Smart Farming: Potato Leaf Disease Detection Using Deep Learning

By
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A thesis submitted in partial fulfillment of the requirement for the degree of Bachelor of Science in Software Engineering

Department of Software Engineering
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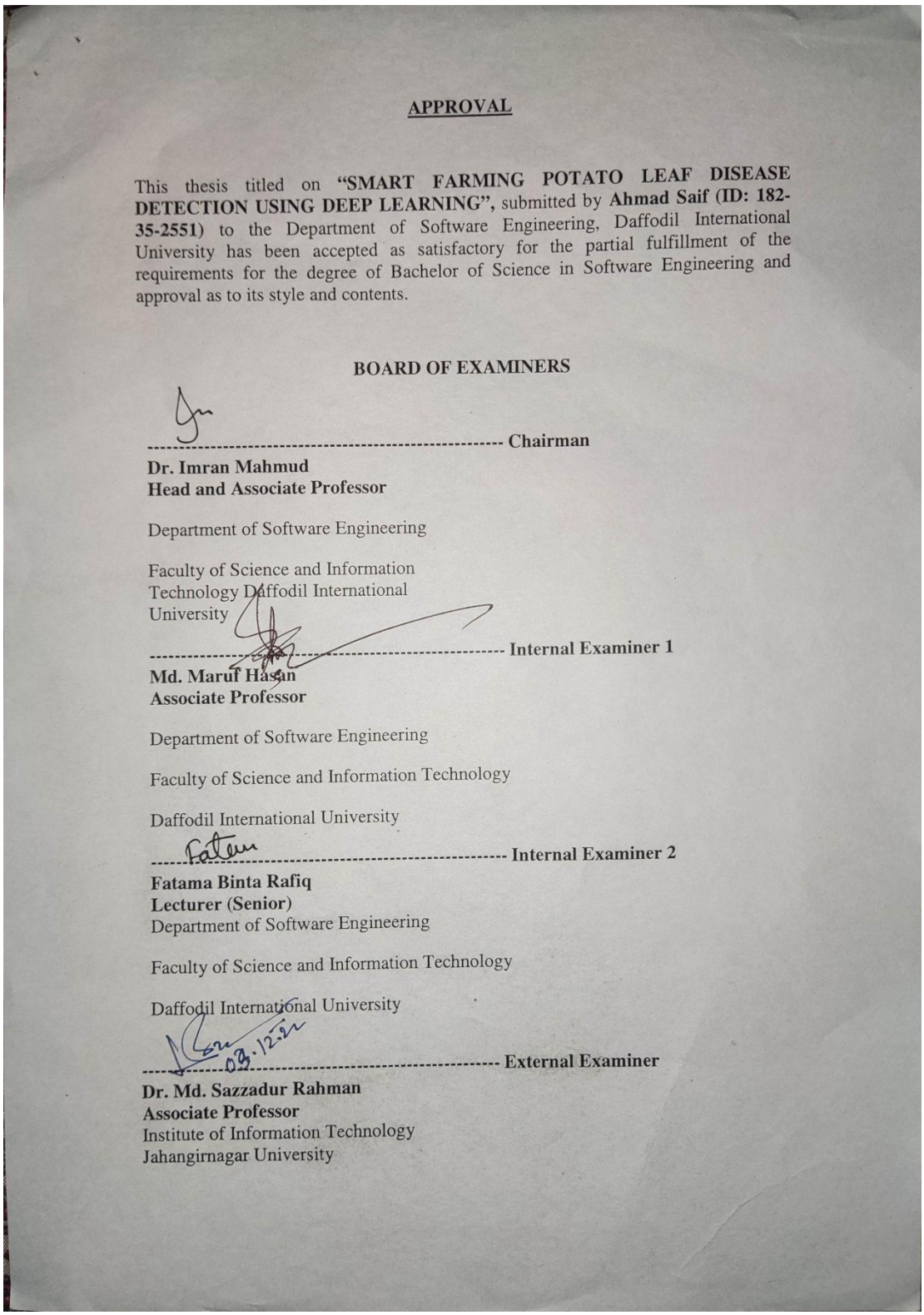
APPROVAL



APPROVAL

This thesis titled on **"SMART FARMING POTATO LEAF DISEASE DETECTION USING DEEP LEARNING"**, submitted by **Ahmad Saif (ID: 182-35-2551)** to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Software Engineering and approval as to its style and contents.

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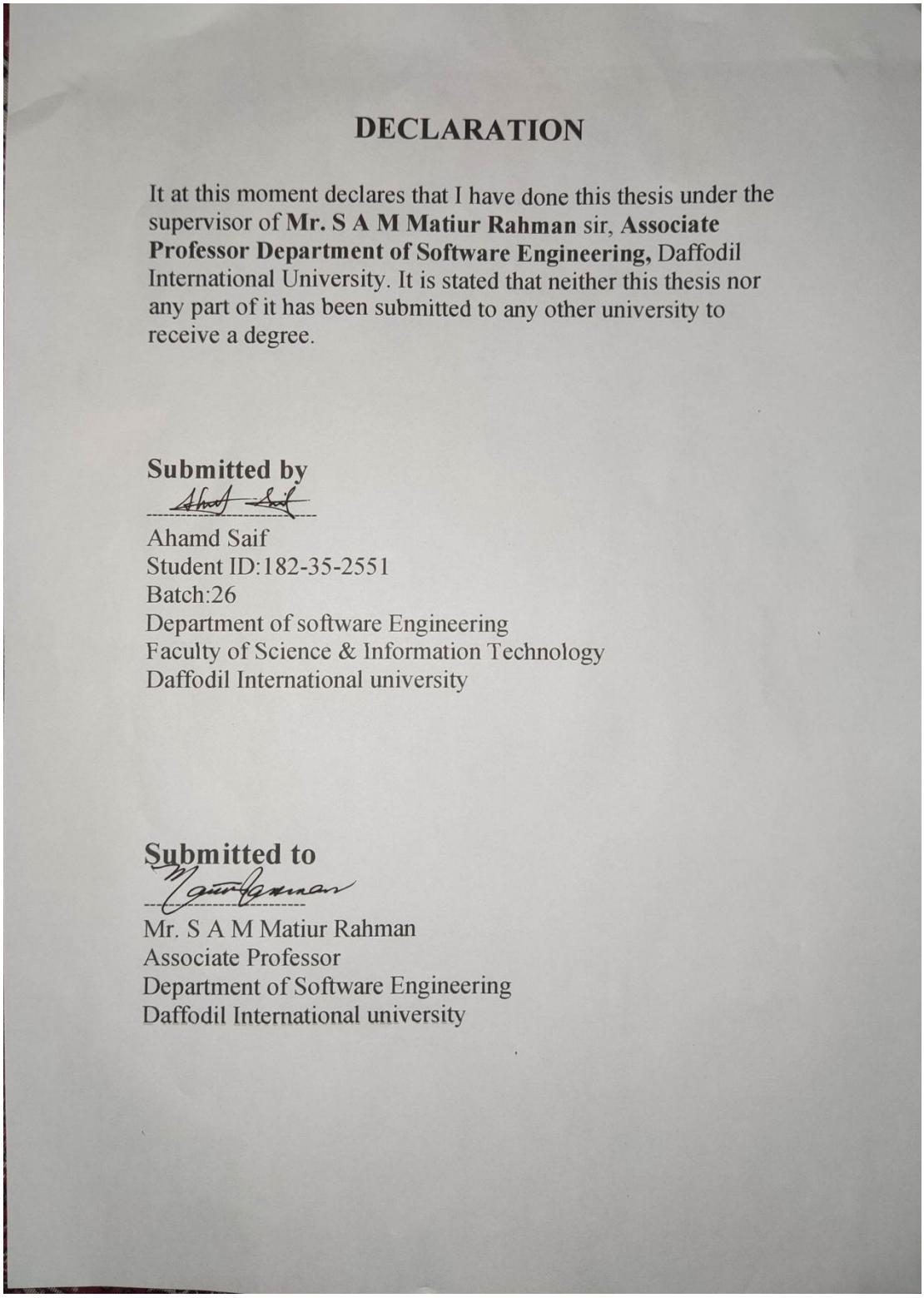

DECLARATION

It at this moment declares that I have done this thesis under the supervisor of **Mr. S A M Matiur Rahman** sir, **Associate Professor Department of Software Engineering,** Daffodil International University. It is stated that neither this thesis nor any part of it has been submitted to any other university to receive a degree.

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Ahmad Saif

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ABSTRACT

Due to a variety of crop species, crop diseases, and environmental conditions, early disease detection is the most difficult task. Several machine learning approaches have been developed to make this challenge easier. Data was primarily gathered by researchers to build their model. They gathered data in a variety of ways, including manually gathering data, downloading data from Google, and obtaining ready-made data from third parties. Because they used a variety of strategies, they received varying accuracy percentages. Even though everyone tried their best to reach the utmost accuracy, no one could come up with the same outcome. In order to construct my model, I employed CNN architecture. I gathered information for this from the Kaggle dataset. Since Kaggle is open source, researchers may quickly gather the precise data they need. After putting my model to the test, I got 99% accuracy. Disease detection from the leaves is very difficult. Early Blight and Late Blight are prevalent diseases in potato leaves. Those who are identified too late harm the crop. For this farmer must deal for both money loss and potato waste.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Potatoes are an important food for most of the population in the world. Even in some countries potato is the main food. In our country (Bangladesh) potato is the second main food. According to Bangladesh Department of Agriculture Extension (DAE) the total production of potato in this year is 1.05 crore tones came from high yielding varieties and 5.24 lakh tones from local varieties. DAE also revealed that the farmers in Bangladesh counted post -harvest potato losses of TK 2,500 crore every year. Many diseases affect potato crops among all, the most common is Early Blight and Late Blight disease of potato leaves. Factors responsible for these diseases are Geographical location and temperature. Both diseases are caused by fungus but at different temperatures. However, both are fungal diseases but their treatment methods are not the same. In my work I tried to detect the disease as early as possible to prevent the spread and damage of crops. Artificial Intelligence(AI) made everything automated. We can do many things with Machine Learning. AI can do that work which is literally impossible for humans.

1.2 MOTIVATION OF THE RESEARCH

Agriculture is the largest employment sector in Bangladesh. Due to a number of factors such as drought, floods, insects and hurricanes have many adverse impacts on our agriculture. Rice wheat, maize, potato, pulses and oil seeds are major food crops of Bangladesh. Potatoes are widely cultivated in all districts of Bangladesh during winter. Farmers of north Bengal mainly depend on potato farming. Sometimes farmers cannot recognize the disease of potatoes. As a result they have to count a

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huge economic loss .It also affects the nutrition value of potatoes. Technology in farming is still in the early stage of agriculture and barriers include high cost, limited awareness of the benefits and lack of appropriate knowledge etc.

Technology can play a major role in the development of our agriculture. For this purpose, I would like to connect this technology with agriculture. In comparison with other countries our technology based agriculture is far behdisind the modern development. This is why I am working on it.

1.3 PROBLEM STATEMENT

Disease is a very serious problem for those who grow crops. Disease causes great harm for their life such as damages of crops, financial loss etc.it became very challenging for them. Scientists are discovering new diseases constantly. Nowadays none can think of smart farming without technology. Machine learning makes disease detection easier than naked eye. Many researchers applied various technologies in this field. Some of them collected their own data and some used ready-made data.

1.4 RESEARCH QUESTIONS

- The research question was
- 1: Is this model able to detect the accurate disease properly?
- 2: Similar symptoms can also be seen in other diseases. Can this model distinguish the disease in that situation?
- 3: Will this model operate more quickly than others?

1.5 RESEARCH OBJECTIVE

The main research objectives are as follows: -

- ✓ Identifying the disease in the early stage can prevent the spread of the disease.

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- ✓ It can reduce the economic loss by minimizing the wastage of potato crops.
- ✓ Early detection of the disease can also help farmers to maintain the nutrition status of the potatoes.

1.6 RESEARCH SCOPE

Research's main scope is as follows:

- Farmers who cultivate potatoes do not need to bring agriculture specialists to detect the disease.
- Deduction of the waste of potatoes can bring more benefits to the cultivators.

1.7 THESIS ORGANIZATION

In the first chapter, finding the early blight and late blight disease in potato leaves, background of the work, motivation of the research, problem statement, research questions, research objective are discussed. The other parts related to my research are as below:

In the next chapter I will discuss the literature review, where I can see some researchers' studies which have already been done in the same field of potato leaf disease, what methodology they used, and the lack of their work. Based on their work comparison between my work and their work. In chapter three, I will discuss the methodology of my work which consists of data collection, pre-processing of data, deep learning and model. The results of the methodology will be discussed, in chapter four. Chapter five is the ending chapter as well as the conclusion part, where I have talked about the total summary of my work. Here I have discussed what work I will do in the future for the betterment of my thesis.

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CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

In a literature review, a researcher reviews the previous work, research, conference paper, books, article, etc. with that one can find out what work has already been done on the topic, summarize the whole topic, and find out what is lacking in the work. After analyzing they can work on limitations and overcome the limitations to get better results.

2.2 PREVIOUS LITERATURE

Javed Rashid et al [1]in their research they used YOLOv5 technique to detect the disease from images. Their proposal method achieves 96.71% accuracy. They collected data from the PlantVillage dataset. They applied different data augmentation techniques to train the dataset.

Divyansh Tiwari et al [2] They used VGG19 technique to create the model. They use ImageNet to train their dataset. With that model they got 97.8% accuracy. Kaggle is open source. They use ready-made data from Kaggle.

Md. Asif Iqbal et al [3] in their research they used many algorithms like Random Forest (RF), Logistic Regression (LR), k-Nearest Neighbors (KNN), Decision Trees (DT) , etc. They applied three types of image processing 1. Hu Moments ,2. Haralick Texture 3. Color Histogram. They use kaggle as a dataset source. With the Random Forest algorithm they got the highest accuracy. They got 97% accuracy with that algorithm.

R. Meena Prakash et al [4] They implemented a work that can analyze and categorize illnesses of citrus leaves. Four components make up the entire system (Image pre-

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processing, Segmentation, and Analysis). utilizing feature extraction, classification, and k-means clustering).35 photos of sick citrus leaves and 25 images of healthy leaves were used to train and test the support vector machine classifier. The suggested system states that it is 90–100% accurate.

Utpal Barman et al [5] in their work they used self-build CNN for computer and MobileNetV2 tor mobile. Their data source was Kaggle. They only applied data augmentation in healthy leaves. For the CPU environment they converted images into 70x70 dimension. With this dimension they create two datasets. They got 2 different accuracies from two datasets. From dataset one they got 96.98 accuracy the other side from two they got 97.63 accuracy.

Prajwala TM et al [6] They proposed using a slightly modified version of the LeNet Convolutional Neural Network model to detect and identify illnesses in tomato leaves (CNN). The technique of automatic feature extraction is a model of a neural network, which aids in classification. The practicality of the neural network is demonstrated by the suggested system's average accuracy of 94–95% in identifying and detecting the leaves.

Chaojun Hou et al [7] in their research they used many techniques to identify the potato leaves disease. Those techniques were k-nearest neighbor (k-NN), support vector machine (SVM), artificial neural network (ANN) and random forest (RF). from those methods they got highest accuracy with SVM.the average accuracy was 92.1%. They collected data from the AI Challenger Global AI Contest.

Kumar Sanjeev et al [8] in their work they used Feed Forward Neural Network (FFNN) in their model. They applied 2 types of method in image processing: partial domain and frequency domain. First is work on pixel values and the second in work

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on frequency values. They collected data from PlantVillage. with this FFNN model they got 96.5% accuracy.

Rizqi Amaliatus Sholihati et al [9] in their research they work on five type of potato leaves. Those are 1. Alternaria Solani 2. Healthy 3. Phytophthora Infestans 4. Viruses 5. Insects. They used VGG16 and VGG19 methods to detect the disease. They collected data from many sources, Malang, Indonesia, PlantVillage, an open-access image database, and Google images. Total collected 5100 images and got 91% average accuracy. They run 250 Epoch for both methods which take a long time to train the machine.

Soumik Ranjan Dasgupta et al [10] in this research they used various network models to find out the disease. Those models are Resnet, Inception, Densenet and VGG . They collected data from the PlantVillage dataset. Some of those models get 98% accuracy and some of them get 94.94% accuracy.

Farah Akmal et al [11] in their research they use many features such as histogram-oriented gradient (HOG), Segmented Fractal Texture Analysis (SFTA) and local ternary patterns (LTP). They work on two crops, 1. potato 2. corn. From two crops, in total they detected 5 diseases They collected data from PlantVillage dataset. The accuracy range was 92.8% to 98.7%.

Md. Khalid Rayhan Asif et al [12] in this research they used several kinds of techniques to notice the disease. Those techniques are AlexNet, VggNet, ResNet, LeNet and Sequential models. They collected data from Kaggle, Dataquest and some manual images were taken as much as possible. from this not all images are helpful for them. they got 97% accuracy with this

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CHAPTER 3
RESEARCH METHODOLOGY

3.1 RESEARCH METHODOLOGY

Python language is used to make this model. To develop this model, I applied Tensorflow, Convolutional Neural Network(CNN), Tensorflow Dataset, and Data Augmentation. For building up this model I collected Data from Kaggle. All of this dataset is made by the US government.

3.2 DATA COLLECTION

Data collection is the first step for making any IoT based project. We can collect data in many ways. First collect data from third parties like Kaggle or etc., Second, collect data and annotate data on your own, third web scripts to collect images from the internet and use tools to annotate data. In my model I used Ready-made data from Kaggle. From Kaggle I collect 3 type of Potato leaves

Early Blight Healthy Late Blight

Figure 3:1 Types of data From Kaggle

3.3 DATA PRE-PROCESSING

In this step I just prepared my data using Tensorflow dataset and did data augmentation. I did data augmentation because I do not have enough images for this so I need to rotate, flip and adjust contrast to create more training samples. In the Tensorflow dataset I can download images from the hard disk in batches. After that I

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can filter, map etc. for this reason I use the Tensorflow dataset. In preprocessing I did caching and prefetching so this will improve the performance. Also I did rescaling and resizing if any one input image it will auto resize it.

Figure 3.2: Data Processing

3.4 DEEP LEARNING

I Used Convolutional Neural Network(CNN) for making my model. I used 32 layers to detect the small features. From the image first it will be convolutional+relu then It will pool again convolutional+relu and pool again it is a long process. I used max pooling. When I do this it will preserve the feature and reduce the size of the image which is very helpful.

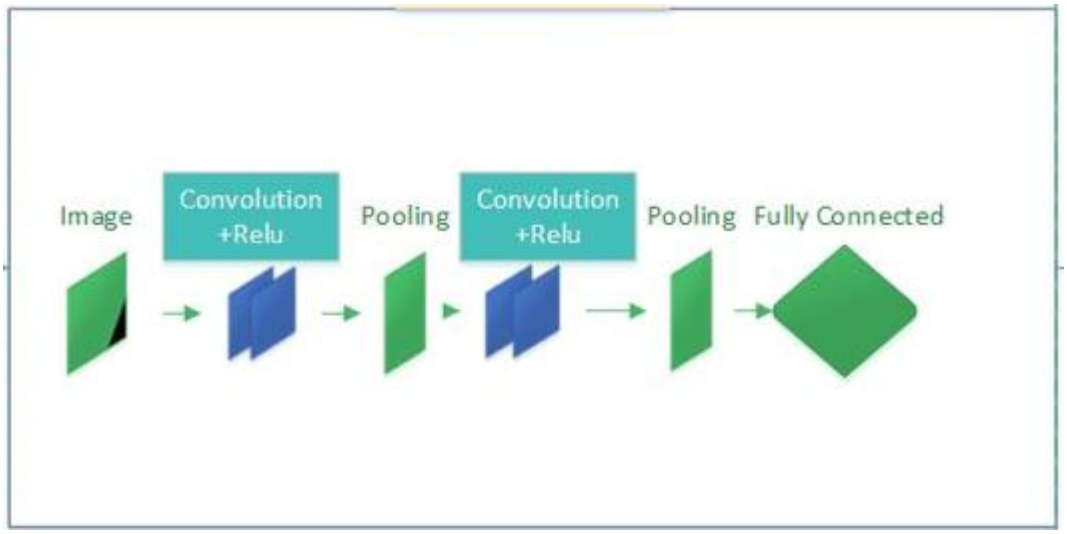

Figure 3.3: CNN Architecture

This in the architecture of my model. I am going to train my data with this architecture.

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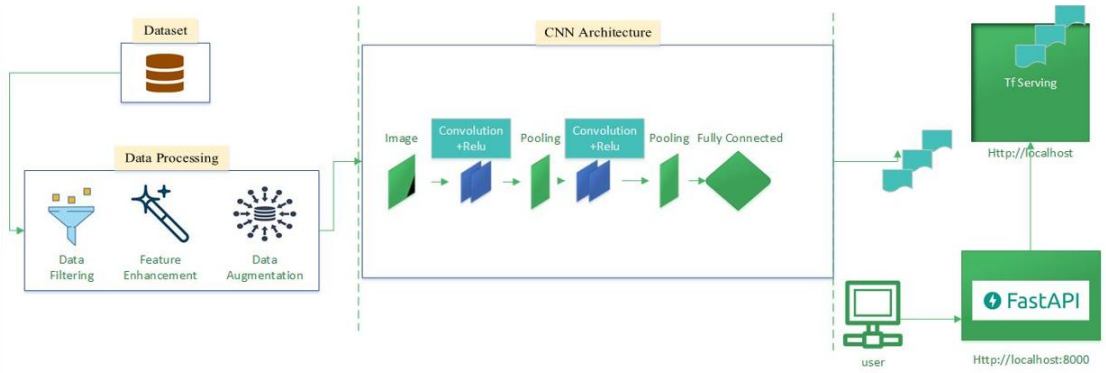

Figure 3.4: Model of my work

CHAPTER 4
RESULT AND DISCUSSION

4.1 INTRODUCTION

A collection of 2152 photos of potato leaves is put into the system in this experimental investigation. Images of 1000 early blight and 1000 late blight-affected leaves as well as 152 healthy leaves make up our dataset. The dataset for our experiment has been divided into three phases: a training phase with 80% photographs, a validation phase with 10% images, and a testing phase with the remaining images. Deep learning models and technologies have made it possible to identify the correct disease. I included the models I used the CNN approach after obtaining and processing the Data. I'll discuss the results of the model I used in that part.

4.2 RESULT DISCUSSION

To build this model I took 80% data from the total dataset for training, 10% for validation, 10% for test. I took 1728 images for training,192 images for validation,256

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images for tests. Deep learning methods can ease a lot of critical work. People use many Deep learning methods to find out potato leaves disease.

YOLOv5, Artificial Neural Network and many more methods have been already used. I get the highest accuracy by running 10 epochs. Each epoch trains the machine to understand the disease. Sometimes people need to run more epochs for better accuracy.

I get the highest performance from this model but this model can only recognize two diseases. I should work more on this model to make it able to detect many diseases.

This is the summary of my model, as you can see in Figure 4.I have a total 183,747 parameters to train my dataset.

```
max_pooling2d_2 (MaxPooling  (32, 30, 30, 64)         0
2D)

conv2d_3 (Conv2D)           (32, 28, 28, 64)          36928

max_pooling2d_3 (MaxPooling  (32, 14, 14, 64)         0
2D)

conv2d_4 (Conv2D)           (32, 12, 12, 64)          36928

max_pooling2d_4 (MaxPooling  (32, 6, 6, 64)           0
2D)

conv2d_5 (Conv2D)           (32, 4, 4, 64)            36928

max_pooling2d_5 (MaxPooling  (32, 2, 2, 64)           0
2D)

flatten (Flatten)           (32, 256)                 0

dense (Dense)               (32, 64)                  16448

dense_1 (Dense)             (32, 3)                   195

=================================================================
Total params: 183,747
Trainable params: 183,747
Non-trainable params: 0
```

Figure 4.1: Total parameter for training

4.3 CONVOLUTIONAL NEURAL NETWORK

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Epoch Loss: Every epoch loss over the train data is going to drop-off. In the first stage of training data as we can see the epoch value is much higher but after that the epoch loss value is going down. That means my model works perfectly.

Epoch accuracy: In the training stage the validation data helps me to track the accuracy. When you can see the accuracy value is higher that means the model performance is getting better. The prediction depends on the accuracy. This is going to help the model to predict the disease the right way. If you can find that the accuracy value is getting high after the end of the epoch you can run more epochs to get the accuracy for a large dataset. Number of epochs depends on the ratio of loss and accuracy.

```
Epoch 1/10
54/54 [==============================] - 111s 2s/step - loss: 0.1148 - accuracy: 0.9543 - val_loss: 0.1804 - val_accuracy: 0.93
23
Epoch 2/10
54/54 [==============================] - 110s 2s/step - loss: 0.1131 - accuracy: 0.9612 - val_loss: 0.1930 - val_accuracy: 0.94
79
Epoch 3/10
54/54 [==============================] - 111s 2s/step - loss: 0.0704 - accuracy: 0.9797 - val_loss: 0.1025 - val_accuracy: 0.97
40
Epoch 4/10
54/54 [==============================] - 112s 2s/step - loss: 0.0699 - accuracy: 0.9699 - val_loss: 0.0403 - val_accuracy: 0.98
44
Epoch 5/10
54/54 [==============================] - 112s 2s/step - loss: 0.0340 - accuracy: 0.9890 - val_loss: 0.0250 - val_accuracy: 0.99
48
Epoch 6/10
54/54 [==============================] - 111s 2s/step - loss: 0.0843 - accuracy: 0.9705 - val_loss: 0.0642 - val_accuracy: 0.97
40
Epoch 7/10
54/54 [==============================] - 112s 2s/step - loss: 0.0456 - accuracy: 0.9809 - val_loss: 0.0753 - val_accuracy: 0.96
88
Epoch 8/10
54/54 [==============================] - 111s 2s/step - loss: 0.0367 - accuracy: 0.9850 - val_loss: 0.0246 - val_accuracy: 0.99
48
Epoch 9/10
54/54 [==============================] - 111s 2s/step - loss: 0.0336 - accuracy: 0.9890 - val_loss: 0.0461 - val_accuracy: 0.97
92
Epoch 10/10
54/54 [==============================] - 113s 2s/step - loss: 0.0407 - accuracy: 0.9855 - val_loss: 0.0714 - val_accuracy: 0.97
92
```

Figure 4.2: Model Accuracy

Training and validation accuracy: The first graph of Figure 4.3 illustrates training and validation accuracy. This graph shows less accuracy in the early stage but after running as much as many epochs the accuracy level has gradually increased.

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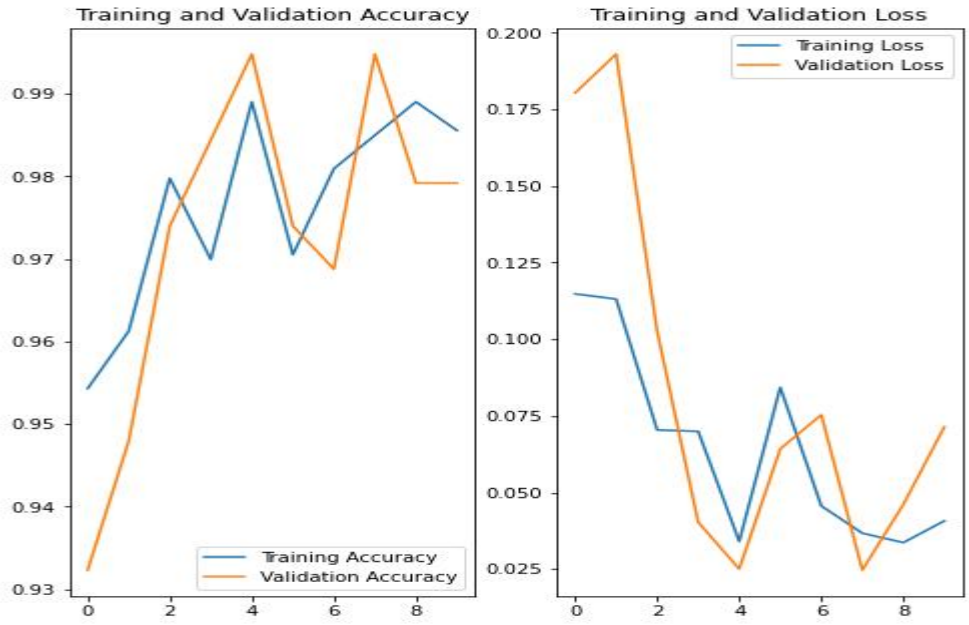

Figure 4.3: Accuracy and Loss Graph

Training accuracy and validation loss: In the figure 4.3, the second one is the graph of training and validation loss. This graph is the opposite of an accuracy graph. In that it shows the loss states of my training data. At the beginning the loss level was high but slowly it fell. While the loss value is decreasing, the accuracy value is increasing

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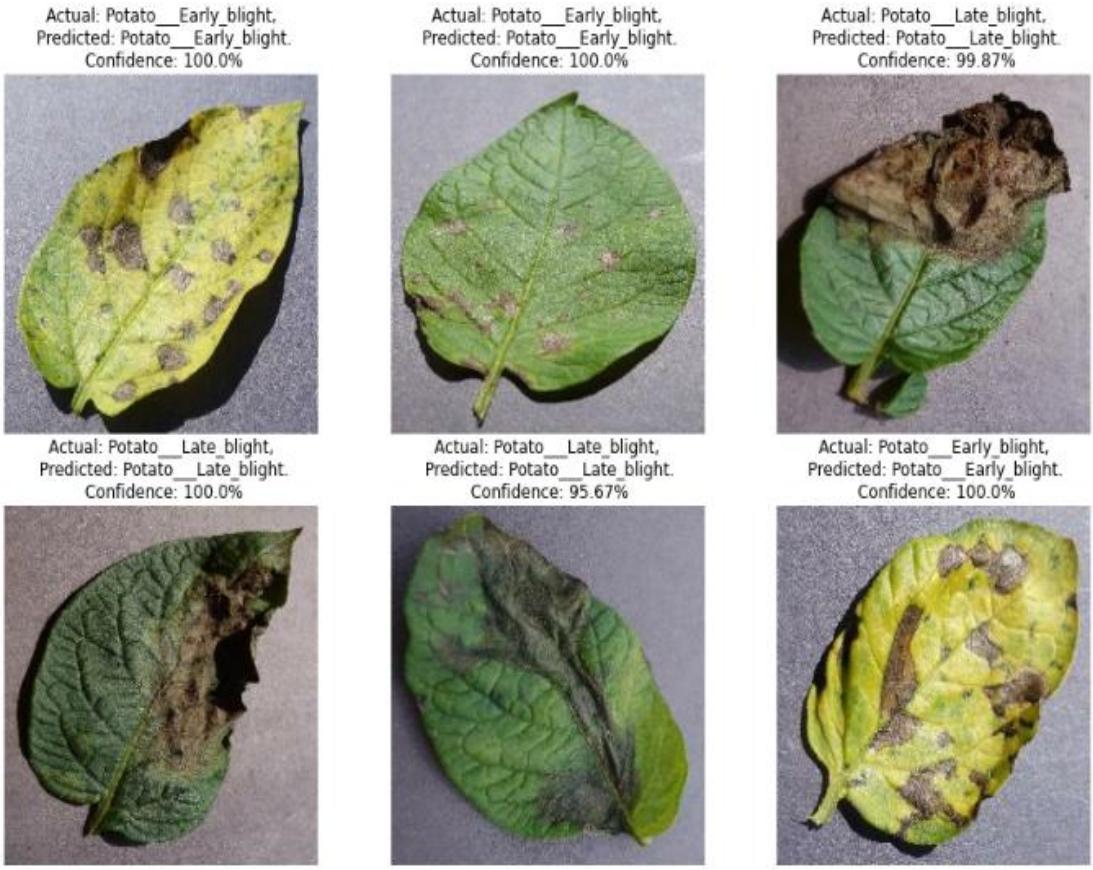

Figure 4.4: Predicted data

[i]The above figure shows a few varieties of prediction. In some cases I got 100% accuracy and some cases it cannot predict highest proper accuracy

CHAPTER 5
CONCLUSION AND LIMITATIONS

5.1 CONCLUSION

In this model, I used a deep learning method which helps detect potato leaf disease and improve crop productivity and quality, and also prevent crop yield losses. I used 1000 early blight images, 1000 late blight images, 152 healthy images among 2152 images. I obtained accuracy of 99% over the test dataset. Figure 6 shows accuracy and loss graph compared with training and validation testing.

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5.2 LIMITATIONS

This model can detect only two potato leaf diseases and healthy leaves. However, it can identify the appropriate disease but it cannot recognize the species.

CHAPTER 6

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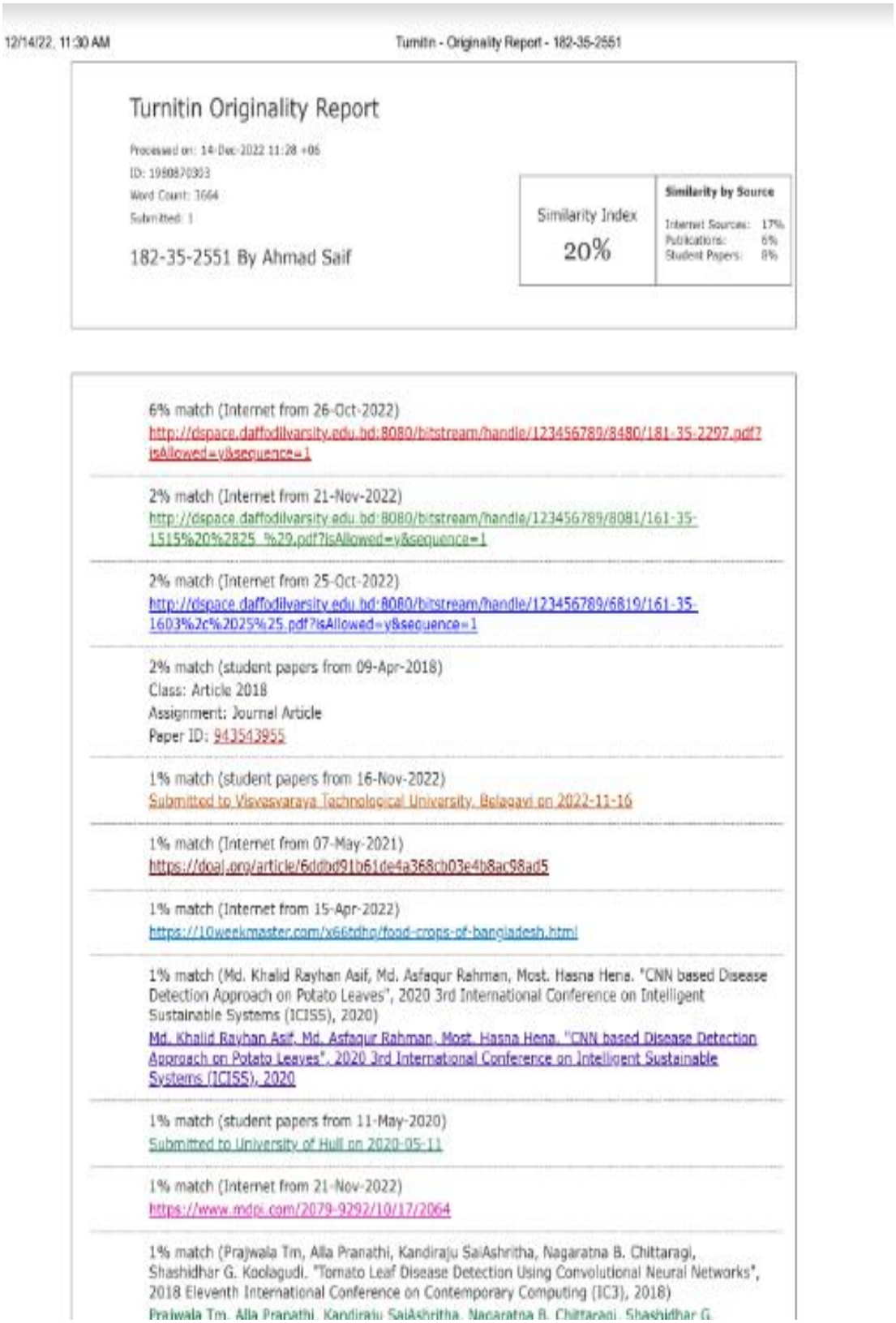

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Smart Farming: Potato Leaf Disease Detection Using Deep Learning By Ahmad Saif (182-35-2551) A thesis submitted in partial fulfillment of the requirement for the degree of Bachelor of Science in Software Engineering Department of Software Engineering DAFFODIL INTERNATIONAL UNIVERSITY Fall – 2022 I | Page APPROVAL DECLARATION III | ACKNOWLEDGEMENT First, I am thankful to the almighty Allah for giving me a chance to complete this thesis. I would like to consider my gratefulness to my supervisor Mr. S A M Matiur Rahman sir, Associate Professor Department of Software Engineering for the invariable help of my research work. His command helped me to find the solution of my thesis work. I would like to be express to my teachers in the Software Engineering department especially our beloved department head Md. Imran Mahmud sir, my advisor Md. Shohel Arman sir and my mentor Khalid Been Badruzzaman Biplab sir, for their support during my study. I am also thankful to my gratitude to all of my friends, senior, and junior who directly or indirectly helped me with the survey of the research. At last, I would like to thank my family, my parents and my precious ones for supporting me piously all over my life Ahmad Saif IV | Abstract Due to a variety of crop species, crop diseases, and environmental conditions, early disease detection is the most difficult task. Several machine learning approaches have been developed to make this challenge easier. Data was primarily gathered by researchers to build their model. They gathered data in a variety of ways, including manually gathering data, downloading data from Google, and obtaining ready-made data from third parties. Because they used a variety of strategies, they received varying accuracy percentages. Even though everyone tried their best to reach the utmost accuracy, no one could come up with the same outcome. In order to construct my model, I employed CNN architecture. I gathered information for this from the Kaggle dataset. Since Kaggle is open source, researchers may quickly gather the precise data they need. After putting my model to the test, I got 99% accuracy. Disease detection from the leaves is very difficult. Early Blight and Late Blight are prevalent diseases in potato leaves. Those who are identified too late harm the crop. For this farmer must deal for both money loss and potato waste. V| CONTENTS Table of Contents ACKNOWLEDGEMENT

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