IOT Based Paddy Crop Disease Identification and Prevention System using Deep Neural Networks and Image Processing

K. Abhirami
Department of Computer Science and Engineering
Kings College of Engineering
Punalkulam, Pudukottai, Tamilnadu

G. Chandra Praba
Department of Computer Science and Engineering
Kings College of Engineering
Punalkulam, Pudukottai, Tamilnadu

R. Sugantha Lakshmi
Department of Computer Science and Engineering
Kings College of Engineering
Punalkulam, Pudukottai, Tamilnadu

***Abstract*-Human population on earth is expected to reach 9.7 billion by 2050 as per FAO projections and to feed this population production to be increased by 70%. This magnificent population growth brings a lot of challenges with food production the major issue to be addressed. Pests and diseases cause heavy losses through deaths, reduced productivity and loss of markets for products. Crop pests and diseases reduce yields substantially, sometimes by over 50 per cent or even total crop failure. Technology enabled farming supported by IoT and Image processing techniques for disease prediction entiles new dimensions in the field of precision farming. Vision-based detection of plant diseases is beneficial in monitoring large fields of crop and symptoms that appear on the plant leaves by deep neural network. Proposed methodology combines IoT and Image processing and performs classification using deep learning model that helps in crop disease prediction and thereby supports increased productivity.**

Keywords—Crop Disease prediction, Deep Neural Networks, Image Processing, Precision Farming.

I. INTRODUCTION

Traditional methods of farming, decreasing farm labour availability, server water scarcity problem, depletion of soil conditions makes agriculture economically unavailable and inefficient. It is also the right time to focus on nurturing the nature, do technology enabled farming to feed the existing and the anticipated population. According to the report by United Nation of food and Agriculture Organization the population will get doubles in 2050. The increased production of the agriculture will support huge economic boost to the nation. Agriculture practices suitably supported by technological inventions are essential for efficient and timely agriculture operations, facilitating multiple cropping & thereby increasing production, convenience. Farm products should provide only nutrients to the consumers and ensure healthy living. The county GDP will get improved by the agriculture production. Agriculture contribution in India is about total GDP of 16% and total exports of 10%. Backbone of Indian economy is depending on the agriculture production. When compare with the growth of other sectors, the overall share of agriculture on GDP of the country has decreased.

The growing interest in technology and automation is apparent to address every aspect of agriculture production cycle. Production life cycle of a farm is a complex operation, with dozens of factors affecting every decision. To monitor crops, various sensors, camera and IT unit are used to capture images at regular intervals and then integrated into imaging system (uses advanced Machine learning and Artificial Intelligence techniques) to get better yield and reduces crop failure. In future, machines integrated with Internet of Things and Image processing could entirely replace the need for humans to manually weed or monitor crops. Integrating advanced technology into existing farm practices, provide quality and high yield products.

In the field of precision agriculture, expansion in the practices of precise plant protection and market for various technology enabled farming techniques comes into existence. Integrating image processing techniques such as color analysis and threshold values to detect and classify plant diseases results in crop protection. Various different approaches are currently used for detecting plant diseases and most common are artificial neural networks . In machine learning and cognitive science, ANN is an information-processing paradigm that was inspired by the way biological nervous systems, such as the brain, process information. The brain is composed of a large number of highly interconnected neurons working together to solve specific problems.

II.BACKGROUND AND RELATED WORK

To enhance the productivity of the crop there by supporting both farmer and nation, it was proposed to use the technology which estimates the quality of crop and provide suggestions. The real time images of various rice blast diseases are acquired using web camera. The interfacing of camera with Raspberry pi was found very easy. The Raspberry pi board is used to process the images of the crops from camera output. Raspberry pi is perfect for any automation. Then various image processing methods are applied to the acquired images to getting useful feature that are important for next analysis process. The image comparison by optimization techniques using open CV.[1]. For overcoming the problems of agriculture, system was developed with a initial framework based on components the first component in the deployment of sensors in the field, we deploy soil sensors, humidity sensors, and temperature and leaf wetness sensors in the field. Sensors collect the data and send it to the servers, on the server side we deploy the expert system, which processes the data and send the recommendations to the farmer about the crop.[2]

Wireless sensor network consists of sensors of different types networked together to collect the information of crop conditions and environmental changes information is transmitted through network to the farmer or devices that initiates corrective action.[3]. Precision agriculture is exact in both the extent of the product territory it screens and in addition in the conveyance measures of water, compost, and so forth. This innovation can separate a solitary plant for checking in the tens or several square feet. Exactness agriculture requires a novel programming model for each land territory, the characteristics soil write and the specific harvest or plants. For instance, every area will get its own particular ideal measure of water, compost and pesticide.[4]. Study and analysis of cotton disease detection using image processing work is carried on. The k means clustering algorithm is used for segmentation. The k-mean concept is added to the proposed system which will divide the leaf into different clusters. The survey of disease identification in cotton leaf is done. Comparison of different detection technique of leaf disease detection is mentioned.[5].

K-Means clustering algorithm used Euclidean distance metric method and clusters the image based on the specified number of groups. Gray- Level Co-occurrence Matrix (GLCM) is one of the most popular methods for texture analysis. It procedures a feature based gray level matrix for the colour image and measures the spatial distance between the pixels. GLCM calculates how often the pixel with gray level intensity occurs. Horizontally values are represented as 'i' and vertically or diagonally values to adjacent pixels are labelled as 'j'.[6]. System was designed with voice navigation system so that a person with lesser expertise in software should also be able to use it easily. The proposed system is providing a solution to recover from the leaf diseases and also show the affected part of the leaf by image processing technique. The leaf disease prediction is done using k-mean clustering algorithm. It includes several steps such as Image acquisition, Image pre-processing, Feature extraction and neural network based classification[7]

To implement the idea if combining image processing and irrigation. Drop box server is server host to private data and it is freely accessible for limited amount of storing data with authentication. It issued in desktop with windows OS and also in smart phone in order to give storage of disease detected images to the former. Blynk server is an IoT platform to control and monitor the processors like aurduino, Raspberry Pi and ESP32. Here they are making use of this server to monitor the irrigation process by giving updates of environmental factors.[8]

III.PROPOSED METHODOLOGY

Internet of Things system includes sensors and cameras to capture the image of the plant leaf which can be divided as 80-20 ratio for training and testing the images. The color, shape, texture and the leaf size are the attributes used for diagnosis.

- Crop Image acquisition : Crop images are captured through cameras set up in the farm. Extraction of leaf image and database creation is the initial stage.
- Crop Image Pre-processing: In this stage the noise removal and data normalization are carried out by the pre-processing model. Here, features are normalized from vector to unit space.
- Crop Image Analysis: In this step, segmentation of images is done to find the region of interest. In segmentation, the technique used is region-based segmentation which separates healthy and diseased region of the plant leaf by using the color of the leaf.

The image acquired from the camera and from the database will be pre- processed. Next the conversion of RGB to gray scale image, as gray scale image gives perfect accuracy to defect detection, then image resizing, followed by image enhancement and edge detection. Then many analytics technique is carried out to classify the images according to the particular problem at hand.

Finally compared image disease will be send to the Cloud using optimization techniques. Already prior work exists in the real time but not in the embedded scenario. The objective of this proposed approach is to implement modern technologies of image processing with deep neural network model. Usage of Internet of Things system makes the process easier which is extended to some level of automation for capturing the images at regular intervals. This in turn helps the end user to monitor the environmental factors easily in spite of getting into field physically.

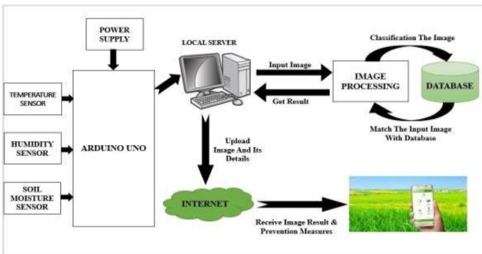


Fig I . Proposed System Design

Neural Network

Neural Network (NN) as a system that is comprised of several *artificial* neurons and *weighted* links binding them. The artificial neurons processing the information are organized into interconnected layers along chosen *patterns*. Every neuron in its layer, receives some type of stimuli as input, processes it and sends through its related links an output to neighbouring neurons. The networks heavily rely on learning in order to adapt to their environments.

The neural network is composed of four main sections:

- Input which is a node that activates upon receiving a trigger from incoming signals
- Interconnections between nodes

- An activation function (rule) which transforms inside a node, input into output
- An optional learning function for managing weights of input-output pairs

Input Layer

This is the first layer of the network. The layer consists of one neuron for each specific attribute used by the network to classify. The number of neurons determine how the input layer is structured. The input layer interacts with the external environment and consists of an independent variable interacting with the environment.

Output Layer

This is the last layer on the neural network. The output is provided after all the inputs have been processed and presents a pattern to the external environment. In the classification process, the output layer consists of the specific groups for which the inputs are assigned into. Hidden Layer .

Hidden Layer

The purpose of the hidden layer is to enable the neural network to produce better results of the expected output for the given input. The hidden layer provides an

intermediate layer for which the activation function has been implemented. The hidden layer consists of hidden neurons. The number of hidden neurons are critical as this prevents the problem of overfitting or under fitting. Critical error- This is the desired mean square error for stopping network training. The neural network was implemented by attaching a weight to the input variables

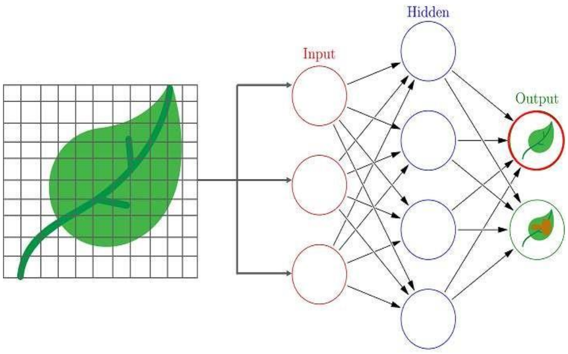


Fig II . Structure of Neural Network

in the network. A transfer function was selected for the model. The model used sigmoid transfer function which lies between 0 and 1. Once the network was trained it classified the target class as the output. A learning rate of 0.2 and momentum of 0.5 was used to train the network. A test was carried out to validate that the network perform as was expected.

Training the deep convolutional neural network for making an image classification model is proposed. The convolutional layer is the essential building block of the convolutional neural network. The layer's parameters are comprised of a set of learnable kernels which possess a small receptive field but extend through the full depth of the input volume. Deep CNN with ReLUs trains several times faster. This method is applied to the output of every convolutional and fully connected layer.

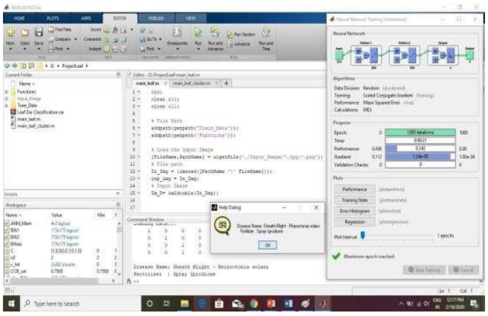
Despite the output, the input normalization is not required; it is applied after ReLU nonlinearity after the first and second convolutional layer because it reduces top-1 and top-5 error rates. In CNN, neurons within a hidden layer are segmented into "feature maps." The neurons within a feature map share the same weight and bias. The neurons within the feature map search for the same feature. These neurons are unique since they are connected to different neurons in the lower layer. So for the first hidden layer, neurons within a feature map will be connected to different regions of the input image. The hidden layer is segmented into feature maps where each neuron in a feature map looks for the same feature but at different positions of the input image. Basically, the feature map is the result of applying convolution across an image

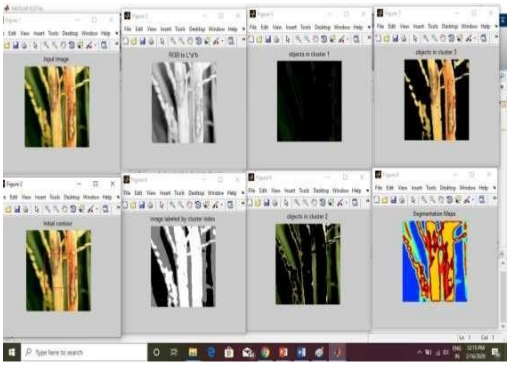
IV.EXPERIMENTAL RESULTS AND DISCUSSION

It is noted that development of the system will helps the farmers to save their crop loss from the diseases. System will detect the diseases in the earlier time and classify the diseases and give information to the farmers to save their crops.

We have implemented the system on an IoT Reference Architecture for local on-field disease detection and cloud analytics for disease prediction. The system will be trained with the disease and their prevention measures using neural network.

The research relies on pixel features of the images that are captured by the farmers. Once the pixel values are obtained, the data is normalized so as to minimize the range of values returned. Back propagation neural network is used to classify the neural network and the diagnosis and prescription are provided to the farmer. Early detection of crop diseases leads to control and management. This results in higher yields and thus a more food secure nation. The application can be built to support local languages since most farmers in the rural areas are elderly. The applications can also be built to support speech to text. The application can be extended to have forums in which farmers are able to share information based on their location.





Crop leave disease prediction
Neural Network based crop disease prediction

CONCLUSION

Automating this approach helps the farmers to monitor the field by working at their own places without being present physically in the field. In future the camera module can be placed as a drone to capture the fields at different direction. Use of Internet of Things in agriculture produces cost management, waste reduction, process automation and enhanced product quality and volumes. Precision agriculture mainly depends on image-based recognition.

In future, the images taken in varying lighting condition is taken for the further modification of the algorithm. Since the shape of the leaf determines the quality as well as the species of a plant by the shape identification the type of the plant also can be identified. Automating this analysis is especially beneficial for those a farmer to which expert knowledge and advice is not readily available or affordable. Our proposed work is to optimize the algorithm to send the data to the cloud. Cloud analytics will be done by python scripts. The data's will be loaded into the database for storing, managing and retrieving information's. The system will be trained with neural network to identify the disease and remedy for it and transferring the information to the user.

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