AN APPROACH TO PREDICT PADDY CROP DISEASE USING CONVOLUTIONAL NEURAL NETWORK

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JULY 2020

APPROVAL

This Project/internship titled **"An approach to predict paddy crop disease using convolutional neural network"**, submitted by Kh. Mahmudur Rahman and Deepa Sharma,, ID No: 161-15-7453 and 153-156569 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 July 2020.

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We hereby declare that this project has been done by us under the supervision of **Anup Majumder, 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 the award of any degree or diploma.

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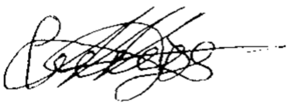

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ACKNOWLEDGMENT

First, we express our heartiest thanks and gratefulness to Almighty God for His divine blessing makes us possible to complete the final year project/internship successfully.

We really grateful and wish our profound our indebtedness to **Anup Majumdar**, **Lecturer**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of *Computer Science* to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project.

We would like to express our heartiest gratitude to **Prof. Dr. Syed Akhter Hossain, Head, Department of CSE**, for his kind help to finish our project and to other faculty members and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate at Daffodil International University, who took part in this discussion while completing the course work.

Finally, we must acknowledge with due respect the constant support and patience of our parents.

ABSTRACT

In the recent past, due to excessive use of human-made wastage and pesticides, plant disease increased at a higher rate. These diseases can be dangerous in a later stage if it is not taking into account. Also, due to a lack of technical inefficiency, sometimes it becomes hard to detect these diseases. So, this paper discussed a model for detecting the disease present in rice crops. We used image processing with a Deep Learning model to specify the affected rice plant. As paddy field disease follows the same pattern, we can discriminate affected rice plant from the healthy plant. Therefore, we can detect these affected plants using deep learning methods with convolutional neural networks (ConvNet/CNN). So, we take the image of the affected plant and dynamically analyze the images of the disease. This system performs diagnose with the dataset of images using deep learning. Besides, we emphasize on the pattern created by the Bactria that reduced the learning time of the model. Thus, the system has obtained accuracy over 90% in detecting the affected corps.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Paddy crop plays a preeminent role in the Asian subcontinent's employment of farmers. Not only does it provide jobs, but it also succeeds to some degree in eradicating poverty. Rice is consumed widely in the Asian subcontinent. It is also used as a staple food in over 100 countries around the world[1]. It is included in most households, with more than one meal a day. It is a bit of a burden, making itself available to everyone. It is calorie-rich and starchy.

Rice Has been the staple food for the Asia region. Above 90% of the rice grow in Asia [2]. Hence it has been the most important grain for the people who live in Asia. Also, it is a crop with a high domestic self-sufficiency rate. Unfortunately, this condition is favored by various kinds of pests and mold. Several diseases and pests hamper rice production, which drops the output of the crop to 37% of its yield every year. There are mainly 40 types of infections in rice, and they are easy to spread among different kinds of rice species. Among them, "Blight", “Leafblast”, “Hispa”, “Brownspot” are the most devastating of all. Production losses due to these disease are as much as 70% with favorable conditions to the disease [3].

Consequently, unless this disease is detected at an early stage, it can be devastating for the area's farmers. At present, farmers have only visual observation with the naked eye to identify the disease. But this process is time-consuming also can be confusing.

Therefore, it is crucial to building an automated system that can solve this problem with precision. In this paper, we describe an evaluation system with machine learning and image recognition system. Where a farmer can easily detect the affected plant with full precision, this paper proposes a system that uses a multi-hidden layer neural network based on deep learning techniques.

1.2 Motivation

Rice is considered to staple food in all over Asia. Found that research was conducted on various diseases of rice such as blast, brown spot. Our proposed model will solve this problem also will help the farmers to amplify their rice production by detecting disease at an early stage.

1.3 Research Questions

The goal of being able to extract usable knowledge and predict paddy crop desease formalized into the following main research question:

RQ: How to predict paddy crop disease from the given dataset?

To help answer this question and accomplish the research goals, three sub-questions are defined:

RQ1: How to predict paddy crop disease using CNN?
RQ2: How to use image processing models to help predict disease of rice crops?
RQ3: What source of model is better for training the images?

1.4 Expected Outcome

- Being able to predict the paddy field disease more accurately using deep learning image recognition models.
- Finding out the optimal technique for predicting disease.

1.5 Layout of Report

Our thesis report is organized as follows:

- Chapter One includes an introduction to our project, motivation, research questions, and expected outcome.
- Chapter Two includes Background, related works, research summary, and challenges.
- Chapter Three includes Research Methodology.
- Chapter Four includes Experimental Results and Discussion.
- Chapter five includes Summary and Conclusion.

CHAPTER 2
BACKGROUND STUDY

2.1 Introduction

To gain some perspective on the research field and its main challenges, a literature survey is performed on tag prediction based on poem classification. First, the works considered the most similar to the work in this thesis are discussed in section 2.2. In Section 2.3, we will give a summary of our related works. In the challenges section, we will discuss how we can increase our accuracy.

2.2 Related Works

Authors M. Jhu ria et al. (2013), proposed algorithms for the neural network to detect and track the fruit plant disease from plantation to harvest. A total of three vectors of characteristics, including colour, morphology, and texture, were extracted. The features of morphology include 90% of the right results relative to the other two vectors[4]. The author U. Shruthi (2019), reviewed different types of machine learning techniques by testing their accuracy. The CNN Classifier shows the most accurate among all the methods of different kinds of plant diseases [5]. The author — H. Q. Cap et al. (2018), proposed the concept of computer-based plant disease detection methods. This method obtained 78% of F1 measurement detection performance at 2.0 fps[6]. The author Konstantinos Ferentinos (2018) proposed deep learning models based on specific convolutional neural network architectures, which can achieve the success rate of 99.53 % in real-life cases [7]. The authors Karen Simonyan and Andrew Zisserman (2014) proposed the convolutional network depth on its accuracy within the large-scale image recognition settings are more accurate. Using an architecture with tiny (3x3) convolution filters [8]. The authors Savita N. Ghaiwat and Parul Arora (2014) reviewed that the SVM approach is challenging to work out with optimal parameters once training data isn't linearly divisible. Also, SVM is more complex and challenging to implement [9]. The author Xin Yang (2017) reviewed that a machine learning algorithm can detect plant resistance genes discovery and plant disease classification. Here the author reviewed different machine learning algorithms on various diseases. Then tested accuracy among the different algorithms [10].

2.3 Research Summary

Following Table 2.1 is showing a summary of related works.

Table 2.1: Research Summary

SL	Author	Methodology	Description	Outcome
1.	M. Jhu ria et al.[4]	Neural network's algorithms	Three feature was extracted. color, morphology, and texture.	Morphology features provide 90% of the correct results
2.	U. Shruthi [5]	Machine learning algorithm, K neiborhood, CNN classifier	Detected different kinds of plant diseases using machine learning classifier.	CNN Classifier shows the most accurate among all the methods.
3.	H. Q. Cap et al. [6]	computer-based methods	Methods computer-based for detecting plant diseases..	78% of F1 measurement detection efficiency at 2.0 fps
4.	Konstantinos Ferentinos [7]	Deep learning models	specific convolutional neural network architectures	Achieved the success rate of 99.53 % in real-life cases
5.	Karen Simonyan and Andrew Zisserman [8]	Convolutional network	Convolutional network depth on its accuracy within the large-scale image recognition settings are more accurate.	State-of-art result analyzing and reviewing all aspects.
6.	Savita N. Ghaiwat and Parul Arora [9]	Support Vector Machine	SVM approach is challenging to work out with optimal	Optimal result by reviewing possible outcome.

			parameters once training data isn't linearly divisible.	
7.	Xin Yang [10]	Machine learning algorithm	Detect plant resistance genes discovery and plant disease classification.	Then tested accuracy among the different algorithms

2.4 Context

2.4.1 Brown Spot

This disease is the black spots developing on the rice plant's leaves. The signs of this disease, such as seedlings death, death of large areas of the root, brown spots, or black spots, may define this. It falls under the class of fungal. It causes a loss in quantity as well as consistency. It causes yield losses of 5% across South and South East Asia. By supplying the crop with the appropriate amount of nutrients and avoiding water stress, we can ensure the rice plant does not suffer from this disease. It can also be helpful to treat seeds with chemical substances, as it decreases the chance of infection.

Figure 2.1: Brown Spot infected leaf

2.4.2 Leaf Blast

Leaf blast is considered among rice plants to be the most severe and damaging disease. It may affect different parts of leaves like the neck and leaves. This disease is prevalent in regions with frequent rainfall, cold temperature, and low soil moisture. At any stage, a Rice crop can have a leaf blast. This can be identified as spots that have dark green borders appear. They can get confused with brown spots. If grown, it might destroy the entire crop. They can get confused with brown spots. When the field is drained as much as possible, this can be done. It can also be handled by separating the application of nitrogen fertilizer into two treatments or more. However, the excessive use of fertilizer can increase blast intensity [11].

Figure 2.2: Infected leaf of Leaf Blast

2.4.3 Hispa

This disease can be detected when the leaves clearly show the grubs mining. If the field is heavily infested the fields of rice will look burnt. If the rice plant gets badly infested then the infected leaves wither away. This disease usually affects young-stage plants. You can control this disease by preventing over-fertilizing the field [12].

Figure 2.3: Infected leaf of Hispa

2.4.4 Bacterial Blight

Bacterial blight can be found in a rice plant's leaf, and can be easily identified by examining the leaves' yellow and white bands. We can tell that by looking at the youngest leaf that will be pale yellow in colour, the plant suffers from bacterial blight. Not using excess nitrogen fertilizer and plowing stubble and straw into the soil after harvesting the crop will prevent this disease [13].

Figure 2.4: Infected leaf of Bacterial Blight

2.5 Challenges

The main challenge for our thesis was not only a huge number of data collection but also make sure that the data is in its purest form. We have collected four thousand data of images in high resolution and intended to run a deep learning model. This is quite challenging for us to fit our model to such a small number of a dataset.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

In this section, we will discuss the research subject and instrumentation, data collection procedure, data processing, proposed methodology, statistical analysis, and implementation requirements. Firstly, in the research subject and instrumentation, we will discuss our topic. In the data collection procedure, we have discussed how we collected our data. Next, in the data processing part, we have discussed how we preprocessed it for our model. Then in the proposed methodology, we briefly addressed the algorithms and methods that were used for this classification. Consequently, in the statistical analysis, we highlighted a few analytical methods and flow charts of the project. Finally, the chapter is closed by a clear concept about what we used for the project.

3.2 Research Subject and Instrumentation

Our research subject is to detect rice disease using convoulation neural network . There are many other disease of plant crops, but we picked mostly occurred disease of rice plants.

3.3 Data Collection Procedure

Table 3.1: Dataset Properties

Train Quantity	Test Quantity	Validation Quantity	Size	Format	Resolution
5200	642	642	7.89 GB (8,471822991 bytes)	.jpg	1144x1144-3188x 3188

For this proposed model, we collect datasets by ourselves. From Table 1, the training dataset consists of 5200 images of infected and healthy leaves. Both Train and validation dataset. It has 642 copies of each class.

3.4 Data Format and Statistical Analysis

3.4.1 Data Format

Following Figure 3.1 visualizing our data.

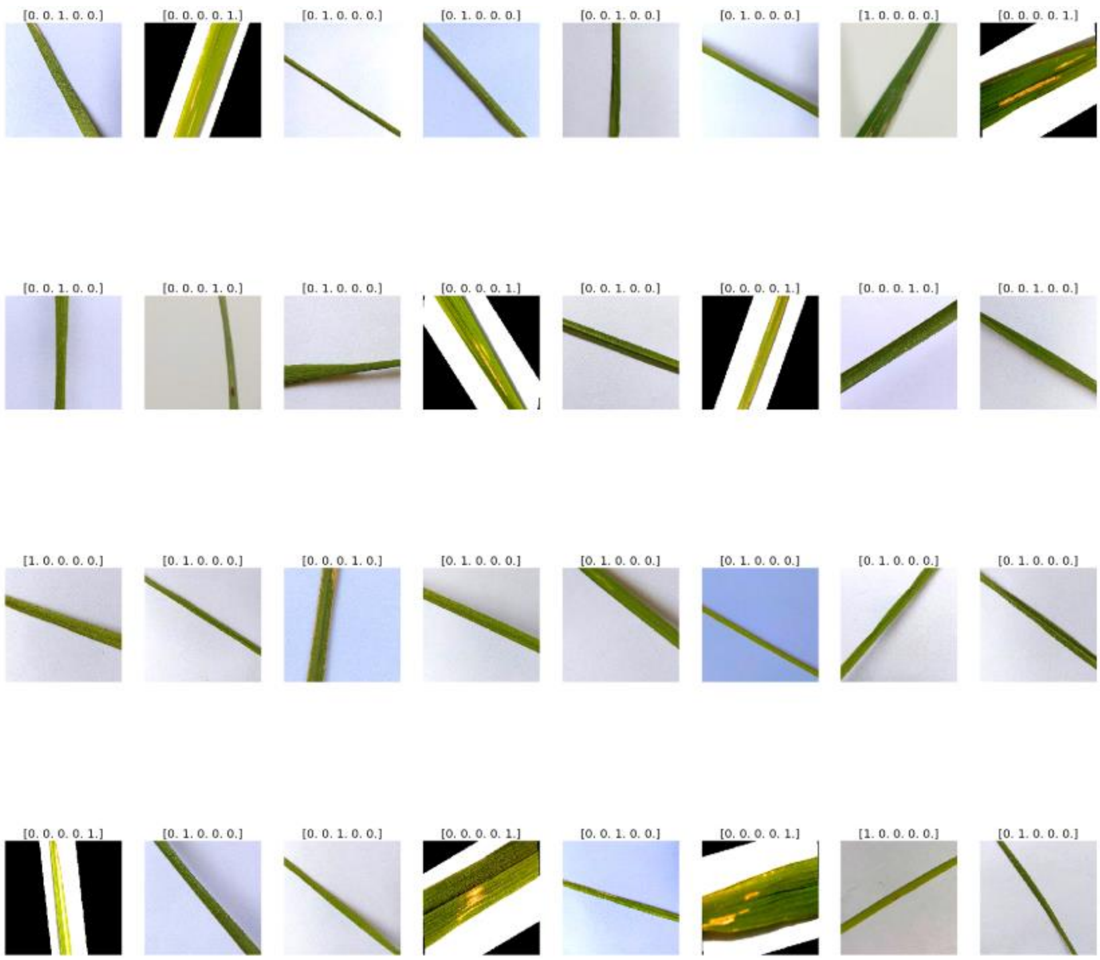
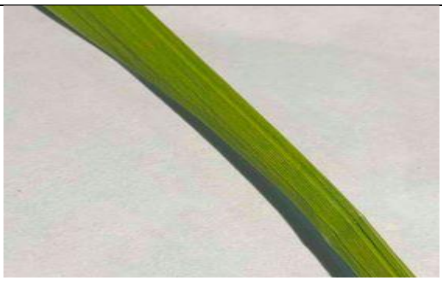


Figure 3.1: Data Format

3.4.2 Data Statistics

Following Table 3.2 explaining the statistics measurement of data:

Table 3.2: Data Statistics

Disease Name	Training	Testing	Sample Image
Blight	2000	200	
Brownspot	400	62	
Healthy	2000	256	
Leafblast	400	62	
Hispa	400	62	

3.5 Data Preprocessing

Since it is hard to work with high-resolution images 1144x1144 to 3188x3188, during the preprocess, the photos were resized to 224x224. Also, the images were converted into RGB images. The RGB represents the accurate color of the infected area. All the diseases creates a grayish defect in the leaf. It is easy to identify the spots with RGB images. Then all the infected photos were stored in a folder named "blight", "hispa", "brownspot","leafblast" and the healthy rest images were stored in a folder named "healthy" These Two folders are the sub-directory of the "train" folder.

3.5.2 Annotated Dataset

Knowledge-based dataset to be generated for two separate types of captured images.

3.5.3 Modified CNN Model

The Basic CNN model was modified with different types of filters and hidden layers. By taking a vgg16 pre-trained model and adding an extra layer at the end of the output layer.

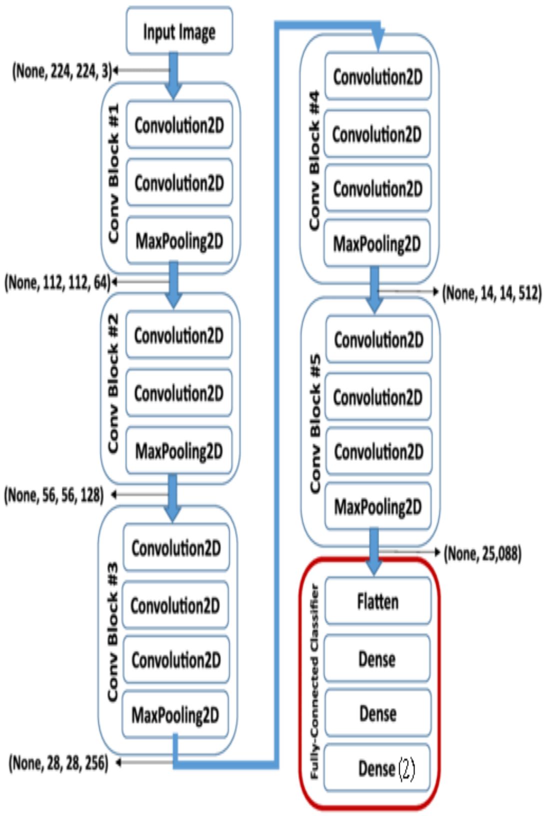


Figure 3.2: Vgg16 fine-tuned model

Figure 3.2 contains the customized CNN model of the proposed method. Here the highly connected classifier was modified to detect two different classes.

3.5.4 Potency of Proposed Model

This Proposed model produces a high accuracy rate than any other basic CNN model. This customized model shows better precision and better accuracy across all the datasets. As this modified model trained on RGB format color tune images, it can detect the colors of the infected leaf more accurately. Thus, the decision making of this CNN model becomes more accurate than others.

3.5.5 Proposed Methodology

The basic CNN model approach fails to achieve a higher accuracy rate with a large number of datasets. In this paper, we have modified the basic CNN and proposed an improved version to detect bacterial disease from the rice leaf with a high accuracy rate. The proposed model of paddy crop disease detection system shown in Figure 3.3.

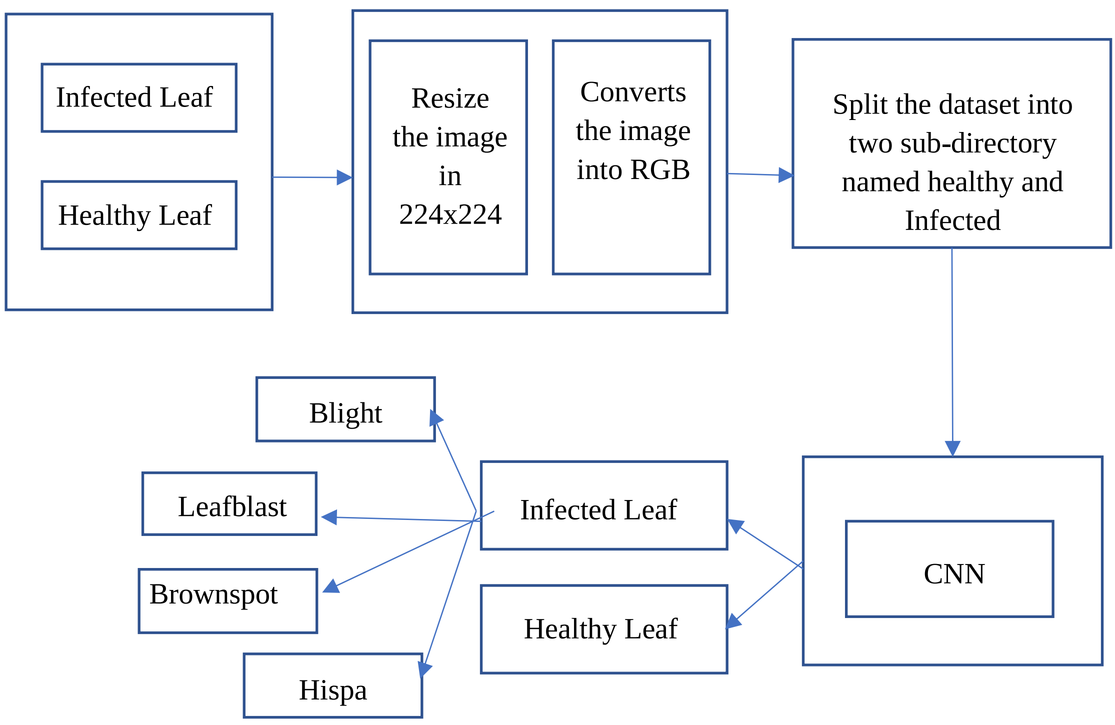


Figure 3.3: Proposed Model Diagram

3.5.6 Deep Learning Algorithm

3.5.6.1 Basic CNN Model

A convolutionary neural network (CNN) is a special form of artificial neural network that uses perceptron, an algorithm of machine learning units, to interpret data for supervised learning. CNN refers to visual recognition, the recognition of human language, and other executive tasks[14]. Figure 3.4 represents the primary figure of CNN.

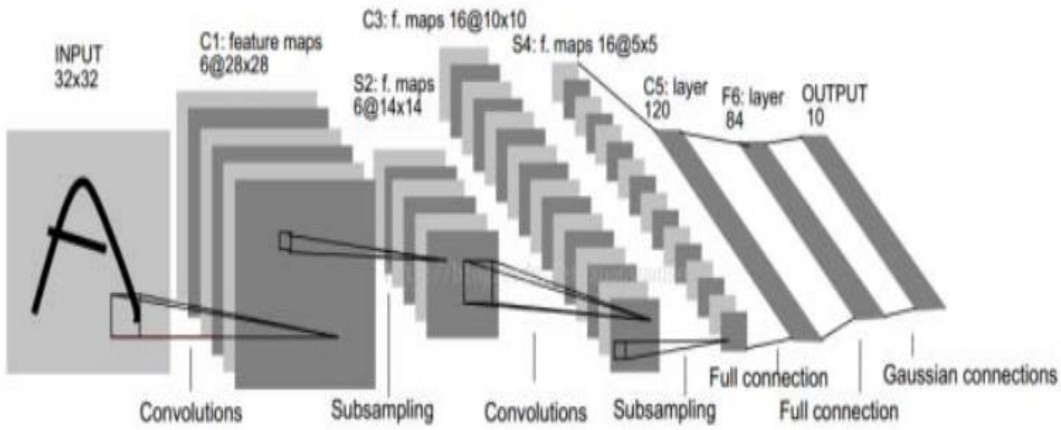


Figure 3.4: Basic CNN model

Fig 3 shows the first figure of the CNN model. Which contains an input layer; this input layer receives the image in 32x32 sized format and passes it through the filters. During the training session, weights change of an image, and while testing an illustration, these weights return high values if the model thinks it sees the same pattern it has seen before. The Combinations of top influences from various filters let CNN predict the content of an image.

3.5.6.2 Image acquisition

To implement the proposed method, it's essential to collect a considerable amount of training and test data. All these images are gathered from rural areas of the Comilla district, Bangladesh. Eight thousand images were taken from both the infected and healthy sections of the field. Those images were captured by Redmi K20 Pro Camera with the 48 megapixels sensor with a white background. The image of an infected leaf is shown in Figure 3.5.

Figure 3.6: Infected Leaf

3.7 Implementation Requirements

After reviewing all the necessary statistical or theoretical concepts and methods, we created a list of Hardware, Software, and developing tools we need for predicting Tag of poems. The probable necessary things are:

Hardware/Software Requirements

- 64-bit Operating System Windows 10 (Windows 7 or above)
- Ram 16GB (more than 4 GB)
- Web Browser Google Chrome (preferably chrome)
- Intel Core i7-8750H Processor(intel core i3 or avobe)
- Graphics GeForce GTX 1060 6GB(not necessary)

Developing Tools

- python 3.8.1
- Jupyter notebook
- CNN Model
- Pandas
- Numpy
- Keras
- Tansorflow in Backend
- Matplotlib

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

In Chapter four, we will discuss the descriptive analysis of our project. We will state our experimental result, and finally, we will close the chapter with a summarization of results.

4.2 Experimental Results

The suggested approach is introduced and evaluated using python programming language on Windows computers., 64-bit windows 10 OS, 3.8 GHz intel CPU, 16 GB RAM, nvidia geforce 1060 gpu. Total 400 images were used in testing purposes.

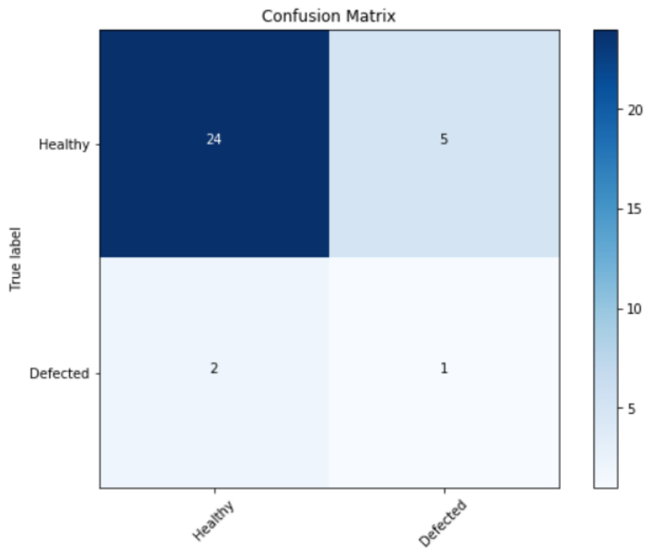


Figure-4.1: Confusion Matrix

From the Figure 4 show that CNN provides better accuracy for both disease and normal images. The Blight disease detection accuracy achieved in the testing session is 93.45%. For better understanding the accuracy was calculated using (1).

$$Accuracy = \frac{\text{TP+TN}}{\text{TP+TN+FP+FN}} \quad \text{…………(1)}$$

Here,

TP =The number of predications was accurate for infected leaf, which is 24

TN= The number of predications was accurate for healthy leaf, which is 5

FP= The number of predications was inaccurate for infected leaf, which is 2

FN= The number of predications was inaccurate for infected leaf, which is 1

From (1) accuracy = 0.9345.

$$recall = \frac{\text{TP}}{\text{TP+FN}} \qquad \text{……….} (2)$$

From (2) recall = 0.96

$$\text{precision} = \frac{\text{TP}}{\text{TP+FP}} \qquad \text{………..} (3)$$

From (3) precision = 0.9230

$$\text{f} - \text{masure} = \frac{2*\text{recall}*\text{precision}}{\text{recall+precision}} \qquad \text{………..} (4)$$

From (4) f-measure = 0.9240

From (1) it can be stated that the accuracy of the proposed model is 93.45% across the whole testing dataset.

4.3 Descriptive Analysis:

Following Figure 4.2 explaining about Training & Validation Loss and Figuree 4.3 explaining training & validation accuracy.

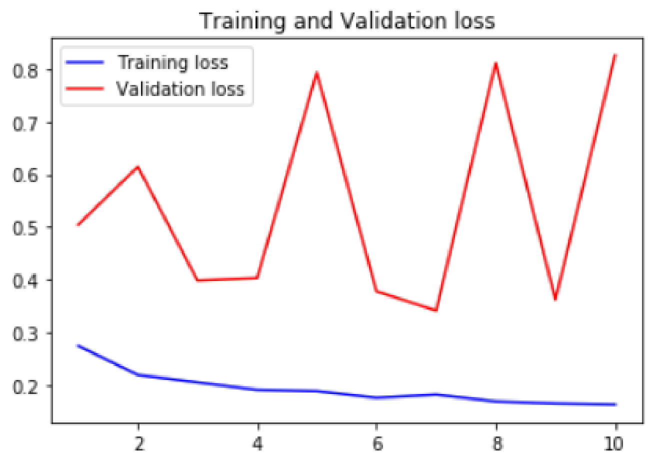


Figure 4.2: Training & Validation Loss

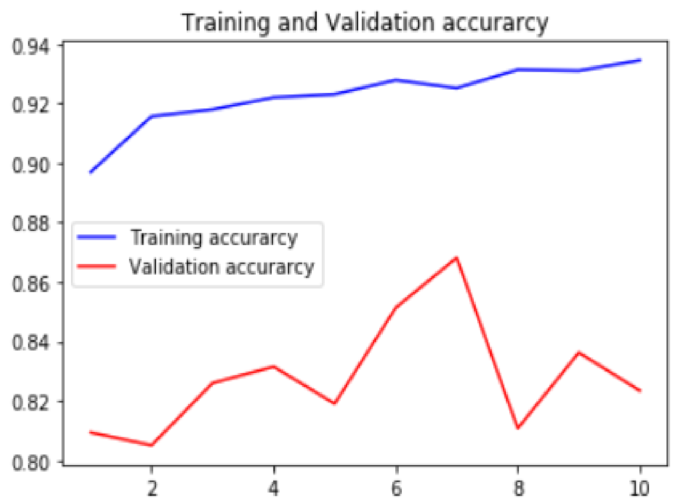


Figure 4.3: Training & Validation Accuracy

Our modified CNN model detected the infected leaf. Following figure 4.4 is an example of how our CNN model correctly and effectively recognize all the disease.

Figure 4.4: The recognition of paddy disease.

4.4 Summary

The model successfully predicted what diseases the rice plant might be affected after checking the model with the test results. We obtained an accuracy of 93.45 per cent of paddy crop disease using the deep learning approach of the convolution neural network. This CNN is an effective approach for solving complex problems in deep learning especially when it comes to image-based problems. This collections of architectures can be very helpful when we have to solve a complex problem.

CHAPTER 5
SUMMARY AND CONCLUSION

5.1 Summary of the Study

Our modified convolution neural network and image recognition model which is a technique for solving complex image processing problems in an efficient manner. Our model uses VGG-16 architecture of deep learning for prediction of disease in the paddy crop. It extracts the feature from the leaves and detect what type of disease the plant could be affacted. Our model strictly follows the principle of classification and detection.

5.2 Conclusions

By the above-mentioned way, their crops can be easily covered from paddy crop disease. Finally, it should be recommended that farmers might use this approach to prevent the spread of disease in the field of crops. They can also make choices at any time to improve crop yields and achieve greater economic benefits. The nature and vision of this platform is really bright. It can be used on the website and an app can be made. The farmer or the person will upload a well-clicked picture of the plant leaf to the website or the android or IOS app and will immediately predict what type of disease the plant is affected by. It will give us a risk of diseases that could damage the farm.

5.3 Recommendations

Few recommendations for predicting paddy disease are:

1. Create a large dataset of paddy disease for higher accuracy.
2. Try to use RGB combination of data for better accuracy.
3. Modified CNN will increase the accuracy and can apply other model & comparison with other model will give better understanding.

5.4 Implication for Further Study

Few implications that possible in further studies are:

1. Adding more disease of rice and the strategy of predicting disease more accurately.
2. Using Computer vision model algorithms like Transfer Learning can apply on this dataset; can get a better understanding of which model give us the best and higher accuracy.

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