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An IoT-Based Model for the Classification of Plant Diseases using Deep Learning

Dhannya J.[1] , Dr. V. Sangeetha[2]
[1]*Research Scholar, Karpagam Academy of Higher Education, Coimbatore*
[2]*Professor, Dept. of Computer Science, Karpagam Academy of Higher Education, Coimbatore*

ABSTRACT

In India, Agriculture is of great importance. Diseases affecting crops is a major challenge faced by Agricultural industry. Hence earlier detection of crop disease has greater importance in agricultural field. In recent years, the number of diseases on plants and degree of harm caused has increased due to the variation in the varieties of microorganisms, inadequate cultivation methods and inappropriate plant protection techniques. In the present study, Farmers spend so much money on disease management, often without adequate technical support, resulting in poor disease control, pollution and harmful results. In addition, plant disease can destroy natural ecosystems, adding environmental problems caused by poor management of crops. A symptom of plant disease is a visible effect of disease on the plant. Symptoms may include a visible change in colour, shape or function of the plant as it responds to the pathogen. A faster method for detection of crop diseases is done with the help of IoT. A sensor network can be created in the farm land using Raspberry Pi 4 model. The images will be captured by the sensor cameras and send to the cloud server via Raspberry pi 4 model. The proposed model is a theoretical model. In this proposed methodology, various image processing techniques will be applied on acquired images for classification of crop diseases using fuzzy c-means clustering algorithm. This paper will also shows the method of image processing techniques such as image acquisition, image pre-processing, image segmentation and feature extraction for classification of crop diseases. Farmers can produce quality crops and thus healthy food can be obtained by this proposed methodology and make more profit.
Keywords: Crop Diseases, Image Processing, Internet of Things, Deep Learning, Raspberry Pi and Sensors.

I. INTRODUCTION

Agriculture is the art of cultivating the soil, growing crops and raising livestock. The basic purpose of agriculture is not only to cultivate food, but to achieve human health. India is a land of agriculture. The major population in India relies on agriculture for their livelihood. The basic economic development of the country lies in agriculture. It also provides employment to many people. Hence plant health monitoring has got a significant importance in the life of a farmer. Proper monitoring will prevent the plants gets affected from various diseases. The existing system of observing plant diseases depends on naked eye observation. This is a very time consuming process. Plant diseases must be predicted automatically at the earlier stages in regular intervals so as to maintain healthy plants.

In this paper, IoT enabled sensor networks are used to capture images and various deep learning methods are used for classification of leaf diseases. Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. Deep learning is used for two reasons in IOT. First reason is data analysis of huge amount of data to obtain smart data and second is the prediction of some specific output using algorithms. Image processing techniques are used for classification, segmentation and feature extraction. In this model, sensors are placed in agricultural land and the sensors capture the images of crops and will be sent to the cloud server through internet using Raspberry Pi 4 module.

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II. RELATED WORKS

Tanilal Bhavsingh Thakur, Amit Kumar Mittal shows the real time application of IoT for monitoring and controlling of agricultural production. They develop a system which is based on machine learning in cloud environment using IoT sensor nodes/devices [1].

Neda Fatima, Salman Ahmad Siddiqui, Anwar Ahmad developed an IoT-based Smart Greenhouse with Disease Prediction using Deep Learning. The purpose of this paper is to design an IoT based smart Greenhouse system which monitors, alerts automate and predict disease.[2].

Rajesh Yakkundimath, Girish Saunshi, Vishwanath Kamatar developed Plant Disease Detection using IoT. They developed an automated system to identify whether a plant is normal or diseased. In this paper an automated system using sensors like temperature sensor, humidity sensor etc. and colour parameters are used to determine whether the plant is normal or diseased. [3].

Nidhi Kundu, Geeta Rani, Vijaypal Singh Dhaka, Kalpit Gupta, Siddaiah Chandra Nayak, Sahil Verma, Muhammad Fazal Ijaz 4 and Marcin Wo´zniak developed IoT and Interpretable Machine Learning Based Framework for Disease Prediction in Pearl Millet. This paper used IoT and machine learning models to determine various diseases in Pearl Millet. Raspberry Pi is used [4].

Abhinav Sagar, Dheeba J, proposed a method On Using Transfer Learning For Plant Disease Detection. They showed how deep neural networks can be used for plant disease recognition in the context of image classification. .They have compared five different architectures including VGG16, ResNet50, InceptionV3, InceptionResNet and DenseNet169 as the backbones for our work. The best result is obtained in ResNet 50[5]

[6] In this paper Konstantinos P. Ferentino used convolutional neural network models were developed to perform plant disease detection and diagnosis using simple leaves images of healthy and diseased plants, through deep learning methodologies.

[7] This paper used methods to optimize for both detection speed and accuracy and applied to multi-class apple plant disease detection in the real environment**.**

III. MATERIALS AND METHODS

The proposed methodology will provide IOT application for classification of crop diseases using deep learning algorithm**.** At first the method is classification of crop disease using image processing techniques to remove diseases from crops .Here Fuzzy c-means clustering algorithm is used for allowing input from IOT and process it.

Some of the diseased plant leaves taken from plant village dataset is shown in figure 1.

Figure 1. Diseased plant leaves

The internet of things is the connection of various physical devices, home appliances, vehicles etc that communicates with each other. IOT consists of various sensors and actuators which helps in the data exchange. The connectivity or network of IOT devices are shown in figure 2.

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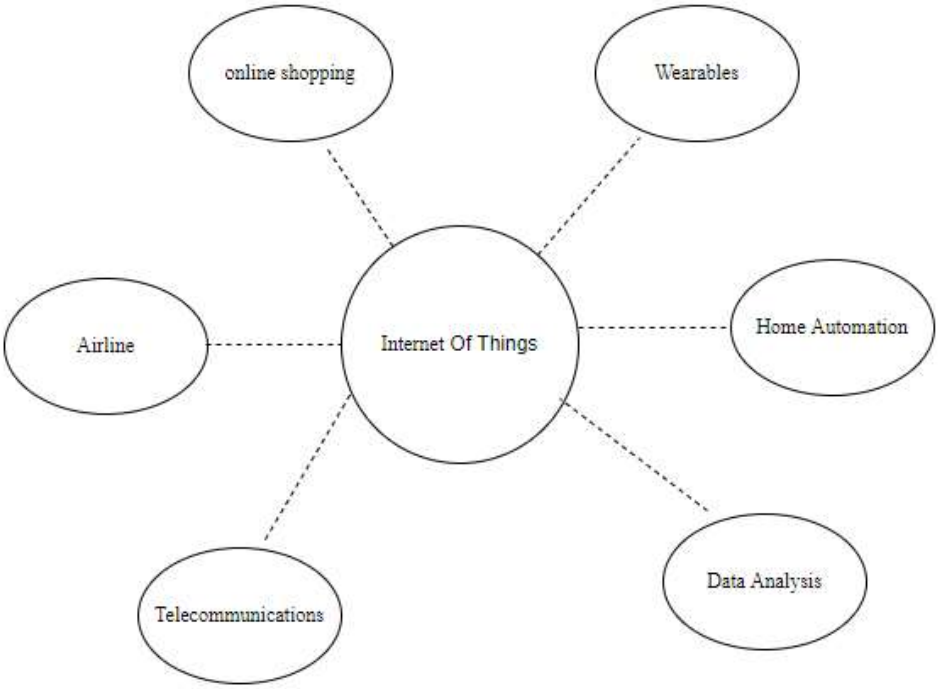

Figure 2. Network of IoT devices

In future, IOT have to be implemented in agriculture to enhance crop production and thus helps farmers to a greater extent.

In this proposed methodology, various image processing techniques will be applied on acquired images for classification of crop diseases using Fuzzy c-means clustering algorithm. This paper will also shows the method of image processing technique such as image acquisition, image pre-processing, image segmentation and feature extraction for classification of crop diseases. Farmers can produce quality crops using proposed methodology and make more profit. In real time treatment of crop diseases, farmer will increase quantity of their crops.

In this model, by creating a sensor network on agricultural land and the collected images of crops from the sensor camera will be sent to the cloud server through internet using Raspberry Pi 4 module. Various image processing techniques are applied for classification of crop diseases on collected images using Fuzzy c-means clustering algorithm. The wireless sensor networks are used in this system. WSN is a network of sensor nodes that are capable of communicating with one another and these sensors measure the parameters of environment such as humidity, temperature, light etc.

The proposed methodology will provide IoT application for classification of crop diseases using deep learning algorithm. At first the method is classification of crop disease using image processing techniques to remove diseases from crops .Here Fuzzy c-means clustering algorithm is used for allowing input from IOT and process it.

. The block diagram of proposed methodology is shown in Fig. 2

In this model, a sensor network can be created in the agricultural land using Raspberry Pi 4 model. The images are captured using sensor cameras and will be sent to cloud server through Rasperry pi 4 model. Live images of crops by sensor cameras can be collected from agricultural land using Rasperry Pi 4 module. Raspberry Pi 4 Module will be installed with Raspbian operating system using node server or express server to store live data. Node.js web application code will be developed for data fetching and also configure in Raspberry Pi 4 Module. Cloud server will be configuring for computing

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and gathering live data from agricultural land.

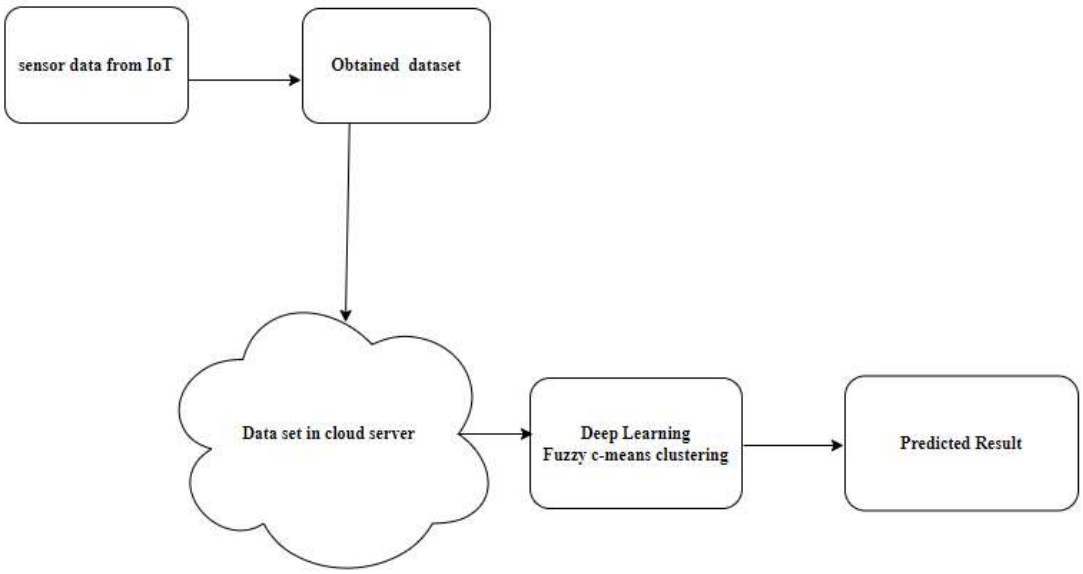

Figure 3. Block Diagram of Proposed Methodology

IV. RESULT ANALYSIS

In the proposed methodology, Fuzzy c-means clustering algorithm is used for classification of crop diseases. Various image processing techniques are applied on the collected images from sensor nodes for classification. The image is fragmented using fuzzy c-means clustering to obtain various clusters of different colors for predicting output. Fuzzy c-means clustering is a soft clustering method in which large datasets are divided into clusters of similar data .Here, the data set which is grouped into N clusters with every data point in the dataset belongs to every cluster to a certain degree. Each datasets is a set of color points of image and can be represented in RGB primary color model. The 'c' refers to the cluster centers. The main purpose of fuzzy c-means clustering is the partitioning of data into a collection clusters, where each data point is assigned a membership value for each cluster.

Fuzzy c-means clustering involves two processes:

a. The calculation of cluster centers and
b. The assignment of points to these centers using a form of Euclidian distance.
c. These processes are repeated until the cluster centers stabilize.

The algorithm incorporates fuzzy set concepts of partial memberships by allowing data points to belong to more than one cluster.

There are some steps to the algorithm perform for desired output:

1) At first the data points are initialized into required number of clusters randomly.
2) Next find the centroid
3) Then find out the distance of each data point from centroid.
4) Update the membership values.
5) Repeat steps 2 to 4 until constant values are obtained for membership values.
6) The membership values obtained are defuzzified.

In this paper several Image processing techniques is used to perform some operation on image for obtaining some useful information from image using fuzzyc-means clustering algorithm .The image processing consists of followings basic steps shown in Fig. 4.

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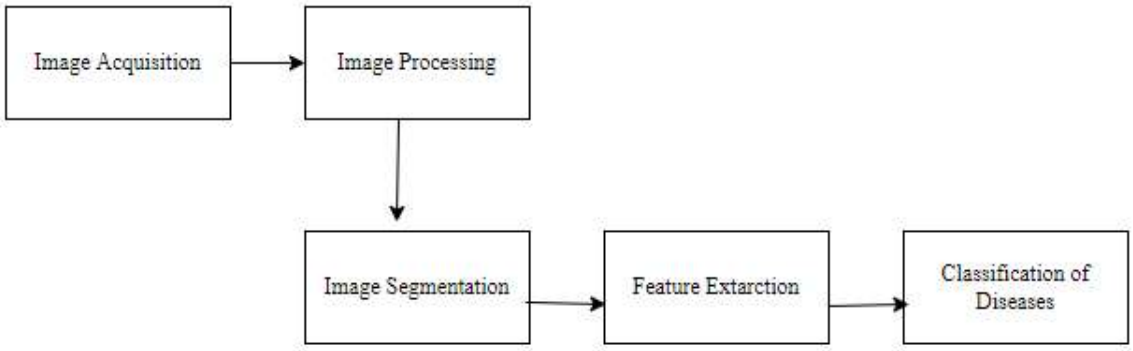

Figure 4. Basic steps of Image Processing

1. IMAGE ACQUISITION

Image Acquisition is the process of capturing images of crops using sensor cameras placed in the farms.

2. IMAGE PREPROCESSING

Image preprocessing is done to improve the quality of the image so that we can analyse the images in an easier way. The infected part of the leaves are identified using this step. The RGB color values can be converted into grayscale.

3 .IMAGE SEGMENTATION

Segmentation is the process of partitioning the images into various segments. For this , Fuzzy c-means clustering algorithm can be used to divide the images into different clusters. Similar clusters of infected leaves can be found using this algorithm.

4. FEATURE EXTRACTION

Feature extraction is used to extract features of images such as color,texture etc .

5. CLASSIFICATION OF DISEASES

Finally images are classified as diseased images and non-diseased images and testing of mages are done using deep learning methods.

V. CONCLUSION

This paper is a theoretical model using IoT and deep learning methods to detect and classify various leaf diseases using Fuzzy c-means clustering as well as image processing techniques can be used to identify the diseases. This can be implemented using sensor cameras in farmers farm lands. Using this model farmers can easily detect leaf diseases and improve the crop production and the quality of their crops.

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