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IOT and Deep Learning Assisted Smart Agriculture System for Plant Disease Identification

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Abstract. Agriculture employed more than 50% of labours and contributed nearly 18% to country's GDP. India is the leading producers of Many crops, such as wheat, rice, lentils, cotton, peanuts and perishable products but in recent years, the percentage of people getting into agriculture has been reduced. Crop disease and incorrect maintenance of humidity and moisture is the major reason that makes new farmers frustrated. Developing a deep learning model, that can identify the crop disease with high accuracy, and using this model one can easily identify the crop disease which makes easier for them treat the crop with pesticide, so that we can't wait for the experts. Using the IOT architecture to find the humidity and soil moisture of the field so that the farmer can maintain the correct level of humidity and soil moisture through irrigation, sometimes extreme high and very low moisture and humidity leads to diseases. An enhanced classification model was suggested in this paper to classify leaf diseases. Dataset with more than 10000 images is used for image classification. Classification accuracy is achieved using AlexNet model and it came out to be the highest in comparison to other models, and IOT part using the Raspberry pi 3 kit with soil moisture and humidity and soil moisture sensor.

Keywords: Internet of Things, Convolutional Neural Network, AlexNet.

1. Introduction

The Internet of Things (IoT) is a network of linked devices and the ultimate technology that enables communication between devices and the cloud, as well as between the devices. The Raspberry Pi (RPi) is a family of single-board computers that are increasingly being used to connect Internet of Things devices. The Raspberry Pi can be connected to a digital monitor. It's a competent tiny device that allows individuals to know about computing and programming in languages such as Scratch and Python, we can use RPi for controlling the sensors and we use them for smart agriculture like maintaining moisture and humidity level in field and also for the smart irrigation facility. convolutional neural networks (CNN) is the leading technology in deep learning, It can be used in wide range of applications such as image and speech recognition and detection, data generation, etc. There are many existing image recognition methods that are used for image classification but CNN emerged as the most effective method for

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solving different types of problems [1]. This paper explains the methodology and outputs of fine-tuning CNN for AlexNet architecture, using the self-collect dataset. Convolutional neural networks nearly as same as Artificial Neural Network (ANN) [2] which have learnable weights and biases with only different in the filters used, CNN filters are very effective with images [3]. Deep CNNs are effective with large dataset and also with large videos. The AlexNet architecture's fine-tuning procedures and learning results are provided. This system is much capable to determine the disease in leaf with image provided by the user.

2. Literature Review

The author in [4] has implemented the CNN model for classification and detection of plant leaf disease among 10 different classes. In [5], the author has proposed a lightweight Deep Neural Networks (DNN) which can run on resource constrained IOT device. Different image sizes have been tested with this architecture to find the optimal size of the input image. The author of [6] proposed a Smart Agriculture System which is composed of cutting edge technologies such as Node MCU Board, IoT Paradigm, Android Application Development, Wireless Sensor Network Architecture, and Machine Learning Algorithms. The author has monitored the weather conditions and premature diagnosis of plant diseases. In [7], the authors have used a novel technique called Region Proposal Network (RPN). This RPN is used to focus the plants in complex environments. The leaf images are segmented using RPN algorithm in-order to overcome the symptoms. Additionally, the authored model is inspected with black rot, bacterial plaque, and rust diseases. In [8], the authors have proposed feature engineering using feature extraction techniques, which helps the algorithm to run on IoT devices. Features considered are such are color, texture, size and etc. the author also performed classification of plant leaf disease using deep learning. The author in [9] has proposed the sensor fusion approach. This approach detects agricultural parameters such as soil moisture, temperatures, salinity, climate conditions, and plant growth by using sensors. The results are utilized in water, pesticide and fertilizers estimation.

3. System Architecture

This paper is about identifying Leaf disease using AlexNet approach [10],The moles from the images is easily extracted by the convolutional layers. The model can easily identify the plant affected by what type of disease. Here we classify 38 classes of leaf diseases. After the model trained the comparison of leaf disease image and trained model takes place to predict the disease. The model executes in the below order, the image that we give is undergo pre-processing where the data augmentation and future extraction where done, then we implement our architecture which is AlexNet to our model then we compare the test and train images to predict the disease. The module description in shown in the Fig. 1.

The IoT part which is a whatsapp alert that is sent to the farmers when the moisture level is very low or extreme high, this may also leads to the plant disease, and also helps in irrigation[11]. This system

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is the two in one facility that can be used to prevent the plant from the disease and also helps in smart irrigation. The idea of the paper is shown in Fig 2.

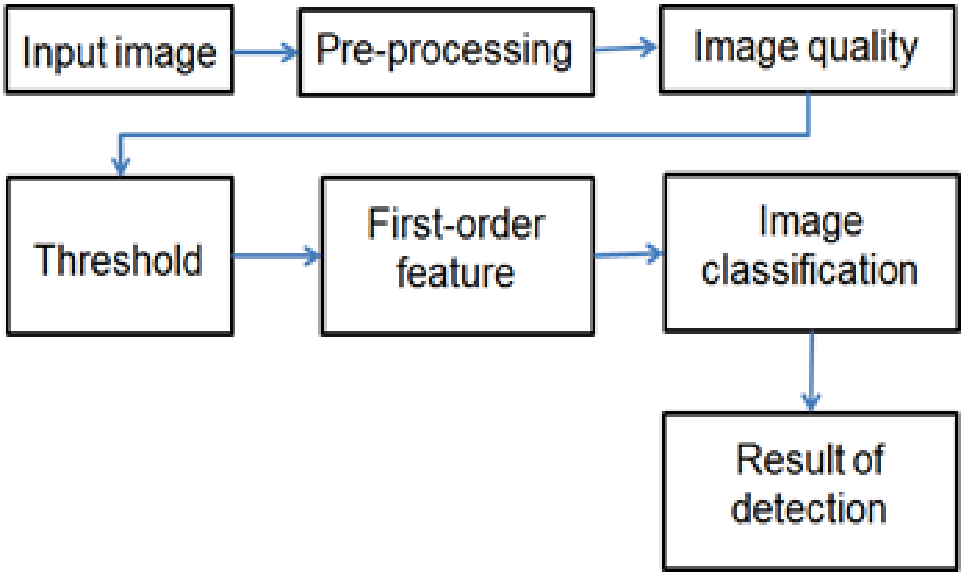

Fig. 1. Proposed.

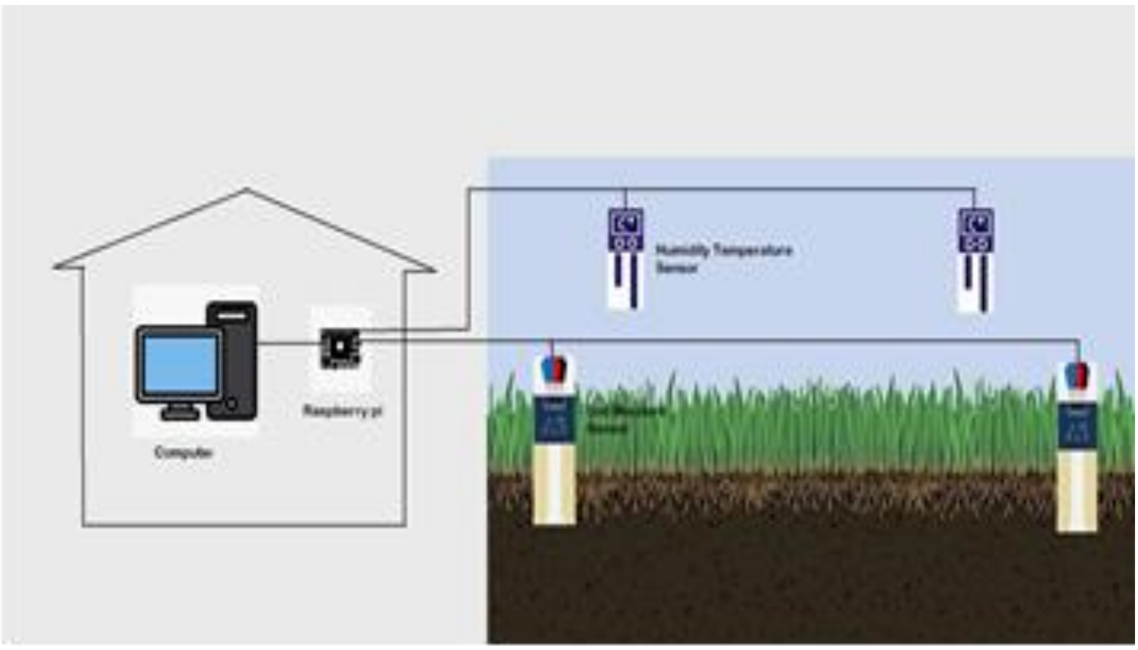

Fig. 2. CNN Architecture.

4. Internet of Things

IoT refers to physical objects equipped with sensors, computing power, software, and technologies that connect to and exchange data with other devices through internet [12]. Recently Social Internet of Things (SIoT) [13] and its outcomes are influenced in many real-time applications as mentioned. To summaraize the layers of in IoT architecture is discussed below.

A. Sensing Layer

This Sensing layer contains sensors, actuators, and devices. These sensors or actuators receive, process, and send data over the internetwork.

B. Network Layer

IoT network layer contains the devices like gateways and Data Acquisition System which is used to converting analog data to digital data.

C. Data Processing Layer

Data processing layer is IoT processing unit. In this layer analyzing and pre-processing of the data is done before sent to the data canter.

D. Application Layer

Top layer of the IoT system is application and its provide the interface between the user and application system. In the data management centres where data is maintained and it can be integrated to end-user applications such as agriculture, medicinal health care applications, aerospace and modelling, farming and smart irrigation system, and defence and security.

5. System Architecture

AlexNet includes convolutional layers, max-pooling layers, normalisation layers, fully connected layers, and softmax layer with the numbers 5,3,2,2 and 1 respectively [14]. Convolutional filters and one non-linear activation function ReLU is present in the each convolutional layer. Max pooling is done using the pooling layers, the input size is fixed [15] shown in Fig.3. The input size is usually stated as 224x224x3, although because to padding, it is actually 227x227x3. AlexNet includes 60 million parameters.

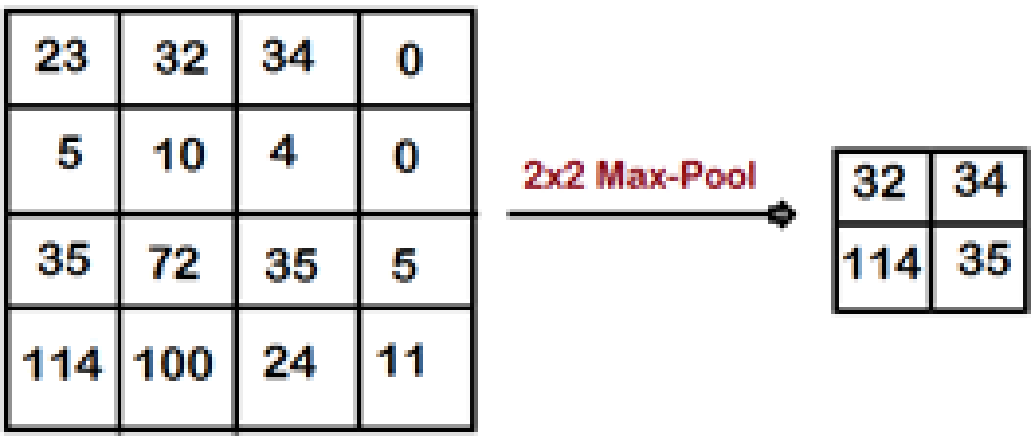

Fig. 3. Max – Pooling.

Max Pool is used to downsample an image or a representation. Its dimensionality is reduced by accepting assumptions about features present in the binned subregions.

5.1 Experimental Environment

Python – It is the high-level language that has many inbuilt libraries. It is very simple to learn and is very effective [16]. Currently it is used in all the advanced technologies. It has the easy access to the advanced libraries. Colab- Colab is the programming platform where we can perform and execute our codes, Colab is also a google product specialized for python. It has the virtual RAM for running the program. Raspbian OS- Raspbian OS is the operating system which is used in Raspberry pi, It is also like as other operating system specialized for Raspberry pi [17].

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5.2 Dataset

Our dataset shown in Fig 4. consists of 10496 images of 38 plant disease. This is the self-arranged dataset, greater the dataset leads to the better accuracy[18] so we use the dataset of more than 10000 images. This dataset is broadly divided into two datasets, the first one is training dataset and the other one is test dataset. These two datasets contain images of plant and every image is represented with a label representing the name of the plant disease.

Fig. 4. Dataset.

5.3 IOT Connection Setup

The connections are made just like the above image, the sensors, soil moisture and humidity and temperature sensor are connected to the raspberry pi using the help of breadboard[19]. The raspberry pi kit receives the readings from the sensors, using our code the raspberry pi reads the results once for given

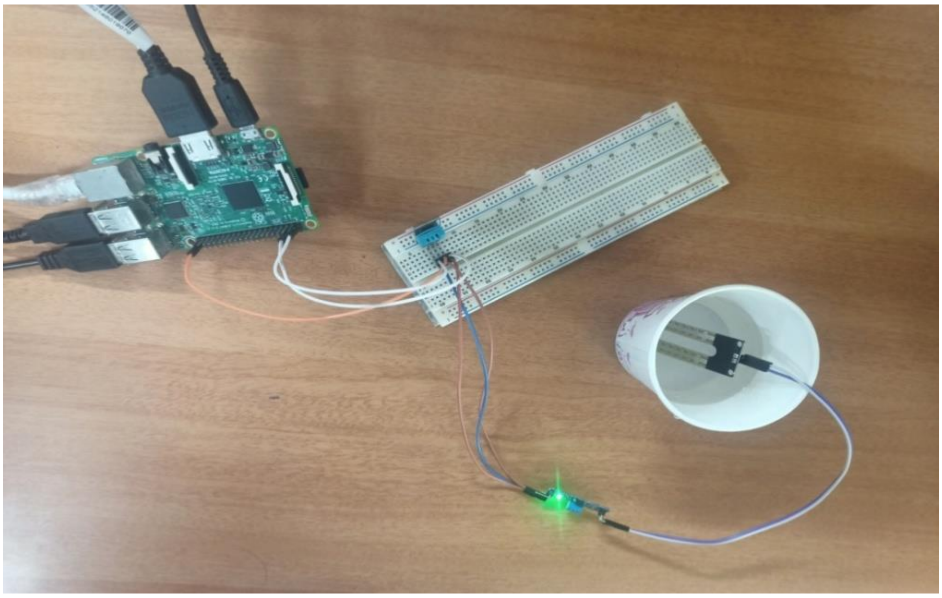

Fig.5. IoT Connections

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time period and alert the user through whatsapp when the soil moisture level is low or high [20][21]. The connections are shown in the Fig 5.

6. Result Analysis

6.1 Alert System

Our system achieves the goal of sending the whatsapp alert to the farmers when the soil moisture level is irrelevant [22]. This system sends the alert message as "There is too much water detected" when moisture level is very high and "There is no water detected" when the moisture level is low [23].

Fig. 6. Accuracy Graph.

This system sends the message immediately after getting the readings from the sensors along with the humidity and temperature [24]. This alert system message is shown in Fig 6.

6.2. Loss and Accuracy

The loss and accuracy is calculated in each iteration and each time the accuracy is improved and the loss is reduced [25]. We run an average epoch value of 25 epochs and it is shown in Fig 8 and 9 as Run 1 and 2. For each epoch the accuracy of the model gets increased [26]. We clearly seen that the accuracy of the first epoch is 95% as the number of epoch increases, the accuracy also increases, the accuracy increases from 95 to 97.6 at the end of the 13th epoch and the loss also gets reduced. During execution, the accuracy and loss are recorded for every epoch. It is found that the accuracy reached 97.8% at the 40th epoch.

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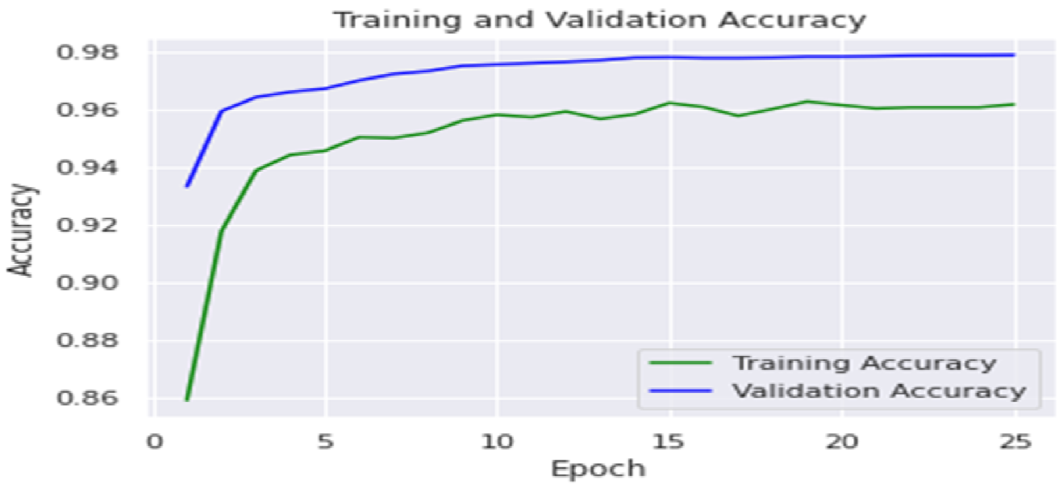

Fig. 7. Accuracy Graph.

Fig. 8. Loss Graph.

Fig 7 and 8. graph represents the accuracy and loss comparison for the each epochs, here the accuracy increases for each epoch and loss decreases, the training time also reduces from epoch to epoch.

6.3 Comparison with Other Models

The AlexNet model gives the better accuracy when compared with other architectures like DenseNet121, MobileNet, MobileNetV2, NASNet, Resnet50, inceptionV3. The maximum accuracy achieved by the former is 95% by InceptionV3, which is also considerably low when compared to AlexNet which is 97.8%. The performance of each model is shown in the Fig 9.

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Table 1. Comparison Table.

Methods	Recognition Speed
ResNet50	93.00%
MobileNet	93.17%
NASNet	93.82%
DesNet 121	94.51%
MobileNetV2	94.58%
InceptionV3	95.00%
AlexNet	97.80%

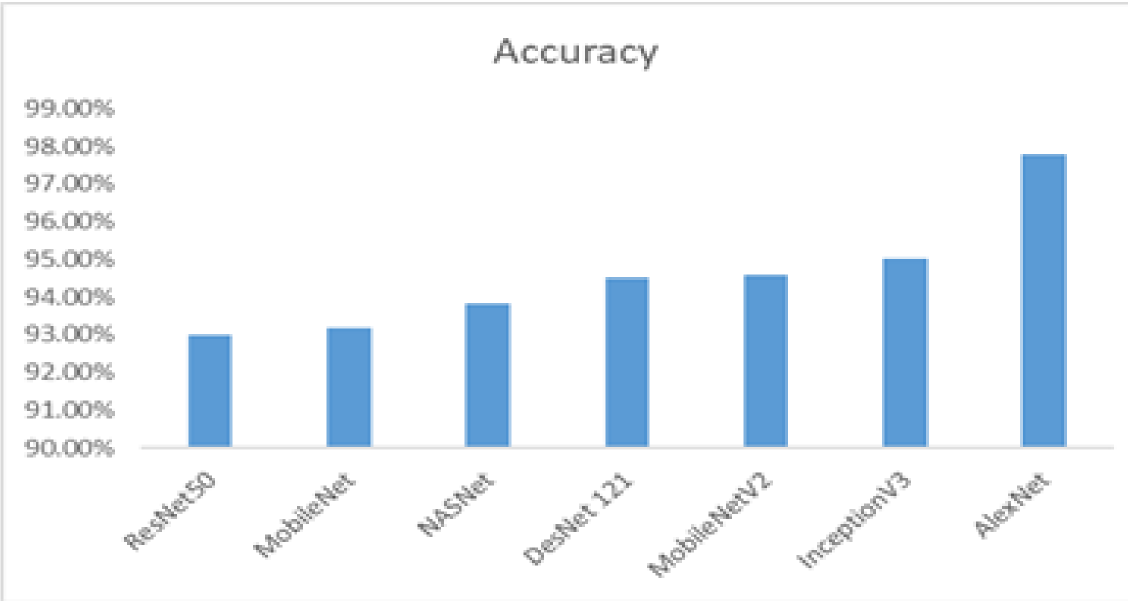

Fig. 9. Performance Graph.

7. Conclusion

The deep learning and image classification are applied to a pertained AlexNet to overcome this major challenge. During training it gives the accuracy of 97.8%. The results obtained by the model was Accurate and that too with the large number of images, AlexNet model performs well when compared to other models. We also successfully implemented the whatsapp alert system using the IoT architecture, the message system is very fast and accurate as it sends the message immediately after testing. Future work may include implementing both the above system in an android application so the all the people can get benefitted out of it, even this paper can make a new revolution in Agriculture field.

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