Smartphone Based Plant Disease Classification using Convolutional Neural Networks

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12 - STEM - Newton

Chapter 1

Introduction

1.1 Background of the Study

Agriculture plays a major role in feeding billions of people all across the globe. It has also provided a means for people to grow revenue and sustain their lives. In fact according to the World Bank Organization, "Agricultural development is one of the most powerful tools to end extreme poverty, boost shared prosperity and feed a projected 9.7 billion people by 2050. Agriculture plays an integral part of the Philippine Economy, in fact according to the Philippine Statistics Authority, the Gross Value Added (GVA) in agriculture of the year 2019 is valued at 1.78 Trillion Pesos. It also contributes to the diet of Filipinos producing various ingredients of that are necessary for the Filipino Cuisine such as rice being the staple ingredient and other leafy vegetables such as cabbage, saluyot and ampalaya.

Each year, farmers spend a lot of money on disease management, they often do so without proper technical support leading poor disease control, pollution and harmful result. Plant diseases cause substantial loss to farmers resulting to large economic loss.

That's why accurate identification and diagnosis of plant diseases is essential; especially now in the era of globalization and climate change.

During the past few years, there has been a rapid advancement to the area of Machine Learning. Because of this there are now self-driving cars that can fully control a vehicle with minimal efforts required from the driver. Engineers and researchers have achieved this through the use of different types of Neural Networks.

Convolutional Neural Network is a type of Neural Network that specializes in finding patterns to images. It is being used in almost all areas of science, for instance (Hadush et al.) has used CNNs to detect breast cancer from mammogram(MG) images achieving a detection accuracy 91.86%. (Elgammal et al.) used CNNs to perform weather classification achieving 82.2% normalized classification accuracy.

This study aims to develop a mobile application that uses a CNN Model to detect and classify potential diseases in plants. Due to the current pandemic, the researcher decided to use publicly available image datasets — which will be used to train several CNN Models that would be embedded in the application — instead of making one. The researcher found publicly available image datasets of the following plants: apple, cherry, citrus, corn, grape, peach, pepper, potato, rice, strawberry (this selection is tentative). These images of different types of plants will be used to train the CNN Model and be able to detect diseases from these plants using an image of the plant leaves.

Because the model inference will happen on the device itself without relying on a cloud-based server, farmers and other people would be able to input an image to this application and use this app and diagnose a plant without having to rely on an

existing data or internet connection. This is important since according to the National ICT Household Survey,which was conducted by the Philippine Statistical Research and Training Institute and the Philippine Statistics Authority, only 17.7 % of all households in the Philippines have Internet connection.

1.2 Theoretical Framework

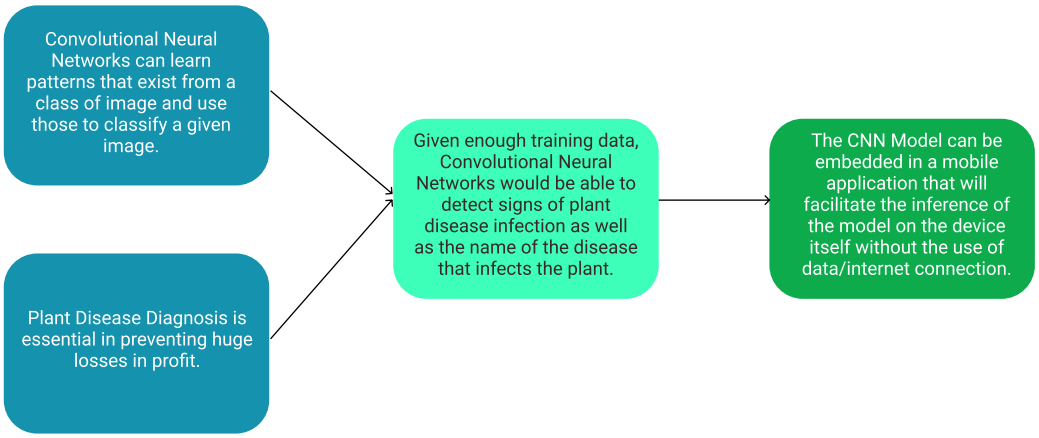

Figure 1.1: The Theoretical Framework of the Study

Convolutional Neural Networks has been experimentally shown to detect certain patterns from images with a high degree of accuracy. This is accomplished by feeding the CNN Model with labeled images and allowing it to "learn" the existing patterns from these images which will grant in the ability to infer the classification a given image later on. This concept can be applied to plant diagnosis by training a CNN Model using a database of different types of healthy and infected plants. Since the CNN Model will be able to learn these patterns and detect if it the input image is healthy or infected as well as the name of the disease infecting the plant.

Plant disease diagnosis is essential in agriculture. Without proper identification of the disease and the disease-causing agent, disease control measures like pesticides can lead to further losses in time, money and may even lead to more plant losses. This is why it is essential to diagnose plants early on.

1.3 Conceptual Framework

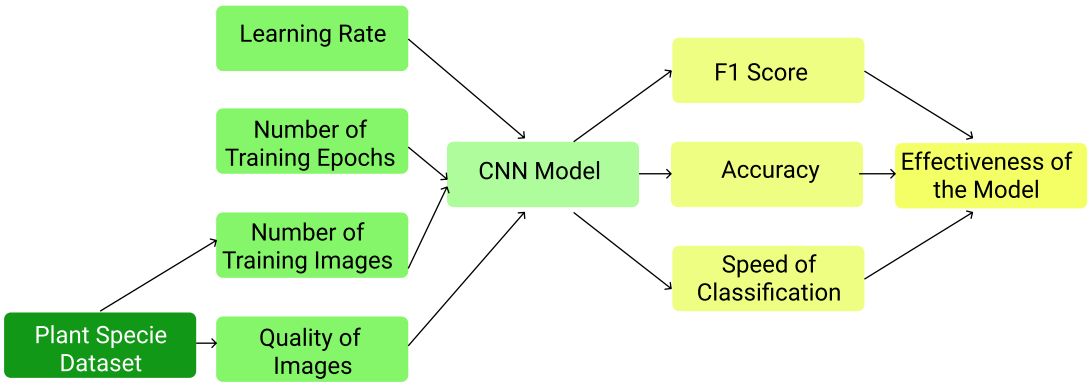

Figure 1.2: The Conceptual Framework of the Study

This study focuses on achieving the optimal effectiveness of the CNN Model that will be embedded in the mobile application.

In evaluating the effectiveness of a Neural Network Model one metric that is used is the F1 Score. It is defined as the harmonic mean of Precision and Recall or phrased mathematically as:

$$\text{F1 Score} = \frac{2}{\frac{1}{\text{Precision}} + \frac{1}{\text{Recall}}}$$

In addition to the F1 Score, accuracy will also be used as a metric to quantify the effectiveness of the model. It is defined as:

$$\text{Accuracy} = \frac{\text{Precision} + \text{Recall}}{\text{Total Number of Test Images}}$$

Finally, the speed of classification will also be used to gauge the effectivenes of the model. These 3 metrics will be used quantitatively measure the effectivenes of the model.

During the training process of the Model, there will be intervening variables that this study will not consider these are: Number of Training Epochs, Number of Training Images, Learning Rate, Quality of Training Images.

1.4 Statement of the Problem

1. How effective is the model in predicting the type of disease present in the given image? In terms of:
   (a) Accuracy
   (b) F1 Score
   (c) Speed of Classification
2. How comparable is the model made by the researcher to other methods of detecting plant disease?

1.5 Hypotheses

1. The F1 Score and the Speed of Classification implies that the model is not effective in predicting the tyoe of disease present in the given image.
2. The model is not comparable to other methods of detecting plant disease.

1.6 Scope and Delimitation

This study will only focus to the effectiveness of CNN Models to diagnose the following plants apple, cherry, citrus, corn, grape, peach, pepper, potato, rice, strawberry

(this selection is tentative). This is due to the fact that without training data on a certain type of plant CNN Models will be inconclusive with regards to the diagnosis of that specific plant.

This study does not include the effects of these factors: Number of Training Epochs, Number of Training Images, Learning Rate, Quality of Training Images that may affect the training and effectivess of the model.

1.7 Significance of the Study

The significance of the study lies on the fact that plant disease diagnosis plays a huge role in minimizing the monetary and material loss in agriculture caused by various plant diseases. That's why proper plant disease diagnosis is a detrimental process in securing the value of crops grown. The study proposes an application that can be used to scan images of plant leaves which would then be used to detect various plant diseases which may be present in an image, this application is designed to run the disease diagnosis without the need of internet or data connection. This study would certainly benefit farmers who have no access to internet connection to diagnose their plants and prevent further crop losses.

1.8 Definition of Terms

- Model

  - A machine learning model is a file that has been trained to recognize certain types of patterns. You train a model over a set of data, providing it an algorithm that it can use to reason over and learn from those data.

- Convolutional Neural Networks

- A Convolutional neural network (CNN) is a neural network that has one or more convolutional layers and are used mainly for image processing, classification, segmentation and also for other auto correlated data.

- Gross Value Added

  - Gross value added is the measure of the value of goods and services produced in an area, industry or sector of an economy.

- F1 Score

  - The F-score, also called the F1-score, is a measure of a model's accuracy on a dataset. A good F1 score means that you have low false positives and low false negatives, so you're correctly identifying real threats and you are not disturbed by false alarms

- Machine Learning

  - Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves.

- Classification

  - Classification refers to a predictive modeling problem where a class label is predicted for a given example of input data.

- Inference

  - Inference refers to the process of using a trained machine learning algorithm to make a prediction

- Recall

  - Recall (also known as sensitivity) is the fraction of relevant instances that were

retrieved.

- Precision - precision (also called positive predictive value) is the fraction of relevant instances among the retrieved instances.

- Learning Rate

  - Learning rate is a tuning parameter in an optimization algorithm that determines the step size at each iteration while moving toward a minimum of a loss function.

- Epoch

  - epoch is a term used in machine learning and indicates the number of passes of the entire training dataset the machine learning algorithm has completed.

Chapter 2

Methodology

The researcher followed different methods and steps to conduct this study. The data gathering procedures, experimental design, methods and steps and the statistical treatment of data are also included in this chapter.

2.1 Research Design

The research design used in this study is

2.2 Locale and Population of the Study

2.3 Data Gathering Instrument

2.4 Data Gathering Procedure

2.5 Statistical Treatment