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Smart Farming

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Abstract—In this span of urbanization, people in cities hardly have time to nurture plants. Well, compromising the quality of vegetables and fruits is impossible. So a model must be developed that can manage these activities in the absence of humans. Our project proposes a model that serves as a solution to this problem.

In this project, the plants are properly nurtured. The variations in temperature is measured. The soil moisture level is measured using sensors.If the humidity level indicates poor water concentration, the required amount of water is provided using a sprinkler system, thus conserving water. The measured features are directly send to the local host at regular time intervals. Cameras are set up for the detailed analysis of the plants. From the pictures of the plants in different angles, its condition can be analysed. Image processing analyses the image of the plant taken by a camera. A model is built inorder to determine whether plant is affected by any disease or whether fruit is ripen or not. These analyses are notified via IOT to end user. And whenever the fruit or vegetable of the plant ripens, it is recognized from the pictures send to camera.With the help of IOT, user is notified to pluck the fruits when they are ready.

This model is capable of taking care of the plants without intervention of humans, thereby saving time.

Index Terms— Arduino, Convolutional Neural Network, Farming, Image processing, Machine learning, Raspberry Pi, VGG.

1 Introduction

Plants have and continue to play a significant role in the earth's life cycle. The oxygen needed for human life on this planet are responsible for it. At the same time, agriculture is important to people as it forms the basis for food security. Agriculture plays a crucial role in Indian economy.

Agriculture is the primary livelihood for over 58 per cent of rural households. Farm exports make up 10 percent of the exports of the country. Therefore, if due to a lack of knowledge of the soil condition, water is not properly available, the farmers' and even of national economy would be destroyed. Thus steps should be taken for a better and profitable irrigation.

The project is extremely useful for farmers, organizations, or individuals operating plant nurseries to turn the wetness of the soil on and off automatically. The benefit of using this approach is that human activity is minimized and irrigation is still guaranteed.

2 Proposed System

For an IOT system, an intelligent farming system is built by using sensors and a micro controller. The purpose of the design is to demonstrate that the microcontroller is intelligent and capable of making decisions on the care of plants based on continuous environmental monitoring in the field.

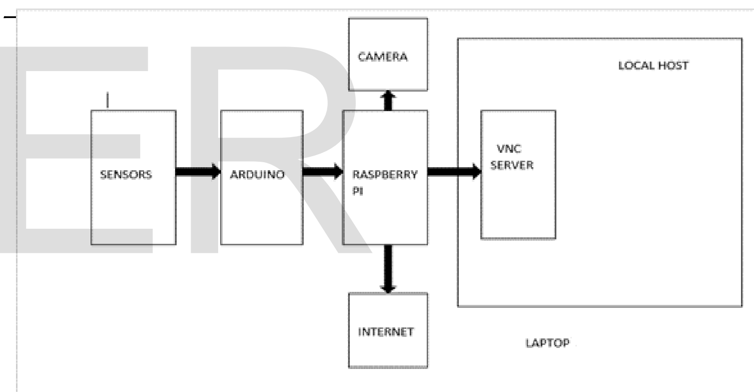

Figure 1: Proposed system - Block diagram.

The sensors including moisture sensors, sensor of temperature and humidity, PIR motion sensor are attached to the Arduino UNO. It works on the open and short circuit principle. There is also a high sensing range. The DHT-11 is a digital temperature and moisture sensor of basic ultra low cost. The sensor and thermistor measure the surrounding air and spreads out a digital signal on the data pin with a capacitive humidity sensor. In order to detect animal attacks, PIR motion sensor does the job by detecting the motion. The Arduino uno is an open source microcontroller board based on the micro chip ATmega328P. An irrigation sprinkler also known as water sprinkler used to irrigate crops is connected to this Arduino. A device called cutter motor is used to chop off the leaves having bacterial wilt symptoms on its surfaces is connected. A wheel motor is connected in case if any motion is required to make use of. The Arduino-based Raspberry Pi can establish a wireless network and run the communication model used to gather data from the Raspberry Pi and pi to the server sensors. This device is concerned with Image processing purpose. The

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digital camera gives the images of leaf safety, light strength, measuring of chlorophyll and maturing amount. After completing this arduino connections, the technology called machine learning is used to train the image and to predict the accurate disease and the result is displayed on the VNC server's output screen.

3 System Design

The first phase of the project includes connections on the Arduino Uno board. It consists of an IDE or a computer software both physically programmable circuit board. The software used here is Arduino IDE 1.0.6 version.

A battery or an AC-to - DC adapter will power up the arduino board. The arduino UNO board operates at 5 volts, but it can withstand 20 volts maximum voltage.

Figure 2:Arduino connections.

For measuring temperature and moisture, the DHT11 sensor is used. It is made up of the VCC, the ground pin and the data pin, linked to arduino Uno's digital pin. The digital pins can either be used as input or as output.

Smart irrigation can be setup with the help of a moisture sensor and a motor. The idea is when there is not enough water or moisture in the soil, the motor should be automatically turned on so that the crop will get irrigated. And when it gets enough moisture, the pump will get turned off. When the moisture sensor shows dry state, the DC motor attached to the arduino Uno will be turned on, which in turn allows water to be pumped through the motor sprinkler. If the system is to be implemented on a large scale, a drip irrigation system can be used instead of the motor sprinkler.

Passive Infra-Red sensors are able to detect movement of objects radiating IR light. The PIR motion detection sensor output can be directly connected to one of the digital pins in Arduino.

The typical symptoms of this disease are bacterial wildness on the leaf surface, such as shrinking, foliage yellowing and eventually collapse of the entire plant. Therefore it is always better to chop off such leaves and the cutter motor serves the purpose.

Second part of the project is image processing. The image captured from the camera is taken as input for processing the image and getting the output as identifying the disease by analyzing the leaf part. Three sets of plants such as pepper, potato and tomato were collected. Each plant consists of around 4 category of disease. As a whole we have more than 10000 images to train and test the input. VGG network is characterized by its simplicity in building network and more accuracy in classifying images. The image processing is done through steps given below:

(i) Import necessary packages and build the VGG network for training.
(ii) Import keras, sklearn, etc packages for training the network.
(iii) Loads dataset using opencv and convert images into array
(iv) Divide the images loaded into labels and data and binarize them by the use of a special multi-label sci-it-learn.
(v) Segment data into training and test sections use 80% of training data and 20% of test data.
(vi) Constructed the image generator for data augmentation.
(vii) Initialize the model as the network final layer by using a sigmoid activation to perform multi-label classification.
(viii) Initialize the ADAM optimizer.
(ix) Train the network.
(x) Serialized weights to HDF5.
(xi) Plotted the training loss and accuracy.

All the above steps are executed using Google Collaboration because collab can be used in attachment with the drive. Based on maximum prediction accuracy calculated from above steps on an image, note down the category of disease. Hence identify the proper disease if any.

4 Future Scope

The model that we created for plant disease prediction is embedded in Raspberry Pi 3 as HDF5 (Hierarchical Data Format version 5) file. HDF5 is used to store large amount of data without the help of database. If it is not converted to HDF5 Format then the computation alone in Raspberry pi is hard and also it is time consuming. Along with this hdf5 file, a script to run the hdf5 file is also embedded in the Raspberry pi. The path of this hdf5 file will be specified in this script.

As an input for the model already in the Raspberry Pi, this image is captured by the camera. To transfer the data from Arduino Uno to Raspberry Pi the 3.3V/GND/TX/RX pins on an Arduino Uno is connected to the 3.3V/GND/RX/TX pins on the Raspberry Pi. The transferred data will be in the form of a string. After decoding the string, it is can be later displayed in the VNC Server.

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All the measured features and notifications regarding plant disease or fruit ripening can be send directly to an android application, which will make it very comfortable for the users.

5 Experimental Results

1)*Arduino:*

After the connection in Arduino board, then analyzed the conditions of plant including the moisture, temperature , etc for checking the scenario. Based on the moisture level we are irrigating the plant and also detect the insect movements too.

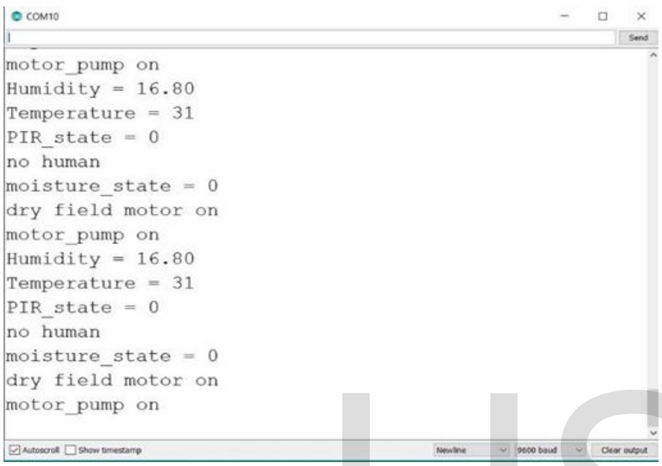

Figure 3: Arduino output.

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2)*Image processing:*

We selected three category of images for image processing and classification. After the training is done in image processing part we got the following graph of accuracy.

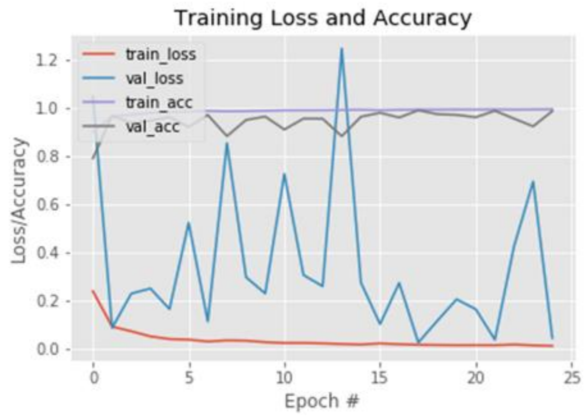

Figure 4: Accuracy Graph.

After capturing the image from the plant, we predict the proper disease if any using machine learning. The final category is predicted by which category of label is having more prediction percentage.

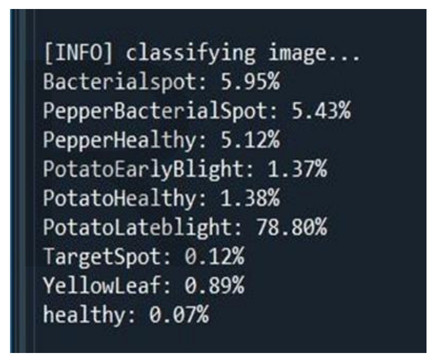

Figure 5: Prediction percentage of each label.

Figure 6: Image with accurate prediction.

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Conclusion

In this way, intelligent farming can revolutionize the agriculture world, increase productivity and quality and save farmers lives.

A program that simplifies the agricultural cycle and makes the farmer's burdens free is desperately needed. With the recent technological progress it has become important that our country India, a completely agro-centric economy, increases its annual crop production efficiency. It is important to integrate these techniques into the farming domain of the country that we are able to maintain our natural resources as well as to boost the crop production and also the time consumption.

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