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Leaf Disease Identification Using Convolutional Neural Network And Deployment

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Abstract - In the recent years there has been a decline in the production of potatoes around the world due to several fungal diseases that are not only decreasing the quality but also the quantity of potatoes that are produced globally. The most common diseases are “early blight” and “late blight”. However, on the bright side, these diseases can be detected in their early stage by looking at the leaves of the potato plant. Although it is not possible to achieve this by human eyes but this can be done by making use of convolutional neural networks which are deep learning networks which are implemented to accomplish tasks that involves visual input such as images. In this paper we will talk about the development and deployment of a convolutional neural network which can accomplish this task.

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

1. INTRODUCTION

This project aims at creating an image classification model using a deep convolutional neural network consisting of multiple convolutional and pooling layers and then deploying that model on the web for anyone to use. The input for the model will be the image of the leaf of a potato plant and it will try to correctly classify the given the image into three possible categories which are “early blight”, “light blight” and “healthy”and then finally output the predicted class to the user. The model will be trained on multiple iterations to ensure that it makes highly accurate predictions. We will choose an appropriate architecture for our convolutional neural network so that it will give highly accurate predictions while making sure that the training time is less.

1.1 Background

Early blight and Late blight are two of the most common yet dangerous fungal diseases that occurs in potato plants, and they can lead to very severe crop failure if controlling measures are not adopted at an early stage of crop growth. According to sources, losses can range from 80% to 85% in epidemic years. However, these diseases can be detected by analyzing the leaves of a potato plant carefully. Due to the fact that the infected leaves of both of these diseases look very similar, it is not possible for humans to do this task by themselves. Thus, it becomes difficult to determine that which leaf is infected with which disease. However, 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 image inputs. Once such models are trained we can then put them to use by deploying them in real world as web applications or mobile applications so that anyone in the field can make use of them.

2. PROPOSED SYSTEM

2.1 Problem Statement

“To create and deploy a convolutional neural network to identify the leaf disease”

2.2 Problem Elaboration

We will try to identify the disease with which the potato plant is infected with by analyzing the image of the leaf of the plant with the help of a convolutional neural network. This convolutional neural network will take the image of the leaf as it’s input and will classify the leaf into three possible categories - “early blight”, “late blight” and “healthy” by analyzing the image of the leaf. We will deploy this convolutional neural network as a web application on the internet so that it can become accessible to anyone in the world who wishes to use it.

2.3 Proposed Methodology

Fig 1 shows the workflow that is followed in this project. We will be using convolutional neural networks which are best suited for image related problem statements. This is because of the architecture of these networks. They consist of convolution layers and pooling layers, which are the backbone of a convolutional neural network. They allow a very efficient extraction of features from image inputs which allows the model to work better with images as compared to traditional feed forward neural networks. Once we are able to create a model with a suitable architecture that can classify the images of the leaves properly, we can deploy that model on the internet.

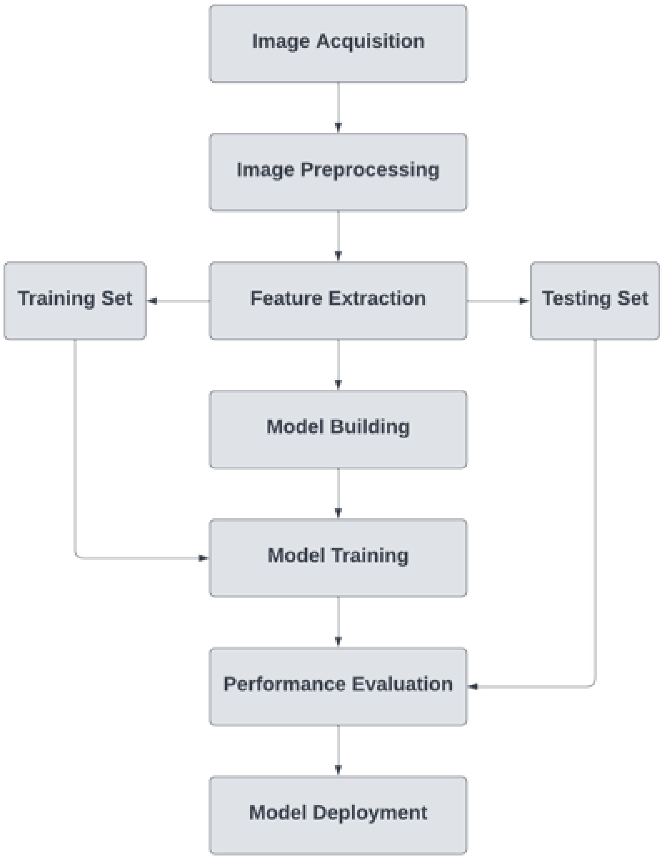

Fig-1: Proposed Block Diagram

2.3.1 Image Acquisition

We start off by collecting data for our model. We collect images of infected as well as healthy potato leaves with the help of a Google extension called "Download all images" which is used to collect images from any web page on Google. Here, we collect a total of 2,152 images belonging to our three exclusive categories.

2.3.2 Image Preprocessing

Once the images are extracted, we perform some preprocessing on them for more convenient usage. We use ImageDataGenerators which are a part of the TensorFlow API and they are used widely to set up convenient input pipelines of the input data. 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 training phase.

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 further 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 rescales 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 split our data into a training set and a test set. The images in the training set are used for the training of our model, while the test set images are 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 during training.

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 the detection of edges, corners, patterns etc. from a given image with the help of filters, also known as kernels. We also use pooling layers, which are used to reduce the size of the representation and thus reduces the computation time. Pooling layers make the feature detection capability of the convolution network more robust by making it more spatial invariant.

2.3.4 Model Building

We will build an appropriate architecture for our model. We've used 6 convolution layers and 6 pooling layers. Furthermore, the model also has 2 dense layers. We have used the "Adam" optimizer to optimize our loss function due to its computational efficiency and lesser memory requirements and finally, since we are dealing with a classification problem, we have used accuracy as our evaluation metric. All the above parameters are experimental and can be tweaked.

2.3.5 Model Training

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

2.3.6 Performance Evaluation

Once the model training is completed, we proceed to the evaluation of our trained deep learning model. For this, we will use the test dataset that we have created earlier. We can check our model's performance based on metrics like accuracy, precision and recall. In our case we have used accuracy as our prime metric so we will go ahead and check for the accuracy value of our model.

2.3.7 Model Deployment

Once we're satisfied with the performance of our model, we will deploy our convolutional neural network model by creating a web service for prediction. We will use Flask Web Framework to wrap our deep learning model which we've built with the help of tensorflow and keras framework.

We can serve the persisted model using a web framework. We create a REST API using Flask. This file is hosted in a different environment, often in a Cloud server. This will allow our model to take input (which in our case are Images of potato leaves) and then returns the prediction in a JSON response.

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

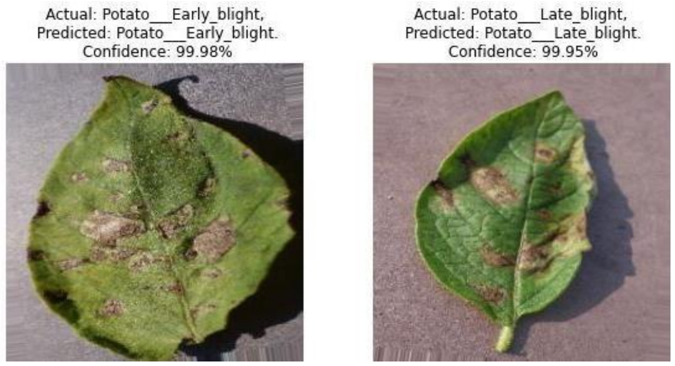

Fig-2: Example Prediction

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 have also discussed the integration of the proposed system with a user-friendly interface and then deploying it on different platforms like 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 be 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 8th 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.