compare our CNN algorithm with KNN and SVM but CNN algorithm is far better than KNN, SVM. By using photographic data, this gadget can determine how much fruit or vegetable is rotting and how fresh it is. Our aim is to reach all the general people for this reason we also build android platform. Here user click one picture then our system automatically generates and show the result We believe, it will be advantageous for all farmers, business owners, and common people.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

For identifying man-made logic and intense deep learning research, image classification and recognition is the most effective evaluator. This is now the most commonly used method of monitoring our everyday activities and work. As a result, it will cover literally every part of daily life. Deep learning technique analyzes and deals with picture information using a layered structure, that can also increase image identification performance. It may grow further and spread more widely in the future. Picture classifiers and recognizers will resolve a wide range of problems. We can handle many challenges in our regular lifestyle by using image processing through deep learning methods. Bangladesh is a farming country, as we all know. Finding defective fruits and vegetables has been difficult, particularly in the farming sector. The look of fruits and vegetables is a major sensory attribute that influences their market value, preferences of consumers, and choice. Although human can classify and evaluating all the stored fruits and vegetables but it is unsatisfactory, time-consuming, unpleasant and costly. Sometimes, we cannot tell if a fruit is fresh or not just by looking at it anymore. We can use CNN to solve so many products and real-world problems. As a result, we proposed a methodology for identifying defects in fruits and vegetables to reduce effort and time, minimize manufacturing costs, and decrease labor hours. Several organic foods and items are not classified based on looks alone. Supermarket lighting can confuse us by providing ill-fitting items. We can categorize every item according to its present status by using a deep learning imaging technique.

We are researching on this kind of fruit like mango, banana, starfruit, jackfruit, guava, papaya and vegetables like carrot, potato, Calabash, cucumber, eggplant, cauliflower as

part of our study. The above fruits and veggies are being used as a demonstration to identify their exact state to use an image processing method. Natural fruit and vegetable are usually

exceeding our ability to care for. As a result, a lot of people have a limited understanding of how to buy such items. Many people can't understand is it fresh or not. By applying our application in this method, we can ensure that consumers will have adequate knowledge about purchasing these items, as well as ensure that all foods have health benefits and nutrients. We can implement a variety of type algorithms, but for this project, we'll utilize one type version of (CNN). So, we'll finally be able to easily find a fresh mango or rotten mango, fresh banana or rotten banana as like starfruit, jackfruit, guava, papaya and vegetables like carrot, potato, Calabash, cucumber, eggplant, cauliflower. It will simplify our lives than before because We can quickly determine whether our expected fruit or vegetable is fresh and get additional information. We can achieve anything with an image classification and recognition technology that is already man-made. This technique works on practically all organic and non-organic objects, such as fruits, vegetables, chemicals, and so on.

1.2 Objective

Technology is needed for our existence because it helps us to deal with the ever-changing structure of our life. This technological era cannot be separated from our daily lives. Our major goal was to recognize between fresh and rotting fruits and vegetables among of the suggested foods. We used a few different types of fruits in our research. We want to use deep learning to detect between fresh and rotting fruits and vegies, finally for ease of use we convert our study in android application. So, here is our aim, which is listed below. There are various more topics to examine, but we will only explore those that are important to our paper work.

Our goal is to sort all of the fruits and vegetables into fresh and rotting categories. Nowadays, separating fresh and rotten fruits and vegetables from the rest of the fruit and vegetable is practically impossible. If humans try to do this impossible work, they become bored after repeating a task, while machines don't. For this reason, we implement this type of technology and a platform has been created to ensure that here we can identify a fresh and rotten fruits and vegetables through this deep learning method. We have made it an Android application for ease of use. Here user just capture a photo then our research method

justify weather fresh or rotten. Here the user only captures the photo, then considering the system is this food fresh or not.

We would like to be able to view and identify various fruits like mango, fresh banana or rotten banana as like starfruit, jackfruit, guava, papaya and vegetables like carrot, potato, Calabash, cucumber, eggplant, cauliflower in order to determine whether they are fresh or rotting.

1.3 Motivation

Fruits and vegetables are a regular part of our diet. We buy these from the market every day. since it's very essential part to a lot of the proteins in our healthy diet plan. However, according to a lack of time, we are incapable to determine if the veggies and fruits are healthy or rotten. In some cases, if we have time, we don't conscious about buying. So, intentionally or mistakenly, sometimes lot of fruit and vegetable are rotting every day. These wasted fruit and vegetable are harmful to our health as well as a waste of money. Bangladesh's product costs are presently so high that wasting food is now considered a luxury. For this reason, to save money and avoid health problems, we are thinking to set up a fully automated system that will guide us to identify if our collected fruits and vegetables are fresh or not. Using deep learning and image processing techniques we can easily get our expected output beginning to end. Then finally we are going to create an android application which can help the user using this in their everyday life. The android phone user number is huge nowadays. To provide healthy fruits and vegetables we can implement of this application. In our research we are mainly works in Bangladeshi fruits and vegetables. In most cases these have to be imported from the village. So, these fruits and vegetables are traveling a great distance to reach different market, there is a high risk to spoil. We can utilize deep learning methods to decrease this sort of uncertain situation.

1.4 Rationale of the Study

AI is widely used right now. Because in several fields, AI has already brought revolution. There is now no challenge that artificial intelligence cannot resolve. In terms of our science

and technology, it is undoubtedly a larger platform. Convolutional neural networks are useful for image data. For this reason, CNN also referred to as an image analyzer. It can be applied in different fields to maintain a variety of issues, for example, finding cancer cells or being able to identify illness in plants. Ultimately, we think it's helpful in solving our own difficulty. Additionally, our study finds that applying CNN works best whenever a current state-of-the-art tensor flow module is used. AI is presently popular sector we all know very carefully how difficult term classify fresh fruits and vegetables nowadays. So, using AI, we finally decide to try something different to identify between fresh fruit and rotten fruit similarly fresh vegetable and rotten vegetable.

1.5 Expected Output

Applying AI to identify fruits and vegetables has a wide range of advantages or expected outcomes. Here are a few of them:

- Create a stable model that can identify if fruits and vegetables are fresh or rotten.
- Help children to learn how to identify rotting fruits and vegetables.
- Make it easier to detect if fruits and vegetables are fresh or rotten.
- Help to save people valuable time.

1.6 Research Questions

This work is very challenging for us, as We are just beginning to complete our first professional project. The main issues on which this research is focused are listed below.

- Using the above image, can we detect if the fruits and veggies are fresh or rotten?
- What kinds of AI's limitation to identifying fresh or rotting produce?
- Does the project detect between so many fresh and rotting fruits and veggies in a single image?
- Who will benefit from our research, specifically?

1.7 Layout of the Report

Our research idea is based on the fact that Bangladesh is a farm base nation. The Bengali diet places a high value on fruits and vegetables. This work helps to identify fresh fruits and vegetables from rotten ones.

In Chapter 1, we have already talked about the initiation of the research papers, the objective, the reasons why we are working on this subject and the reasons why we are choosing these particular fruits and vegetables, problem statements, the expected results, the research question, and research methods.

In chapter 2, we'll talk about the history of the study and the relevant tasks that must be completed for this article This part is all about our study summarization. We also talk about the difficulties we have completed our task effectively and evaluate against the concepts we've selected.

In chapter 3, the approach of this research is provided. With the help of an appropriate graphic and table, we will quickly outline our whole coding procedure in this part.

In chapter 4, the experimental findings and discussion are covered. There will be several testing and research models.

Chapter 5 is all about Summary, comparison and analysis, Advantage of our application are covered.

Chapter 6 is all about conclusion and future research.

Chapter 7 Here all the references we used for this research.

CHAPTER 2

BACKGROUND

2.1 Introduction

This portion is actually about our previous work. Because our current work is based on previous work. The previous work left us with many points from which the idea of creating something new can be found. In this section, we explain our result real situation and look at our connected work concept. Here we will describe our experience with this project because it was challenging enough for us. We also describe in detail of our advantages and utility. Strong approach strategy as well as how we achieved this goal flawlessly and with the aim of improving performance and explain about how we reach this accuracy level.

2.2 Related Works

The application of deep learning has changed various sectors, including agriculture, healthcare, and others. There is a ton of deep learning ongoing thesis work. From the angle of Bangladesh, the author [13] classified medicinal plants using deep neural networks. Fruits and vegetables assorting has an impact on the export industry as well as evaluation. Humans can sort and grade, but it is lengthy and subjective. To assure their freshness and market worth, an expert fruit sorting system is required. Fruits and vegetables are rated using a computer vision approach that is accurate, egalitarian, and non-destructive. Author [1] used to Acquisition, segmentation, feature extraction, and classification are the four major processes of a computer vision-based examination.

Classifying different types of fruits is a difficult task. This paper describes a system for identifying between four different types of fruit and analyzing the fruit's quality rank. The author [2] utilized in-depth learning to analyze the fruit's quality ranking. The functionality from the extracting fruits from the input data using a Convolutional Neural Network (CNN). The authors [3] used suggested model performs admirably both transfer learning technique and state-of-the-art methods in regards to effectiveness. For disease

classification, CNN methods rely on hand-crafted characteristics that are not strong and complicated. Author [4] support our proposed model's superiority. Advanced artificial methods, such as CNNs, have emerged as a promising way to achieve higher accuracy, contempt the fact that they require a huge number of samples. The exterior qualities of fruits and vegetables, such as pigment, volume, shape, structure, and the presence of harm, are what define overall quality. examined damage to apple fruits to demonstrate several methods for extracting features for probabilistic neural network (PNN) forecast development. [5]. The aims of this project is to use CNN to understand whether an apple is fresh or not. The author [6] used CNN Detection and Maturity Status Classification. By trying to identify apples using Resnet 50 and classifying them using the proposed architecture, where able to achieve 97.92% accuracy.

The fruits can be sorted by the system. It can be used to inspect the status of fruits. It can be used to classify fruits in a retail store's self-service system. The system makes use of the high-quality 'ImageNet' dataset. There are 5 different kinds of fruit images in it. CNN are used in the model to recognize fruits from images. The accuracy was found to be 92.23 percent. Deep learning algorithms perform much better than Machine learning techniques. [7]. The traditional method is inconvenient, inconsistent, and quickly affected by the environment. The outcomes show that perhaps the suggested CNN model is capable in classifying fruits. The image data are then separated into fruit categories using a SoftMax function [8].

Traditional methods for detecting food spoilage are slow, time-consuming, subjective, and inefficient. For extracting features, mentioned a vision-based framework employs histograms, gray level co-occurrence matrices, a bag of features, and convolutional neural networks. Support vector machines-based classification techniques are used to carry out the classification [10].

Fruit classification is difficult due to many types and similarities in features. For fruit identification, the Pure Convolutional Neural Network (PCNN) obtains 98.88% accuracy. PCNN is built of seven convolutional layers, among which several are stride-followed [11].

The natural product business has increasingly recognized the value of technologies for picture analysis and machine vision. The ability of applying machine vision frameworks to advance item effectiveness while relieving individuals of the conventional basic sorting of natural items has been demonstrated in this field. This study discusses several image processing algorithms for fruit categorization. Author used [12] this approach to detect fruit or vegetable. This area points to utilize the dense CNN algorithm to identify and give successful way which is identifying the obvious citrus fruit flaws. Citrus fruit pictures are gathered and divided into two groups, excellent and injured, in order to identify and classify the photo collection. [15]. A modern Fully automated fruit assessment techniques built on a model are suggested. The CCD sensor is attached to the top of a conveyor system, and the computerized structure captures video footage from it. Analyses the images to gather a few important characteristics that are related to the fruit's freshness as well as maturity level. The system sorts the fruits into four tiers using fuzzy rules. Author used [16] fruit identification apparatus that employs machine vision. Implementing an image processing technology, which has been shown to be much more accurate, robust to visual contamination, and having another more reasonable computation approach, can be used to identify fruit skin conditions. The color histogram is retrieved as a picture inclusion inside this local image patch, and the linear SVM (Support vector machine) is used to train the classifier. [19].

In our work area, the proposed CNN model gives extremely high accuracy in reaching the conclusion that fruits and vegetables are fresh or rotten.

2.3 Research Summary

We ultimately realize to use convolutional neural networks after analyzing a vast collection of studies and other sources on our topic (CNN). Considering CNN's image categorization efficiency is consistently among the best, However, we recently employed a number of techniques to verify that those are KNN & SVM. Finally, we got the best accuracy by using CNN.

- On natural foods like fruits, vegetables, etc., this algorithm operates successfully. Now it combines with our objectives, work style, and motivation level. With appropriate training, CNN offers the highest performance for other picture classification and identification algorithms, with 95 percent or higher accuracy rate where KNN offer 64% and SVM 66%. Here we have compared which algorithm has more appropriate.
- With the right progression information, we can apply it without hassle in our new work plan. There are also several online resources that are easy to collect.
- It functions basically on every product, but when it relates to determining the nutritional value of vegetables and fruits, in comparison with other algorithms, it operates substantially more effectively. Furthermore, it is easy to tell whether such a fruit or vegetable is good or bad.
- CNN layers allow us to provide satisfactory results with high accuracy,

We are using CNN layers and deep learning techniques as we choose CNN (Convolutional Neural Network) as the major classifiers. To develop the system, we utilize Scikit-Learn, TensorFlow, keras, pandas, NumPy, matplotlib, on the backend. Using an inner database and Jupiter notebook is our major target. Using NVIDIA GTX 1660 6GB To support CUDA Code and fast processing. Its ability to increase capability while yet remaining within the budget-friendly range for graphics cards is what makes the Nvidia GTX 1660 so interesting.

Our final target is to construct machinery that could really distinguish among fresh and rotting fruits and veggies, as well as continually evaluate the outcomes.

Therefore, we used the Normalization layer, MaxPooling2D layer, Dropout layer (use 5 layer), Con2D layer (use 12 layer), flatten layer, activation layer to build our CNN layer. During the first time, the fruit area will have jackfruit, starfruit, and other approachable fruits, while the vegetable section will include cucumber, potato, and carrot. We can't classify items that are challenging to locate since doing so would reduce predictive performance. For this reason, we collect a huge amount of data. Our veggies and fruit database consists of six different kinds of produce. Combining fruits and vegetables such as carrot, potato, calabash, cucumber, eggplant, star fruit, jackfruit, papaya, and others, we ought to be capable of achieving acceptable precision. We pretend to be able to identify

among good and bad, as well as determine if a fruit or vegetable is nutritious and how excellent it is.

We have created an Android application to make our work easier and more user friendly

Implementations steps are given below:

1. Register to the firebase cloud:

In our application user have to create his/her profile using user name, E-mail address, phone numbers and password

2. Login to the firebase cloud:

After completing registration successfully user can log in by using phone number and password. In our application user have to create his/her profile using name, E-mail address, phone numbers and password before

3. Select the target photo:

We can use the camera to capture a real-time image in order to obtain a result. The application that demonstrates how we will choose a fruit image and display our results is given below. In this manner, we can also choose a picture of a vegetable from the gallery.

4. Send the photo the rest API server:

If we select a fruit affected by a disease, then the application will test and tell how much percent of it is good to eat. After that select a targeted photo from gallery or directly capture fruit, vegetable picture then sends the photo the rest of the API server for getting accuracy.

5. Fetch the result:

We can use the camera to capture a real-time image in order to obtain a result. The application that demonstrates how we will choose a fruit image and display our results. In this manner, we can also choose a picture of a vegetable from the gallery.

6. Show the result:

Finally, our expected result will be shown in our application display.

2.4 Scope of a Problem

Fruits and vegetables are the main food source in our countries people. However, individuals living in our country frequently experience a variety of issues as a result of their inability to correctly distinguish between fresh and decaying fruits and vegetables. Our objective is to create a system that will make it simple to distinguish among harmful and healthy veggies and fruits. We selected this Classification approach because, like we have taken by various our investigations, the Convolutional Neural Network act this type of function extremely well. These technologies will be available to be used for a variety of locations, including large factory superstores, in the future. We have currently trained our system to recognize fruits and vegetables from Bangladesh. Despite the fact that food is our basic right, consumers are constantly cheated with adulterated food or such spoiled fruits and vegetables.

We will create our project as open source and freely available for everyone to utilize. Our method makes it simple for magistrates to carry out their duties in various wholesale shop throughout our nation where rotten food is sold.

2.5 Challenges

2.5.1 Data Collection

Firstly, we haven't previously been used to deep learning work. For us, it is something entirely new. The present pandemic issue is the most fearful thing, ignoring all other situation. When we initially started working on this research, we were dealing with this pandemic problem. This situation has an impact on our first main task of collecting raw information. We are unable to contribute fully to this research because of this pandemic, which prevents us from working together. Due to this, we are having a lot of difficulties

with our work. Physically we could not collect data. We collect our necessary data from Google. However, gathering this data presents several challenges for us. Since the Bangladeshi fruits and vegetables dataset is not so much available in Kaggle, we had to collect it manually from google. Additionally, it has been difficult for us to gather information from Google on decaying fruits and vegetables. We initially thought that we would collect our data physically from farmers. Which actually did not happen for the covid 19 situation. However, we preprocessed and cleaned our data so that it would work correctly. Therefore, in order to establish this presence of freshness identification, we must conduct our training and testing process. To obtain better results, we wait till our ultimate solution.

2.5.2 Model Selection

Model identification is the method which is most important and effective part. New data is simulated using training and validation sets. There seem to be a lot of deep learning techniques available. Selecting the appropriate model among them is a big challenge. It is generally easier to complete the task when appropriate data and the appropriate model are chosen. Various kinds of image categorization models may be found. From there, we evaluated our system using CNN model to check how it did. Due to their great accuracy, CNNs are utilized for picture categorization and identification. Our model is implemented using Scikit-Learn, TensorFlow, keras, pandas, NumPy, matplotlib library.

2.5.3 Comparison

We first built our system based on our CNN model. However, it is contrasted with two distinct algorithms to determine whether it actually provides the best accuracy or if an alternative approach produces superior outcomes. So here three types of algorithms are used those are CNN, KNN and SVM. Here we mainly faced so many difficulties. Trained this KNN and SVM model is very challenging. SVM model is very much time-consuming process and those two-model accuracy was not so good.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Bangladesh is a country whose economy is built on agriculture. In our research we mainly focus Bangladeshi fruits and vegetables. mostly because farming is our source of revenue. Bangladesh's farming industry provides for 14.2% of the country's GDP and employs 42.7 percent of the workforce. Fresh fruit or vegetable sales are increasing every day. Health-conscious shoppers always select top-quality, naturally healthy fruits and vegetables. Fruits and vegetables contain nutrients, enzymes, and items that are derived from plants. They have a lot of fiber, too. There are numerous unique fruits and vegetables available, as well as various different ways to prepare, cook, and serve them. Having a balanced diet full of fruits and vegetables can help us from getting cancer, hypertension, and cardiovascular disease. The financial condition of most of the people in our country is not so good. In most cases, our agricultural society suffers a lot of losses due to spoilage of products. To secure their safety, it is necessary to differentiate decaying or unhealthy fruits or vegetables from fresh ones. This is the most important initiative in our farming sector. Nowadays, automation technology is an essential feature of existence. If farmers or retailers can detect and isolate bad fruits and vegetables early on, they will be protected from major action losses.

3.2 Research Subject

The fruits and food production industries are playing a more active role in the twenty-first century. The outflow of demand for fruits and vegetables, as well as global trade, govern the relationship between manufacturers and importers. There is a lengthy and time-consuming transportation technique for exporting or importing rotten or nearly rotten fruit which also obstructs quality assurance of a large quantity of fruits and vegetables. As a result, compared to prior years' global agricultural production and export, fruits and

vegetables output is predicted to drop even more. The collapse of trade is not just another challenge, unstable environmental trends, climate change, and Temperature rise is one of the major causes. Import or export response is generally required to monitor the condition of fruits and vegetables in a special way. Because it helps to understand the vitality of fruits and vegetables or how long it can be stored.

3.3 System Architecture

A system's complete specification and representation—known as its architectural description. System architecture contains a characteristic of the phenomenon, structure, and other characteristics. An ultimate system's implementation will be carried out by a number of interconnected sub-systems, which can be included in a proposed system. Fig. 3.3 is the system diagram we recommend. Here, we explain our entire working process. The system's working parts are all visible in the structure. The architectural style displays the abstract and overall viewpoint of how the system functions, as was indicated below in the overview portion.

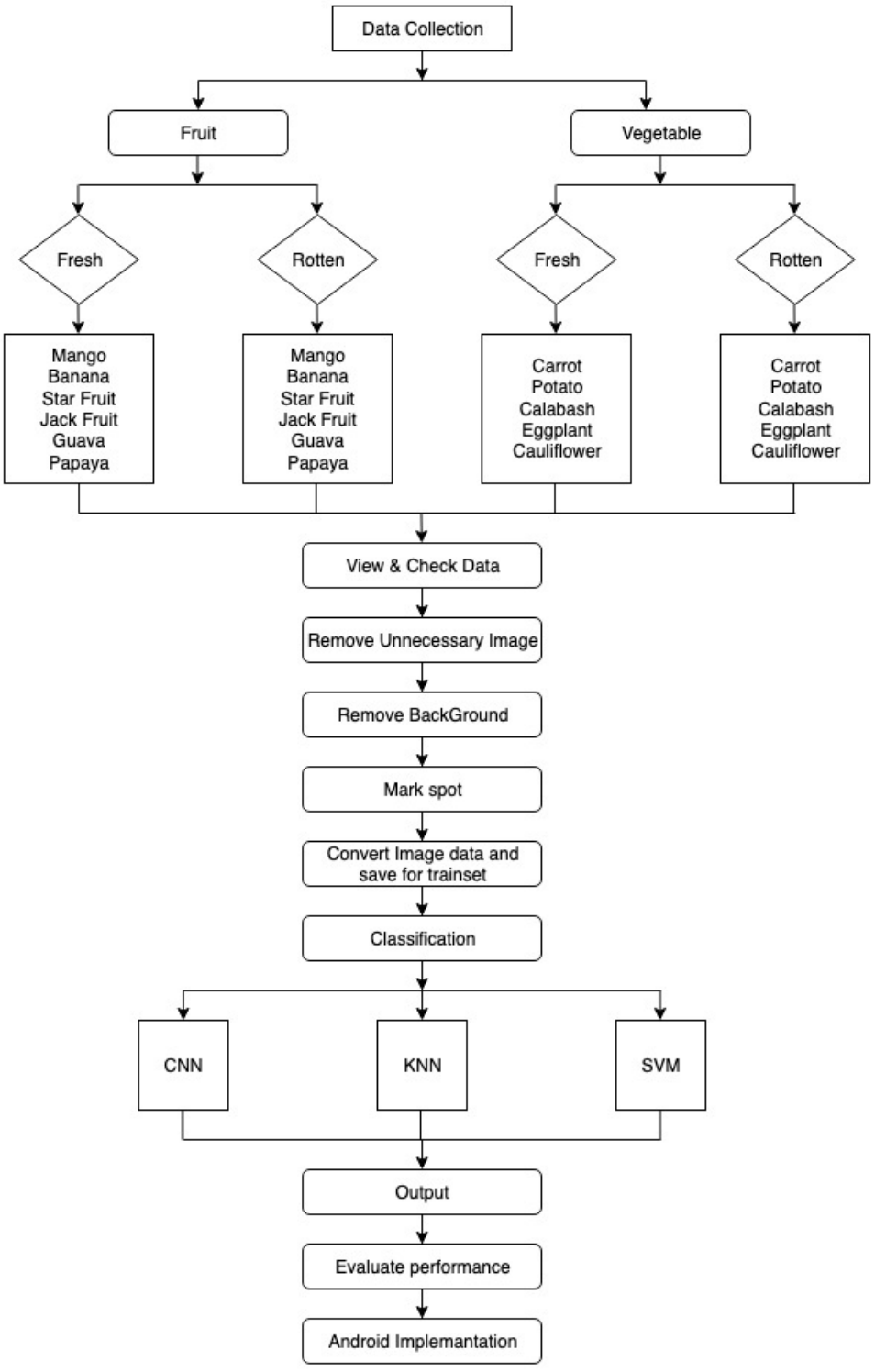

Fig. 3.3 System architecture

3.4 Data Collection

We used some commonly available Bangladeshi fruits and vegetables in our research. We have collected our required dataset from Google.com and kaggle.com. We gathered information for two major categories: fruits and vegetables. In these two categories also divided into another two categories. For classification, the dataset includes fresh fruits, rotten fruits, and fresh vegetables, rotten vegetables. There are six types of fruits in the collected data and vegetables is divided into 5types.

As follows:

Fruit: Mango, Banana, Starfruit, Jackfruit, Guava, Papaya these are our collected data for fruit section from our research.

Fresh Fruits:

Here is our fresh fruit.

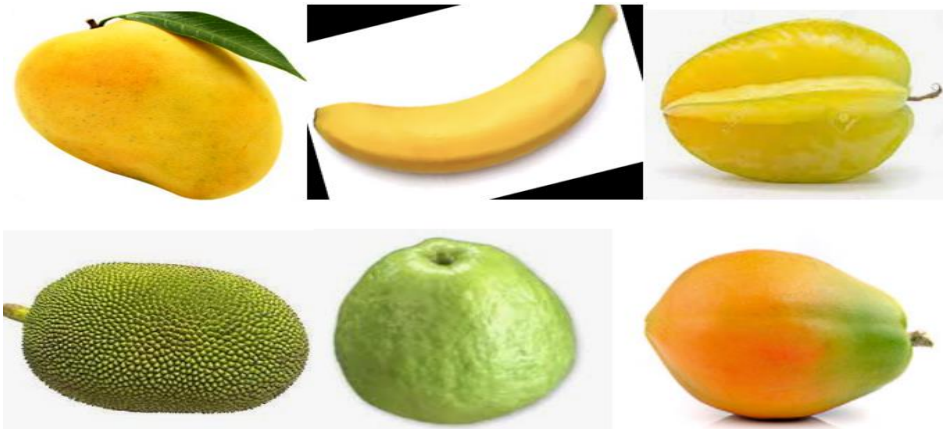

Fig. 3.4.1 Fresh fruit from dataset

Rotten fruits:

Some of our collected rotten fruit sample.

Fig.3.4.2 Rotten fruit from dataset

Vegetables:

Carrot, Potato, Calabash, Cucumber, Eggplant, Cauliflower those are our vegetable portion dataset.

Fresh vegetable:

Here are our fresh vegetable images.

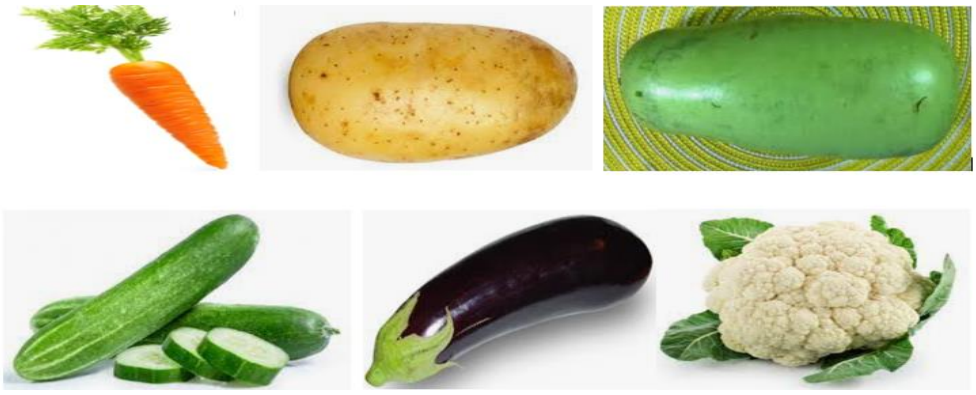

Fig.3.4.3 fresh vegetable from dataset

Rotten vegetable:

Here are our rotten vegetable images that we were collected form google.

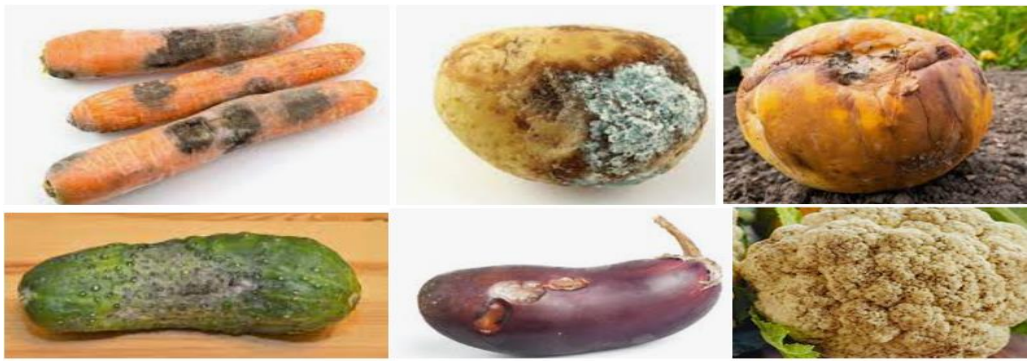

Fig.3.4.4 Rotten vegetable from dataset

The dataset which was used for training and test. In the training section we used 160 images and the testing part we used 40 types of images. Here we mainly split our dataset in the standard format.

Table 3.4 Data collection

Name of Fruits & vegetables	Number of Training Data		Number of Testing Data	
	Fresh	Rotten	Fresh	Rotten
Mango	160	160	40	40
Banana	160	160	40	40
Star fruit	160	160	40	40
Jackfruit	160	160	40	40
Guava	160	160	40	40
Papaya	160	160	40	40
Carrot	160	160	40	40
Potato	160	160	40	40
Calabash	160	160	40	40
Cucumber	160	160	40	40
Eggplant	160	160	40	40
Cauliflower	160	160	40	40

3.5 Data Preprocessing

Data processing is a method of changing information from a given form to one that is considerably more useful and desired making it more instructive and useful. This procedure may be managed using Machine Learning techniques, numerical methods, and analytical expertise. Data preprocessing is a very important term. We have divided data preprocessing into different parts in our research. It helps us to get out expected output. Looking at the images of fruits and vegetables, our main task is to determine the percentage of good and bad.

3.5.1 Data Visualization:

The graphic display of content and documentation is commonly referred to as visualizing. Data representation techniques offer an easy approach to observe and analyze statistics, exceptions, and structures within information by utilizing visual components as singles charts, graphs showing, and locations. In this plot graph is mainly display our images height and widths data visualization which is shown by Fig. 3.5.1.1. Raw data must be seen before analysis, so we mainly visualize our data here. Through this we understand how the data is and the similarity between them.

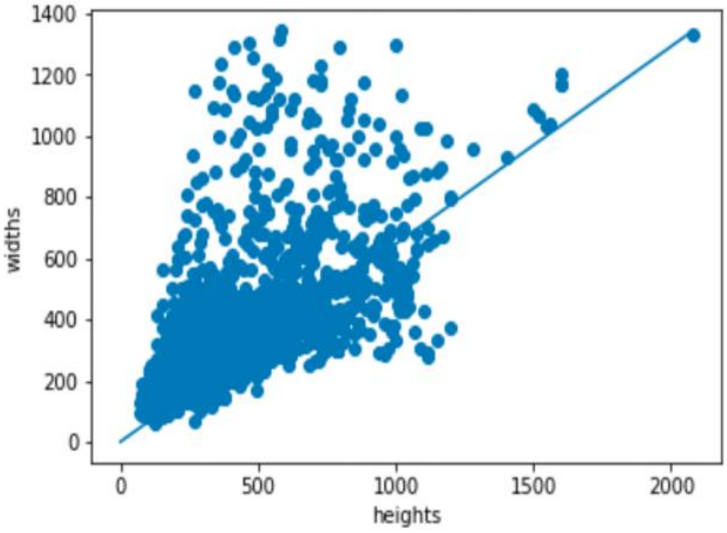

Fig.3.5.1.1 Data visualization

View and check Dataset:

At first, look over everything and double-check the dataset. View data means that the data we collect is all we see one by one. After the set of data gathering techniques had been successfully completed, the gathered data were examined, examined, and produced higher effective by removing irrelevant information.

I. Remove unnecessary image:

We have 2 categories of data in our dataset and there are some more types of these 2 types. We must make sure that information is first separated into classes. Additionally, one object class does not belong in another. If there is any such unnecessary data then it should be removed. We collected the dataset in a random way. However fresh information is required for the integrated processes. For this reason, this step is very essential.

II. Remove background:

Removed all image background. To remove the background from the dataset, a third-party library was used which is 'rembg'. This library makes our task much easier than it was previously. It would be extremely tough and time consuming to complete this investigation in Photoshop. Due to the size of our data set This library solved our problem quickly and easily. In Fig. 3.5.2 we display some of our data picture. After completing this background removing part our collected all datasets are shown like this.

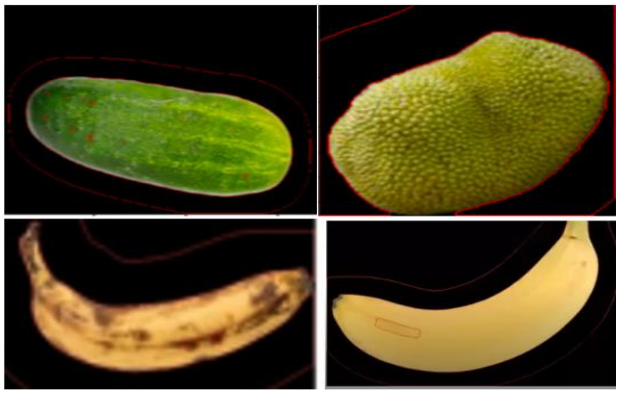

Fig.3.5.2 Background remove from Dataset

III. Mark spot:

Then the next term is mark spot on all dataset. Here we also use a 3rd. party library which is ‘contours. When fruits or vegetables start to spoil, a variety of spots and color changes occur. The machine basically determines whether the fruit or vegetable is good or not based on the color that has changed from its normal color or this type of spots. Therefore, spot detection is necessary in this case. Depending on the size of the spot, the machine will decide exactly what percentage is good. Because in our collected dataset fresh fruit or vegetable is looking good and fresh and the rotten part is totally opposite. Since we have used 3rd party libraries for spot detection, Fig.3.5.3 shows how our system detects a sport in Fruits and Vegetables. Mainly depending on these sports, our system generate result either fruit or vegetable is fresh or not. So, its undoubtedly an important term. Our system perfectly detects every spot as we can see.

Fig.3.5.3 Mark spot

v) Convert image data and save for trainset:

After that convert image data into image dataset class by class. Here Not all images in the dataset are the same size, so here all images are resized according to their category. Images are transformed to NumPy arrays for easier analysis. Input size in Neural Network is 500*500 pixels. The scaled photograph is modified to NumPy since the machine cannot comprehend RGB values; it can only interpret Floating and Integer varieties of values, and

NumPy turns each pixel to a float variable. Because our input layer is one dimension, all values are first in three dimensions and then converted to one dimension.

3.6 Proposed Methodology

Data are classified into classes or categories using classification methods. Both organized and unstructured information may be used to conduct it. We've used three kinds of algorithm in our Research which is CNN, KNN, SVM.

3.6.1 Algorithm Classification

3.6.1.1 CNN Classification

In our research, we used OpenCV in Python to develop an image classifier for recognizing fresh vs. rotting fruits and vegetables. Instead of analyzing the complete picture, CNN focuses on finding useful elements within it. CNN has a number of levels that aren't visible to the human eye. Simultaneously as an output level and as an input level. To attain our destination, we'll utilize Convolutional Neural Networks (CNN), one of the most commonly used machine learning techniques for categorizing images. Convolution is a method for combining two analytical operations in a single function. As we all know, A machine learning method called CNN enables computers to recognize and remember visual characteristics in order to predict whether the identification of a new photo has been included in the system. The operating procedure of our CNN model is represented in Fig. 3.6.1.1.

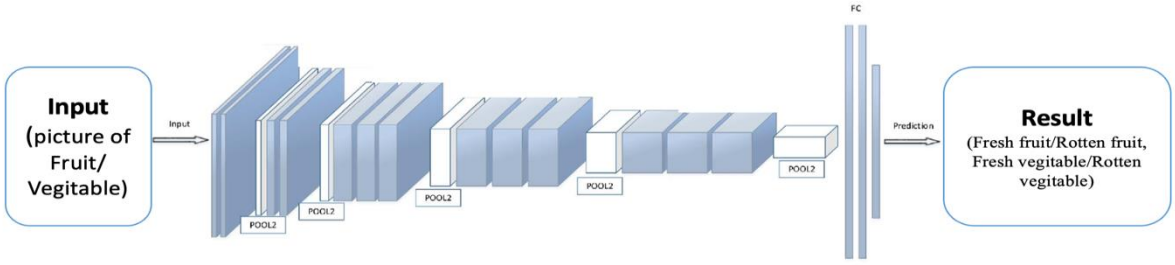

Fig 3.6.1.1 CNN classification

3.6.1.2 KNN Classification

To classify fresh and rotting fruit and vegetable images, we'll use our k-Nearest Neighbors (k-NN) algorithm. In this study, we'll use the k-Nearest Neighbors classifier to try to identify each one of these types in a picture using only raw data points. In order to categorize a picture as input from the categories, the KNN method is now applied. The K-NN approach primarily maintains all available information and recognizes a new piece of information based on how closely it resembles the available information. This suggests that the K-NN technique can swiftly categorize new information whenever it arrives into an appropriate section. It works mainly by Choosing the K - th neighbor's value. Find the Euclidean separation among K neighbors. Using the maximum distance, select the K nearest neighbors.

Where,
Euclidean distance is

$$\mathbf{d = \sqrt{[(x2 - x1)^2 + (y2 - y1)^2]}} \quad \mathbf{(1)}$$

3.6.1.3 SVM Classification

SVM is known as a Methodology for supervised learning of machines that can be applied to both in regression and classification problems. Although We may also suggest that segmentation is the best solution for regression problems. Finding a hyperplane in an N-dimensional structure that classify data point more clearly is the aim of the SVM approach. These points we mainly known as support vector. There are two kinds of SVM:

A linear SVM Classification algorithm is a form of classifier that uses a single straight line to divide data set into two groups. We have such a collection with two categories for fruits and vegetables, along with new and rotten parts, giving it two features x1(F1, R1) and x2(F2, R2). We need a predictor that can categorize the coordinate pairs x1(F1, R1) and

x2(F2, R2) in either fresh or rotting fruit or vegetables (fresh or rotten). It is shown in the equation 2.

Non-Linear SVM is applied to classify non-linearly divided information, which indicates that if any information can't be organized to use a solid line. We've utilized two dimensions for linear input, x and y, therefore we'll add a third dimension, z, for non-linear data. It can be calculated by utilizing the equation below:

$$z=x^2+y^2 \quad (2)$$

3.7 Output

Here we have shown some of our experimental result. We have analyzed 6 types of Bangladeshi fruits and vegetables in our research. Here are some output examples. Using our technique, rotting veggies and fruits can be quickly found. We can find our expected result here. 99.28% accuracy is provided when we selected fresh jackfruit. Additional fruits and vegetables proceed in a similar manner. Segmentation of fresh cucumber, potato, and carrot using information images. Fresh cucumber accuracy is 98.12%, potato is 95.28% and carrot is 99.69% similarly rotten percentage is cucumber 68.84%, potato 70.59% and carrot is 68.91%. All of the output information's are given below in details.

3.7.1 Showing Result in Fruit Section

3.7.1.1 Detection of Fresh Jackfruit and Star Fruit from Dataset Images:

First, we checked at two popular fruits in Bangladesh: jackfruit and starfruit. Bangladeshi productivity and land area the jackfruit is Bangladesh's second-most produced fruit and has the third-largest region of agriculture. We can see here when we selected fresh jackfruit then our algorithm identifies it and provide 99.28% accuracy. Similarly when we selected our collected another fruit which is starfruit our proposed system provide 96.11% accuracy which is really good. Fig. 3.7.1.1 is contain our outcome.

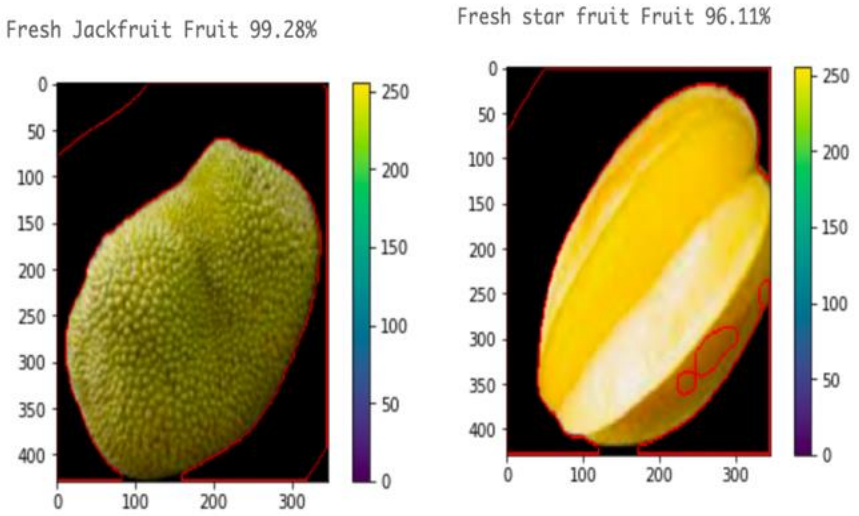

Fig. 3.7.1.1 Detection of fresh Jackfruit and star fruit from dataset images

3.7.1.2 Detection of Rotten Jackfruit and Star Fruit from Dataset Images:

In the same way when we check rotten Jackfruit and star fruit from dataset images. Here also our system provides expected result. when we select a rotten jackfruit then our system checked how much percent rotten and it was 87.27% rotten and when we selected rotten starfruit our system provides 90.49% accuracy. Fig. 3.7.1.2 shows our output.

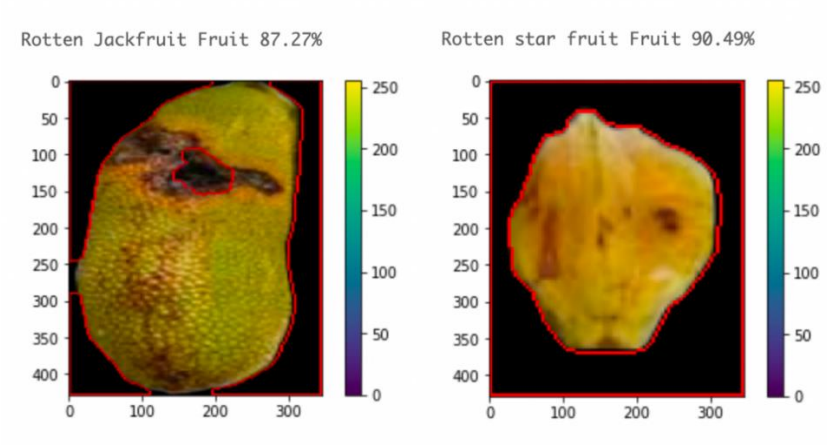

Fig. 3.7.1.2 Detection of rotten Jackfruit and star fruit from dataset images

3.7.1 Showing Result in Vegetable Section:

3.7.2.1 Detection of Fresh Cucumber, Potato and Carrot from Dataset Images

In this vegetable part at first, we analyzed cucumber. Cucumbers is a Warm-season veggies. They cannot stand freezing. Warming under 10° C (50° F) may have an adverse effect on crop development. Temperature is a fact here. But now we get all kinds of fruits and vegetables throughout the year. This is especially important for our system. Because it can be seen that it is difficult to analyze whether summer vegetables are available in the cold season and how good or bad, they are. When we analyzed fresh cucumber, our system provides us 98.12% accuracy and also Fig. 3.7.2.1 is shown a fresh cucumber. So, it is clear that our system provides us accurate result.in this similar way we checked potato and carrot freshness. 95.28% accuracy is provided in potato and 99.69% accuracy is provided in carrot.

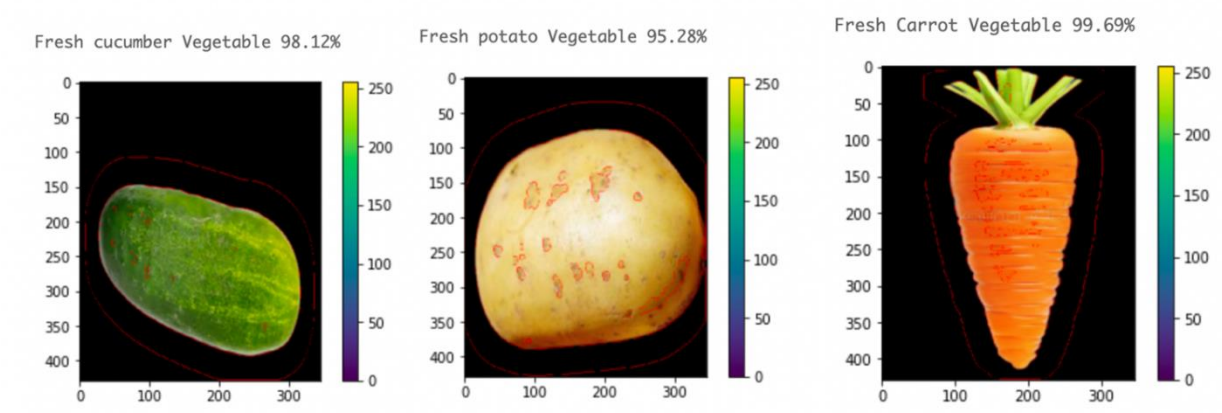

Fig. 3.7.2.1 Detection of fresh cucumber, potato and carrot from dataset images

3.7.2.2 Detection of Rotten Cucumber, Potato and Carrot from Dataset Images

Similarly, we have checked to use in our system how rotten cucumbers, potatoes, carrots are. rotten percentage is cucumber 68.84%, potato 70.59% and carrot is 68.91%. As we can see Fig. 3.7.2.2.

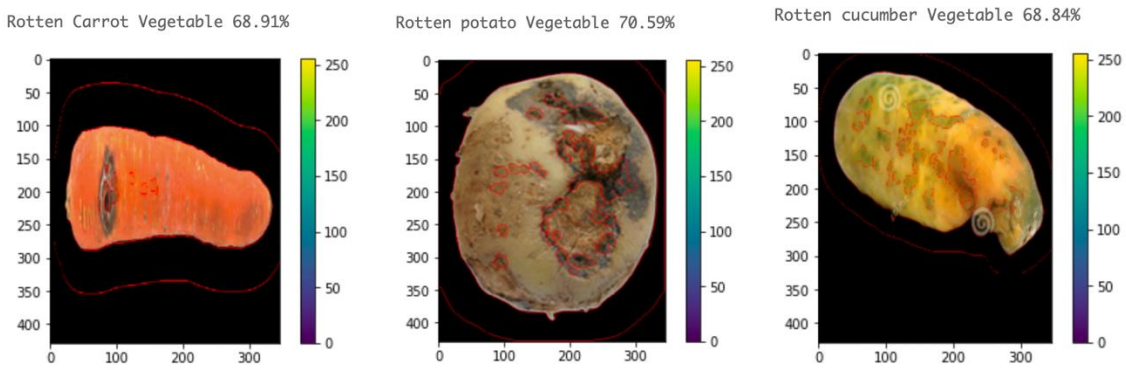

Fig. 3.7.2.2 Detection of rotten cucumber, potato and carrot from dataset images

3.8 System Implementation

We have created an Android application to make our work easier and more user friendly.

1. Register and login to the firebase cloud:

In our application this is the first part. Firstly, user have to create his/her profile using user name, E-mail address, phone number and a password. After completing registration successfully user can log in by using cell-phone number and password which was already sated. As we can see Fig. 3.8.1.

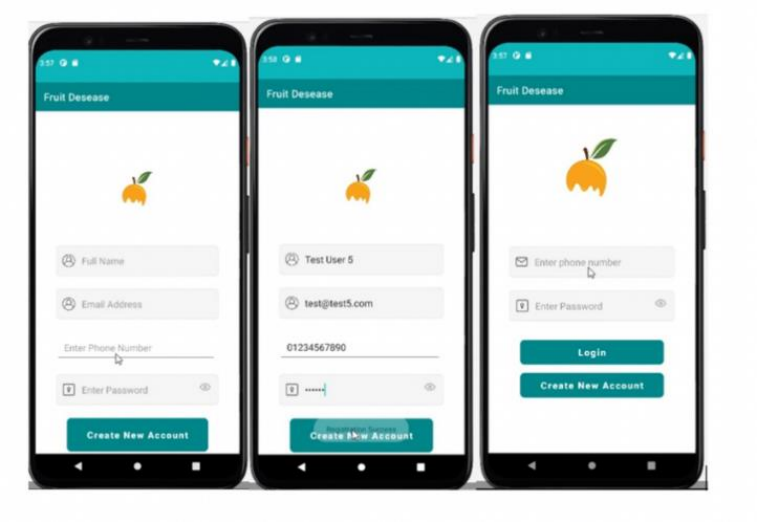

Fig 3.8.1 Register and login of our system

2. Capturing and Selecting the target photo & send the photo the rest API server:

After that select a targeted photo from gallery or directly capture a photo then Send the photo the rest API server for getting accuracy. Using Python Flax framework at first, we created an API. For which when we capture a picture from android and send it our generated server, server process it and give our result. Like If we select a fruit affected by a disease, then the application will test and tell how much percent of it is good. Fig.3.8.2 is containing our application second interface. After completing login or registration section our system proposed directly capture picture so that user can easily understand what can they do.

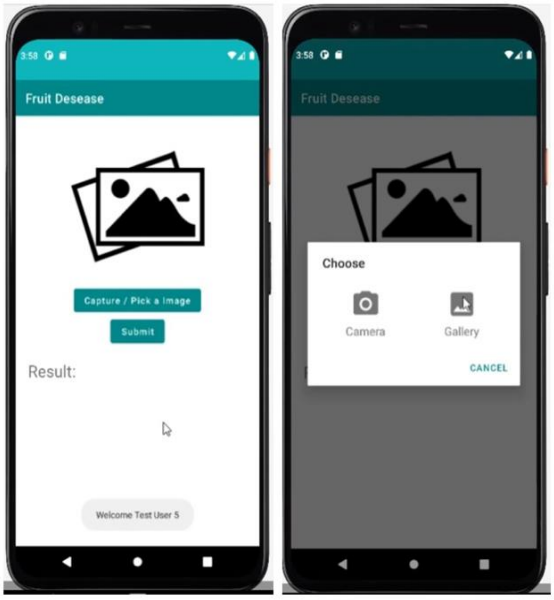

Fig.3.8.2 Select the target photo

3. fetch the result & show the result:

The application that demonstrates how we will choose the fruit image and display our results is given below. Similarly, we can choose a picture of a vegetable. In order to achieve the desired outcome, we chose the image in the image from the gallery. In this manner, we can use the camera to capture a real-time image in order to obtain a result. Here fetch the result & show for Banana Fig.3.8.3. Our application analyzed it's a fresh banana because its 44.91 % are fresh.

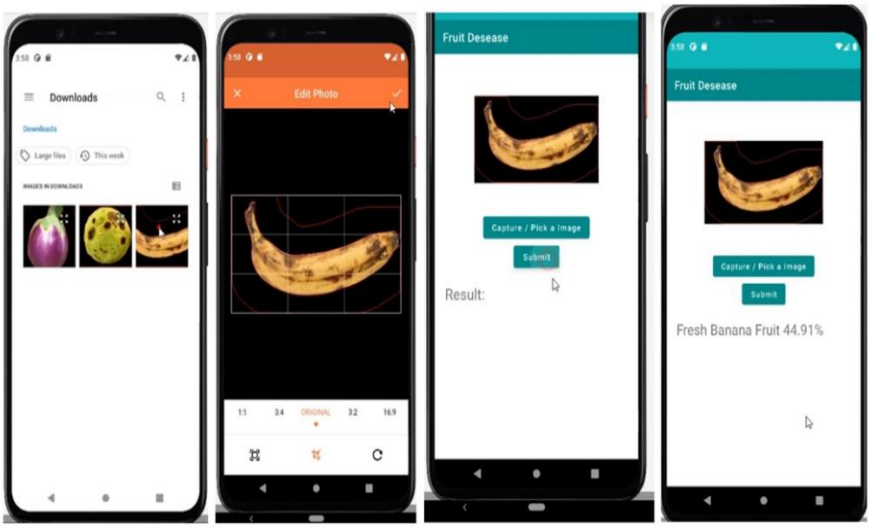

Fig.3.8.3 fetch the result & show for Banana

In the same way is followed in Fig.3.8.4. Here checks the Guava fruit. At first collect a picture from gallery then push the submit button after that our system automatically generate result and shown. In our application It is clearly shown it's a rotten guava and the accuracy is 72.35%.

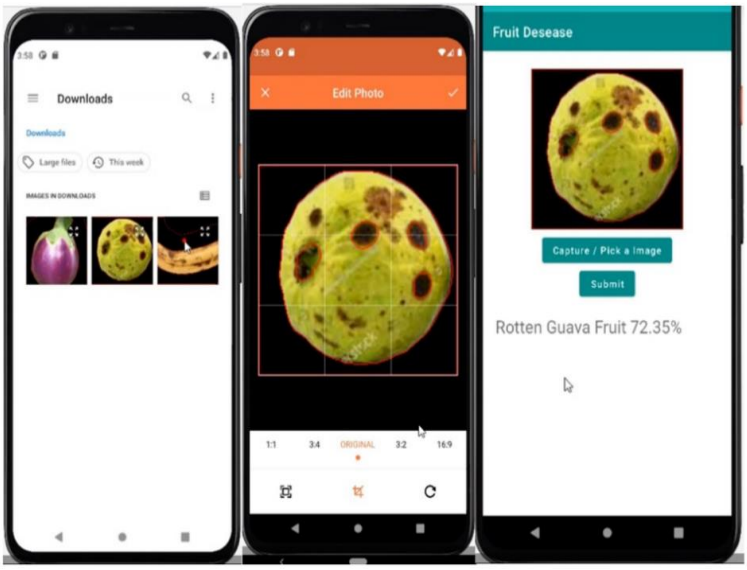

Fig.3.8.4 Fetch the result & show for Guava

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Model Accuracy

Model accuracy is a statistic used to assess that what model is most effective in detecting patterns and correlations among data samples depending on the information, or trained, information. In every phase of the process, we see that the overall accuracy keeps rising. Then, we reach an accuracy of up to 95 percent, which is training accuracy, as well as an appropriate Val accuracy of 78 percent.

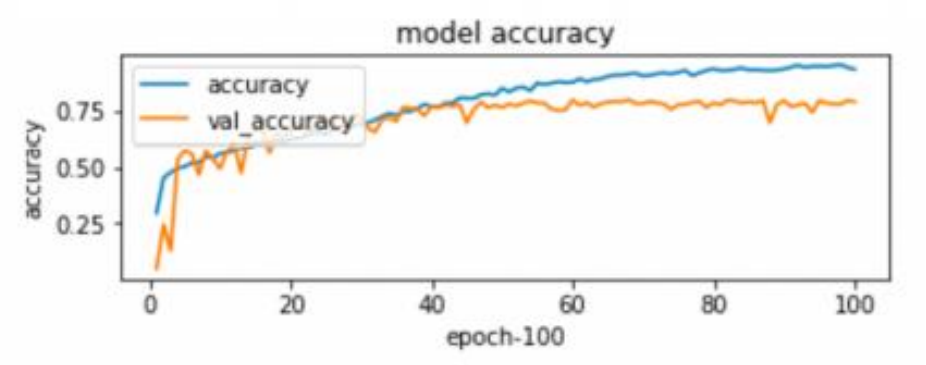

Fig.4.1 Model accuracy

$$\textbf{Accuracy} = \frac{(\textbf{TP}+\textbf{TN})}{(\textbf{TP}+\textbf{TN}+\textbf{FP}+\textbf{FN})} \quad \textbf{(3)}$$

The confusion matrix shown in equation 3 is frequently applied to evaluate how well the classification methodology works. Here TP (true positive), TN (true negative), FP (false positive), FN (false negative). True positive means an assessment that was expected to be positive and turned out to be such. True negative (TN) rate refers to the percentage of expected values that are really negative. False positive (FP) observations are those that are projected to be positive but are really negative and false negative (FN) denotes for the various types of information set, positive values were expected to be negatively.

4.2 Model Loss

In other words, loss is a measure of how poorly the model predicted a particular case. This loss-v-loss (validation loss) graph demonstrates that the loss is falling. This equates to 7%. This validation loss can be calculated on the v-set once our data has been processed (validation set).

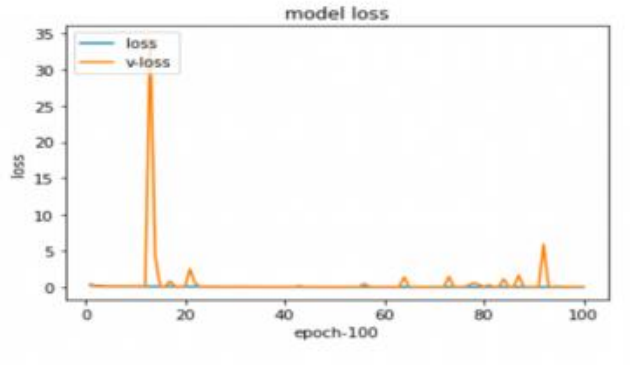

Fig.4.2 Model loss

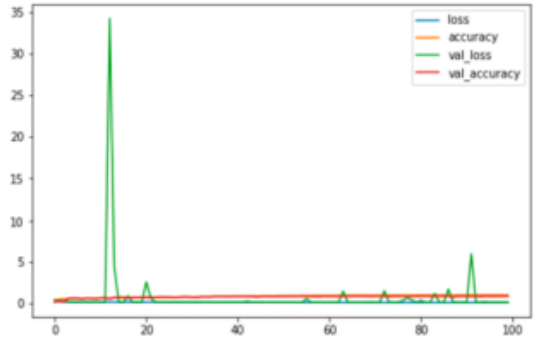

Fig. 4.2.1 Validation loss and accuracy

4.3 Algorithm Techniques

Our Classification algorithm has a validation accuracy of 78%, our validation loss of 7% and a training accuracy of 95%. Additionally, the SVM obtained a 66 percent training accuracy, a 5 percent validation loss, and a 58 percent validation accuracy. KNN model improved its training accuracy by 64%, while seeing a 56% increase in validation accuracy.

CNN model has the maximum accuracy in this analysis, thus. Table has been updated with a brief explanation.

Table 4.3 Algorithm technique

Algorithm	Epoch	Training Loss	Training Accuracy	Validation Loss	Validation Accuracy
CNN	100	2%	95%	7%	78%
SVM	23	4%	66%	5%	58%
KNN	23	5%	64%	6%	56%

4.4 Result Discussion

We discovered the desired results after running our all collected information then building the model using the supplied data. After training and test data, we discovered that our model is working quite good & it can reliably identify freshness and damaged fruits 95% of the time. Our anticipated outcomes came from CNN, and for comparability, two additional techniques were also analyzed before we could eventually choose our best system.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTANABILITY

5.1 Impact on Society

Our country is mainly farming based. Most of the village people earn their livelihood by doing agricultural work**.** in our project we mainly work Bangladeshi very common type of fruit and vegetable. In our dataset we collected in fruit section: mango, banana, papaya, guava, jackfruit and star-fruit. On the other hand, in vegetable section, we have collected potato, carrot, calabash, eggplant, cucumber. Those types of fruit and vegetable is very common. This type of fruit and vegetable is produced by most of the people at home. our main aim is to reach all the general people. General people can use our research for buying and selling product because we also implement it in an android application. Most of the people in our country use android feature phone. So, we think it's easy to use. User just capture a picture or select picture from gallery and our research justify the fruit and vegetable condition. Our work can utilize farming people, businessman and general people.

Most of the people in our country buy it any wholesale market or any supersharp. Due to the lack of time, they cannot determine whether this food is fresh or not. So, in this time they can use our technology.

5.2 Impact on Environment

To ensure healthy diet and concern about health issue we implement this type of automation system using deep learning. The majority of individuals in our nation purchase it at any superstore or wholesale marketplace. They don't have enough time to check to see if the food is fresh. They can thus utilize our technologies at this moment. Checking when buying fruits or vegetables is a time-consuming task. Most of the time people cannot concern about that. For this time, they buy rotten fruit or vegetable which is very much harmful to our health and waste of money. To reduce this type of problem and concern about health issue to build this type of automation system.

5.3 Ethical Analysis

The proper moral course of action in a given circumstance can be determined by a methodical process known as ethical analysis. You can determine whether solutions are both practical and desirable by doing a logical analysis of the problem in accordance with your moral principles. The guidelines for ethical assessment urge you to accurately assess the situation and consider the implications of your choices before acting. When employees or superiors act unethically, you can utilize ethical analysis to steer your organization back in the right direction.

In our research we mainly work in Bangladesh perspective. Our main ainis to reach all the general people. Every profession people can use our system. If it uses any farming sector people, they able to know about the condition of their productive product. General people can use it after buy those type of fruit or vegetable. All the products that people have to buy from the market every day is a difficult and time-consuming matter. Mainly job holder persons suffer a lot because of it. So, they can easily use it. Besides it will be very helpful for those who buy wholesale products.

5.4 Sustainability Plan

In our country Fruit and vegetable is our main food. Most of the people depend on it is their major meal. Our application is made depending on the food migration of the people of Bangladesh. And very common type of fruit and vegetable are kept here so that common people can use it in real life. It does not cause any harm to the environment. Rather it can help to prevent rotting of fruits or vegetables. If it is possible to know the percentage of freshness of fruits or vegetables from this system, then our farmer sector and general people both will understand how long a fruit or vegetable can be kept.

CHAPTER 6

SUMMARY, RESULT COMPARISON, ADVANTAGES OF THE APPLICATION, CONCLUSION AND FUTURE RESEARCH

6.1 Summary

Our experiment's goal was to test the ability of a given image to discriminate between fresh fruits and vegetables and rotting ones. In our article, we discovered that CNN identifies images fairly effectively. Our original data for the study came from a variety of organizations. To finish our project after preprocessing, we separate the training from the evaluation. Eventually, we got the results we were hoping for. To make our system user friendly we are also making it an Android application. Because it is the work of the farming sector and currently most of the people use Android phones and more or less knows how to use it, so using such an application will not be very difficult. With this in mind, we have built this application where the quality of fruits or vegetables can be understood through the use of picture captions. The application not only identifies the freshness or rotten fruit or vegetable, it is also able to tell the nutrition of fruit or vegetable.

6.2 Result Comparison

Table 5.2 comparison with some previous works:

Work	**Algorithm**	**Accuracy**
Fruits and vegetables quality evaluation using computer vision	SVM	97%
Identification of Fruits Using Deep Learning Approach	CNN	92.23%

A comparative analysis on fruit freshness classification	SVM	86%
A Deep Neural Network based disease detection scheme for Citrus fruits	CNN	89.1%
Automatic Classification for Fruits' Types and Identification of Rotten Ones using k-NN and SVM.	k-NN and SVM	96.3%
A Design of Deep Learning Experimentation for Fruit Freshness Detection	CNN	88%
Detection of fruit skin defects using machine vision system	SVM	96.7%

The following table shows how many researchers have used different kinds of algorithms and also have obtained various precision and accuracy, but the best accuracy is 97%. SVM is employed in this study to determine the fruit and vegetable quality. Another research publication uses the same method to identify fruit skin defection and achieves 96.7% accuracy, that is excellent. This method is often used to categorize the freshness of fruit. Here, reliability is just 86%, indicating a lower level. In the same study, CNN offers superior accuracy (88%). The next study obtained 96.3% using k-NN and SVM to categorize the kind of fruit and distinguish rotting from the rest. Using CNN to this task of fruit identification results in less reliability than in the past. 92.23% of this is production. The disease detection performance for citrus fruits using the CNN approach was 89.1%. After reviewing all those papers, we tried to implement our system. By looking at the above papers, we have been able to detect rotten fruits and vegetables in one platform. We simply utilize CNN, and during data preparation, we simply resize the photo to meet our needs. This model can accurately distinguish between fresh and rotting fruit and vegetables, making it a far better option for our farmers, business faculty, and the general public. We get our best accuracy from CNN 95% accuracy.

6.3 Advantages of The Application

At present we get all kinds of fruits and vegetables in every month in supermarkets or any whole sell shop. It is very difficult for consumers to identify good and bad among all kinds of fruits and vegetables and it's also a time-consuming process. In this case our system will help general people. They can easily find out whether this fruit or vegetable is fresh or not using our technology. Our main goal is to reach all the general people. For this reason, we also build an android application. Because in our country most of the people can operate android feature phone. We build a simple application. Here user only capture fruit or vegetable picture then our system provides this food rotten or freshness. If the fruit or vegetable is fresh then what percentage is fresh our system provides this. A pie chart will also show it for ease of understanding. In the similar way if this food is not fresh then what percentage is rotten it will be shown. Our system is very helpful for farmers and businessman. Our application is very good for businessman because they buy many fruits and vegetables in wholesale. Not all fruits and vegetables are sold in one day. Again, while buying in wholesale, it is not possible to check the quality of all the products. Our application can help them in this case. Within a short time, they will be able to see how good or bad the product they bought is. They can determine which products are selling quickly and which are not by doing this. It is possible to sell in advance the produce that would spoil if maintained in the store. is would save the massive volume of fruits and vegetables that are wasted at wholesale marketplaces.

Our system will also helpful in our farming society. Because they also can easily find out which products will sell early and which not. Because the farmers of our country are always neglected. Big traders buy products from them for less money and sell them in the market for much more money. Farmers also give products at a low price so that they don't waste food by keeping it. Which is really unfair. By using our system or Android application, they can understand how long they can sell any vegetable or fruit. By doing this, other unscrupulous people will not be able to cheat them and buy products at low prices.

6.4 Conclusion

This research proposes a novel approach for categorizing fruits and vegetables using a convolutional neural network algorithm. The findings shown above were obtained utilizing total of 160 and 40 photos for training and testing. The preceding technique was coded and tested using Anaconda application. Various fruit & vegetable kinds from varity origins were selected for training and testing. The suggested method had a 95% accuracy rate. The CNN technique is used in this study to classify fruits & vegetables. Multiple arrangements of the dataset's convolution layer were used to create the efficiency and loss graphs. This study examines many strategies and methods for the identification and classification of rotten fruit and vegetables, all of which are dependent on the machine learning technique.

6.5 Future Work

It is hoped that in the future the work can be extended to a larger data set containing more varieties of fruits and vegetables. Consider implementing several CNN-based algorithms to evaluate their efficiency using the same collected data. Can also be studied on other features for classification and classification, can identify disease types and/or the resulting texture structure. All this is a direction in the future. We will add new features to our Android application. Going forward, we will try to detect how long a fruit and vegetable will stay alive and whether there is any kind of poisoned in eating it. Because currently farmers use formalin to keep fruits and vegetables good for a long time. That is very harmful to our health. For this reason, we will try to detect this

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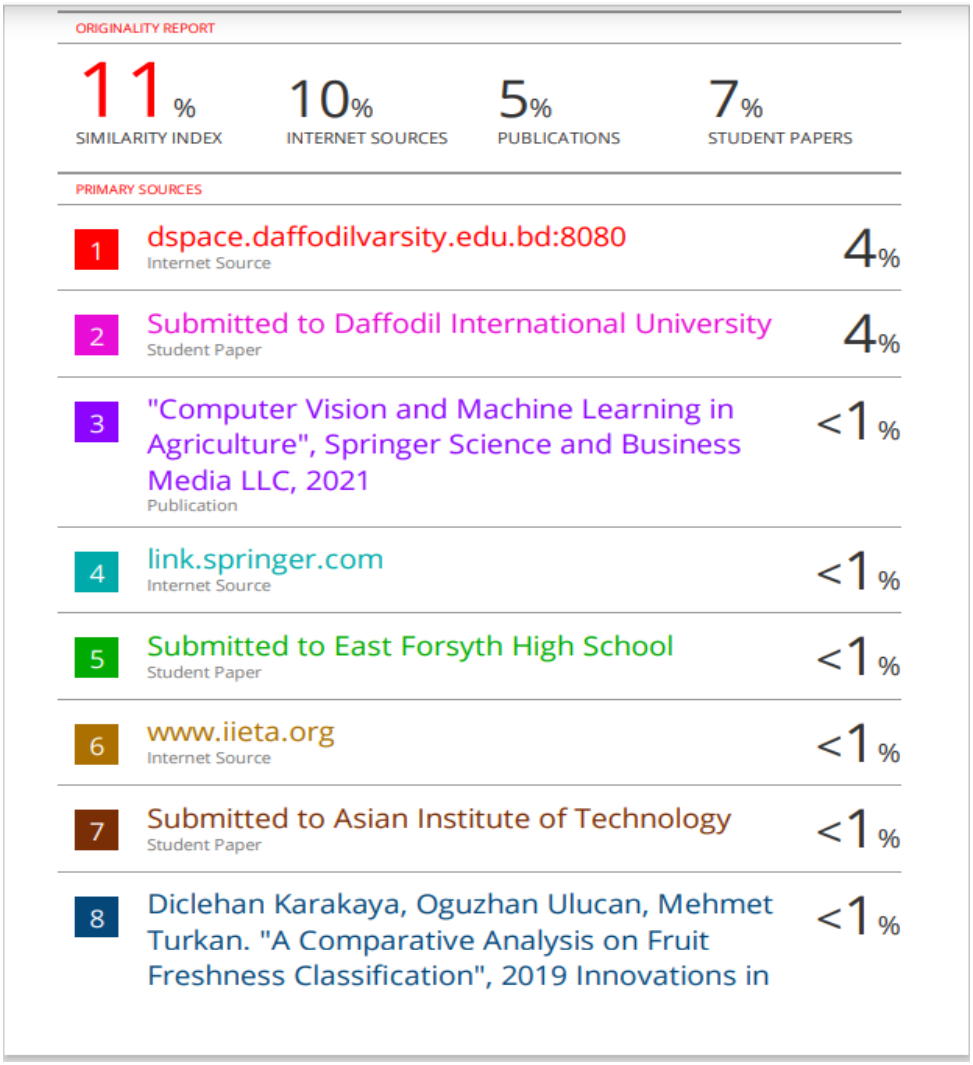

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