Plant Leaf Disease Detection By Using Raspberry PI

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Abstract- *The transmission of diseases from unhealthy to healthy plants is one of the most disastrous threats to the agriculture industry. Diseases transferred spread like wild fire and have the potential to infest the whole farm if not detected early. Plant disease detection methods aid in identifying infected plants in their very early stages and also help the user in scaling the identification of plant diseases to a variety of plants in a cost-effective manner. The aim of this thesis is to implement two different machine learning models, namely, Convolution Neural Networks (CNN) and K-nearest Neighbors (KNN) for the application of plant disease detection in tomato leaves.*

The proposed system will provide a much better and convenient way for the farmers to monitor their plants. This system provides a disease classification feature which will be trained using a Machine learning technique called Transfer learning and it will deployed to a Raspberry Pi connected with a camera. After the classification, it will return the classification result and it will be forwarded into a cloud database. Then, a mobile application will retrieve the data from the database. If there is any positive disease-presence result, it will send a notification to the farmer that there is a plant in their farm got infected.

I. INTRODUCTION

The aim of this project is to implement two different machine learning models, namely, Convolutional neural network (CNN) and K-nearest Neighbor (KNN) on the plant village dataset and also evaluate the aforementioned models based on the following evaluation metrics: Accuracy, Precision, Recall and F1-Score. The study focuses on the disease identification of tomato leaves from the plant village dataset in specific (J and Gopal, 2019). The novelty of this study lies in the fact that these studies also aims at providing transparency and explain ability for the decisions made by the aforementioned models using the Explainable Artificial Intelligence (XAI) technique, Local interpretable model-agnostic explanations (LIME). The use of XAI in order to explain the predictions made by the machine learning models is very rare and not to be found in many of the research papers in this particular domain.

II. PROPOSED SYSTEM

Artificial Neural Networks

Artificial Neural Networks, abbreviated as ANNs can be described as computational systems that are designed to replicate the human brain‟s analysis and information processing skills, and just like the human brain an ANN consists of a directed graph with interconnected processing elements known as neurons (Jain, Mao and Mohiuddin, 1996).

There are different types of neural networks such as the Recurrent Neural Network (RNN), Multilayer Perceptron (MLP), Convolutional Neural Network (CNN), etc. Among the many Neural Networks present the most common one is the Multilayer Perceptron network (MLP). A typical MLP network comprises of different node layers, namely, an input layer, one or more hidden layers and finally an output layer. All of the nodes are connected to each other and each node is associated with a weight and threshold. The weight refers to the importance that two nodes connecting have in a network and data is transferred from one layer to another only if the output of an individual node is above the threshold specified.

Convolutional Neural Networks

Regular Neural Networks such as the Multi-layer Perceptron (MLP), in the past were used for image classification purposes however as the resolution of the images being used to classify became higher and higher the networks became computationally hard to deal with and the number of total parameters used for classification would be far too many.Convolutional Neural Networks are very similar in working to regular neural networks such as the MLP, however, what changes in Convolutional Neural Networks is that the layers of a CNN have three- dimensional arrangement (width, height and depth) of neurons instead of the standard two-dimensional array and for this simple reason CNNs are widely used on image data for the purpose of classification as the architecture of a CNN is designed to take advantage of the 3d form of an image.A simple Convolutional Neural Network‟s architecture consists of three main layers, namely, Convolutional layer, pooling layer and the fully connected layer. The Convolutional layer is regarded as the main building block of a CNN; it consists of learnable parameters known as filters/kernels. The filter is responsible for finding patterns (textures, edges, shapes, objects, etc.) in the input image. Each filter slides/convolves over the height and width of the input image, computing the dot product between the filter and the pixels present in the input image. The resultant of a Convolutional layer is a feature map that summarizes all the features found in the input image (Yamashita et al., 2018).The Pooling layer is another building block of a CNN that is used to perform down sampling in order to reduce the spatial size of the feature map. This is done to reduce the number of parameters, computations in the network and also to make sure over fitting is controlled. There are two different types of pooling in CNN namely, Max Pooling and Average Pooling. Max Pooling returns the maximum value that is present in the portion of the image convolved by the kernel and Average Pooling returns the average of all the values present in the portion of the image convolved by the kernel.

K-nearest Neighbor's

The K-nearest Neighbor is a machine learning algorithm that estimates how likely a new sample belongs to a label, based on the voting of the majority labels that the data points nearer to the new sample are found in. The algorithm works by calculating the distance between the new sample and all the other samples after which it sorts the values calculated in ascending order. Based on the „k" value the majority label is chosen as the prediction. Here„k" signifies the numberof nearest neighbors to be included in voting of the majority label (Guo et al., 2003).

The choice of „k in KNN makes or breaks the predictions in the algorithm. If the value of „k is too small then the classification is very vulnerable to noise and the model might be over fitted. On the other hand, if the „k" value is too big then the model most likely will classify any new sample as the majority label all the time (Paryudi, 2019).

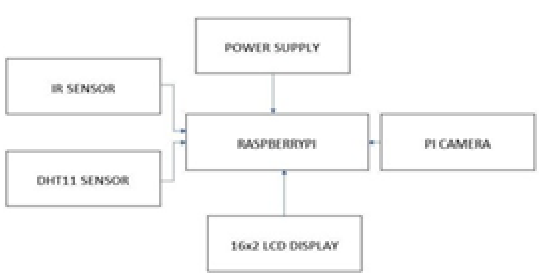

Fig 2.4- Block diagram of Plant Disease Detection

III. HARDWARE DESCRIPTION

System Requirement

This project will be employing a Raspberry Pi 3 Model B connected with a Raspberry Pi NoIR Camera V2 which allows the Raspberry Pi to capture the image of plants and 2 LEDs to indicate the current status of the system. The software components include Ubuntu OS, Raspian OS, Firebase Database, Tensor flow, Android Studio and UV4L video streaming driver software.

IV. RASPBERRY PI 3 MODEL B

The Raspberry Pi 3 is the heart of the entire system. It has moderate specifications for an embedded device to run machine learning process but it is reasonable in pricing and easy to get. It also has a complete Linux distribution which is specifically for Raspberry Pi which is an embedded device powered by an ARM processor.

Fig 4.2.1- Raspberry Pi 3 Model B (Raspberry Pi Foundation)

Raspberry Pi No IR Camera V2

This camera module has a Sony IMX219 8-megapixel sensor. It also does not employ an infrared filter which gives us the ability to see in the dark with infrared lighting but by daylight the pictures will look decidedly curious. It also comes with a little square of blue gel film which can be used to monitor the health of green plants but we do not use this feature in this project.

Fig4.2.3-IR Sensor

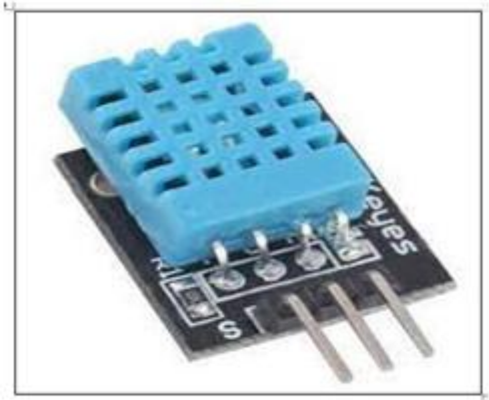

Fig 4.2.4-DHT11 Sensor

Fig4.2.5-Potentio meter

V. SYSTEM IMPLEMENTATION

In this project, total of two different colors LEDs (2 pins) are needed. These LEDs are indicating the status of the system. Each color LED is representing different status of the system as in the full system there is no display for the user to view the status of the system. This allows the user to be aware that what the system is currently doing.

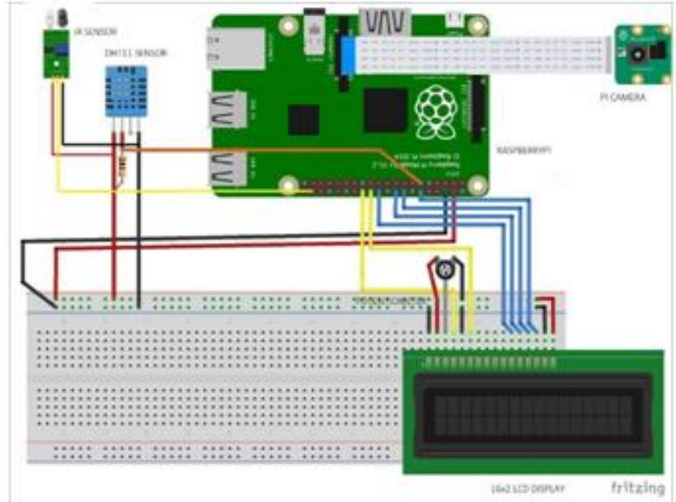

Fig 5.1 Actual setup of the status indicator setup

Fig 5.3 - Original image of a tomato leaf with „Late blight" disease

VI. CONCLUSION

On implementing two machine learning models, Convolutional Neural Networks. (CNN) and K-nearest Neighbors (KNN) on the disease detection of tomato leaves from the plant village dataset and also evaluating the aforementioned model using the following metrics: Accuracy, Precision, Recall and F1-Score, the study shows that CNN model performs better than the KNN model in the plant disease detection of tomato leaves by outperforming the KNN model is all of the four evaluation metrics. The study also makes use of the XAI technique Local Interpretable Model-agnostic Explanations (LIME) in order to provide explain ability to the predictions made by the models. With the execution of a user study, this study is able to get feedback from farmers on if they trust the aforementioned AI and XAI models. The results from the user study indicate that the farmers find the predictions and explanations from AI and

XAI models inadequate and therefore do not trust the implemented tools for the detection of plant diseases.

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