Leaf Disease Identification Using Convolutional Neural Networks

Abhishek Garg[1], Ms. Namita Goyal[2]

[1]B Tech Student, Dept. of Information Technology, MAIT, Delhi, India
[2]Assistant Professor, Dept. of Information Technology, MAIT, Delhi, India

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Abstract - *Potato is one of the most widely consumed commodity in India and around the world. It is used in different forms around the globe. Not only regular households, but the fast food industry is also heavily dependent on potatoes for a large variety of their products. The importance of potatoes can be seen from the fact that the per-capita potato consumption in India was 26 kg in 2018 and 32.3 kg in the world. Thus, the demand of potatoes is also soaring around the world.*

In the recent years, fungal diseases are leading to decline in the quality and quantity of potatoes around the world, the two most common ones of them being "early blight" and "late blight". These two diseases can be detected, and their classification can be done correctly by looking at the leaves of the potato plant. This can not be achieved successfully by human eyes. However, this can be done by harnessing the power of deep learning, which is a subset of artificial intelligence. A special kind of deep learning neural networks known as convolutional neural networks can be used to solve our problem.

Key Words: **Classification, Artificial Intelligence, Deep Learning, Neural Networks, Convolutional Neural Networks.**

1. INTRODUCTION

The goal of this project is to create an image classification model using a deep convolutional network consisting of multiple convolutional and pooling layers. The model will be able to take the leaf of a potato plant as it's input, and it will be able to correctly classify the given the image into three categories which are "early blight", "light blight" and "healthy". We will be training our model on multiple iterations to ensure that it makes highly accurate predictions. We will be trying to choose an appropriate architecture for our convolutional neural network so that we will get high accuracy in lesser training time.

1.1 Background

Early blight and late blight are fungal diseases which are the most common yet most dangerous diseases that occurs in potato plants, and they lead to a very severe crop failure if controlling measures are not adopted at the correct time. According to sources, losses can go as high as 80% in epidemic years. However, these diseases can be identified by analyzing the leaves of a potato plant. It is not possible for humans to do this task by themselves, as the leaves that are infected with these diseases look very similar, and it is not possible to determine that the leaf is infected with which disease. This task can be performed with the help of convolutional neural networks which are deep learning neural networks that are used to solve problems which involves images as they tend to perform much better and faster when compared to other deep learning models.

2. PROPOSED SYSTEM

2.1 Problem Statement

"To identify the leaf disease using convolutional neural network"

2.2 Problem Elaboration

We will try to identify the disease with which the potato plant is suffering by looking at the image of the plant leaf. For this task, we will build a convolutional neural network which will take an image of the leaf as it's input and will return a prediction. We aim to classify the plant leaf into three possible categories - "early blight", "late blight" and "healthy" by analyzing the image of the leaf with the help of deep learning.

2.3 Proposed Methodology

From Fig 3.3, we can see the workflow which is followed in this project. As discussed earlier we will be using convolutional neural networks for the project which works best for problem statements that involves images. This is because of the unique architecture of these networks. They consist of convolution layers and pooling layers, which are the backbone of a convolutional neural network. They allow very efficient extraction of features from image inputs.

The number of convolution and pooling layers can be changed, and we can try multiple values and finally go with the values that gives the most accurate results. In our case, we are using 6 convolution and 6 pooling layers.

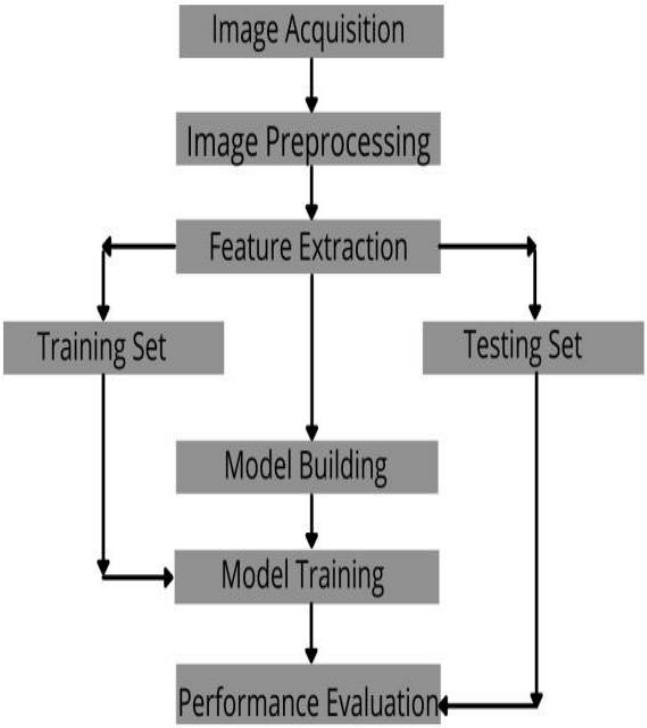

Fig-3.3: Proposed Block Diagram

2.3.1 Image Acquisition

The first step is the data collection step, where we collect images to work on. In this project to gather images of infected and healthy potato leaves, we use a Google extension known as "Download all images" which is used to collect images from Google. In total, we collect 2,152 images belonging to our three different categories.

2.3.2 Image Preprocessing

In this step, we perform some preprocessing on our collected images for more convenient usage. We use ImageDataGenerators which are a part of the TensorFlow API. These help in setting up very convenient input pipelines of our images. We use 3 different generators each for our training, validation and test set. The ImageDataGenerators also lets us augment our images in real time while our model is in the process of training.
They help us in applying random transformations on our images. In our project we have applied several transformations like "horizontal_flip" which randomly flips some of our images horizontally which helps with regularization of our model. We also apply "rotation_range" and "shear_range" which allows us to rotate and shear our input images while the model is still training. Lastly, we have also used "rescale" which rescale the size of our images to a newer scale. This new scale is smaller than the original scale and allows us to reduce the size of our images, which allows faster training of our model.

2.3.3 Feature Extraction

We first split our data into a training set and a test set. The images in the training set is used for training our model, while the test set is used for the final evaluation of our model. In addition to this, we will also maintain a validation set, which will help us to ensure that our model is not overfitting.

We use the convolution layers to extract features from our input images. Convolution layers helps in the detection of features from an image. They are used for detection of edges, corners, patterns etc. From a given image with the help of filters or kernels. We also use pooling layers, which are used to reduce the size of the representation and thus speeds up the computation. Pooling layers make the feature detection capability of the convolution network more robust.

2.3.4 Model Building

We will build the most appropriate architecture for our model. The model has 6 convolution layers and 6 pooling layers. Furthermore, It also has 2 dense layers. We have used the "Adam" optimizer to optimize our loss function due to its computational efficiency and little-memory requirements and finally, since we are dealing with a classification problem, we will use accuracy as our evaluation metric.

2.3.5 Model Training

Here we train our deep learning model on our training data which consists of 1506 images. We have trained our model for 20 epochs and the verbose value is set to 1 so that we can see the information along with the model training. We will also use our validation data to make sure that our model is not overfitting to the training data.

2.3.6 Performance Evaluation

Once the model training is completed, we proceed to the final step, which is evaluation of our trained deep learning model. For this, we will use the test data that we have maintained earlier. We can check our model's performance based on metrics like accuracy, precision and recall.

3. RESULT

The accuracy of the model is 97.9%, which is very satisfactory. Fig-4 shows that when the model is run on an example image. We can see that the "actual" and

"predicted" label matches with one another, thus indicating that the model is making correct predictions.

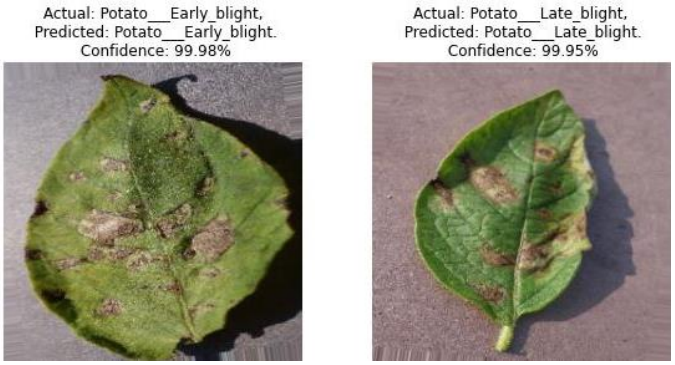

Fig-4: Example Prediction

4. CONCLUSIONS

In this paper, we have seen a very efficient and practical application of convolutional neural networks. If we were to perform this classification task by human eyes, then the possibility of an error or incorrect classification will be very high. Thus, performing such a task with this level of accuracy is not possible for a human. We have built a deep learning network with the right architecture.

We can integrate the proposed system with a user-friendly interface and then deploy it on different platforms like mobile applications or web applications so that this system can be utilized in a real world scenario. As discussed in the beginning these fungal diseases are very common, yet very deadly for the crop production and early detection of these can prove to very helpful for timely treatment. This is a very good example of how artificial intelligence can help us solve a very common but complex real world problem.

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BIOGRAPHIES

Abhishek Garg is an engineering student, who is doing his Bachelors Of Technology at Maharaja Agrasen Institute Of Technology. He is currently in his 7th semester of engineering. He is pursuing his engineering in the branch of Information Technology. Furthermore, he has worked on Machine Learning and Deep Learning projects from different domains like retail, entertainment.

Ms. Namita Goyal is working as an Assistant Professor in the Information Technology department of Maharaja Agrasen Institute Of Technology. Her area of Specialization are DS and Compiler Design.