# Automatic Greenhouse Monitoring System using IoT and Image Processing

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*Abstract*— The aim of this project is to design and build a greenhouse controller that can maintain the environment, by acting upon live sensor readings and be able to display the status of the system to the owner. A greenhouse provides an environment to grow plants all year round, even on cold and cloudy days. A small size greenhouse is developed with constant monitoring system using IoT and an individual system to capture plant images used to detect disease in plants using image processing. The project was split into two parts: programming a raspberry PI using Python language to act as the central hub that manages the various sensors such as Temperature & Humidity sensor (DHT11), soil moisture sensor, and LDR as transducers; and using online software platform to allow the user to interact with the greenhouse controller. The ultimate goal of this project is to produce low cost, less energy consumption system which can be used by farmers as well as consumers.

***Keywords:*** Greenhouse, IoT, ThingSpeak, Image Processing, Matlab

## I. INTRODUCTION

Greenhouses are a great way to make plants available all year round, however their effectiveness depends on the weather conditions which vary constantly. Although we are able to predict the weather to a high degree, the predictions are not always 100% accurate and so planning ahead would not help all of the time. Some of the problems that can occur are frost, condensation and overheating which can lead to the plants becoming damaged.

Greenhouses are structural buildings with various types of covering materials such as glass or plastic roof and frequently glass or plastic walls. Hence, these buildings are controlled-area environment to grow plants, in today's greenhouses, many parameter measurements are required to monitor and control for the good quality and productivity of plants. But to get the desired results there are some very important factors which come into play like Temperature, Humidity, Light and Water, which are necessary for a better plant growth.[1]

For remote monitoring, values which are read in greenhouse environment should be also saved on a database and become reachable online. In this way, the collected data are not only useful for monitoring past events but also provide raw material for data mining to predict future events. Nowadays, mobile phones and computers have become an integral part of human life. The spread of internet usage even in distinct villages, more and more people become familiar with the technology. Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product it is very difficult to monitor the plant diseases manually. [1]

Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification, keeping these parameters in mind we have built an automatic greenhouse monitoring system using IOT and image processing by using Raspberry Pi. [2]

Several computer-microcontroller designs have been purposed to control and monitor greenhouses viaautomation systems ensure affectivity, productivity and utility. Automation systems require long research period and their installation costs are quite high. Due to these facts, greenhouse automation systems are not commonly used. However, nowadays, computer usage becomes undemanding and control and monitoring systems fulfill setup cost in a short period of time. [3]

Thus, IoT is suggested and internet connection has been chosen as interconnection method. The purpose of this work is to propose a basic design of greenhouse automation which hascapability to expend, update and upgrade with cheap installation cost, low-power consumption.

## II. SYSTEM OVERVIEW

The proposed system uses Internet of Things and image processing to make Greenhouse more advance, various sensors will be monitoring different parameters. All this data can be viewed from IoT platform ThingSpeak, also the image of the plant's leaf will be fed to user which can be further processed for finding common diseases using Matlab. Raspberry pi controls all the parameters from the sensors and also the actuators, further this data is uploaded on IoT platform ThingSpeak, IoT is the fastest growing technology in today's era using it user will be always up to date about plant's health and growth.

## III. BLOCK DIAGRAM EXPLANATION

Fig. 1. shows block diagram of the system:

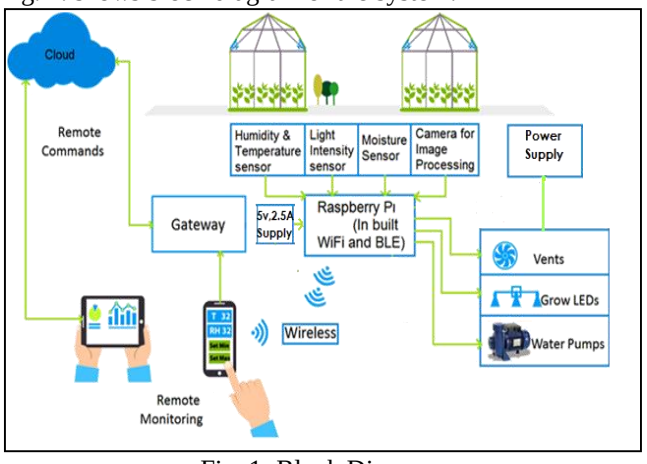


Fig. 1: Block Diagram.

 

*A. DHT11:*

This sensor will measure the temperature and humidity of the greenhouse atmosphere. It is a digital sensor which can measure the temperature in various units and moisture in percentage.

*B. Light Sensor:*

Sensor uses LDR to measure the light intensity. It is a digital sensor which gives output as high or low, threshold value can be set using potentiometer of Light sensor.

*C. Moisture sensor:*

It measure soil moisture using resistive method i.e. it measures potential difference between the two probes. It gives both analog and digital readings.

*D. RaspberryPi Cam:*

This 5mp camera module is capable of 1080p video and still images and connects directly to your Raspberry Pi.

*E. Raspberry Pi:*

The Raspberry Pi 3 A+ is the most recent form of the Raspberry Pi, a fully-fledged computer that can run applications from word processors and spreadsheets to diversions. The Technical Specification of raspberry pi:

1) Broadcom BCM2837 64bit ARMv7 Quad Core Processor powered single board machine running on1.4GHz.
2) 512 MB RAM
3) Wi-Fi on board.
4) Bluetooth Low Energy (BLE) on board.
5) 40pin extended GPIO, 4 x USB 2 ports.

*1) Actuators:*

1) Vents (12V DC Fan) to control the humidity and temperature of the Greenhouse.
2) Growing LED's (20 watt LED) to give light for constant growth of plant.
3) Water pump (6V DC water pump) to supply water for plants growth.

*2) Cloud:*

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak.

*3) Power Supply:*

The Controller requires 5V 2.5A power supply,sensors get supply from the controllers pin. Actuators have different voltage and current parameters, using different power supply will be sufficient.

## IV. SOFTWARE IMPLEMENTATION

The system uses Python 3 software to control sensors and fetch data from them, as the controller is Raspberry pi it has inbuilt Python language.

For image processing Matlab is used using various processing methods like:

*A. Image Acquisition*

The images of the plant leaf are captured through the camera. This image is in Red, Green and Blue form. Color transformation structure for the RGB leaf is created here.

*B. Image Pre-processing*

The RGB image is converted in grayscale image to remove noise and then histogram equalization is done to enhance the plant disease images.

*C. Image Segmentation*

Segmentation means partitioning of image into various parts of same features or having some similarity. The segmentation can be done using various methods like otsu' method, k-means clustering, converting RGB image into HIS model etc.

*1) Segmentation using Boundary and spot detection algorithm:*

The RGB image is converted into the HIS model for segmenting.

*2) K-means clustering:*

The K-means clustering is used for classification of object based on a set of features into K number of classes. The classification of object is done by minimizing the sum of the squares of the distance between the object and the corresponding cluster.

*3) Otsu Threshold Algorithm:*

Thresholding creates binary images from grey-level images by setting all pixels below some threshold to zero and all pixels above that threshold to one.

*D. Feature Extraction*

Feature extraction plays an important role for identification of an object. In many application of image processing feature extraction is used. Color, texture, morphology, edges etc. are the features which can be used in plant disease detection.

*E. Classification*

After feature extraction is done, the learning database images are classified by using neural network. These feature vectors are considered as neurons in ANN. The output of the neuron is the function of weighted sum of the inputs.

## V. RESULTS

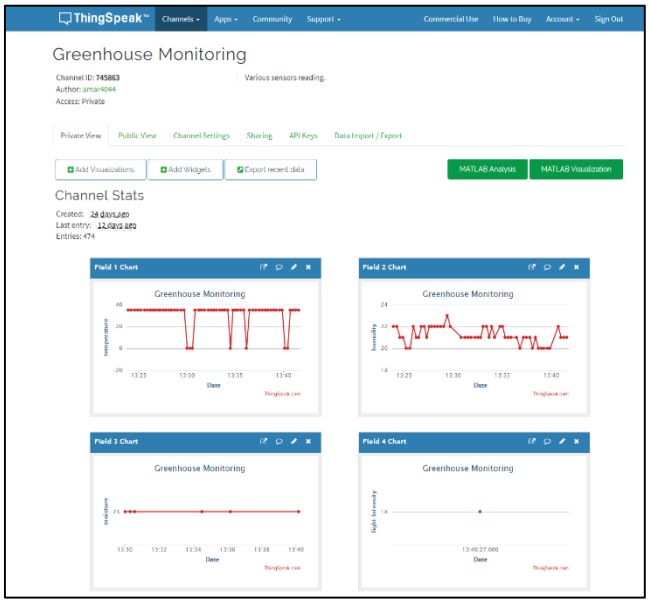


Fig. 2: Sensor data on IoT platform ThingSpeak.

Different sensor data can be monitored on ThingSpeak, further images taken from the controller can be used for image processing in Matlab. As fig. 2. Shows different parameters reading's in graphical presentation at different interval of time, and fig. 3. Shows the classification of disease found using Matlab

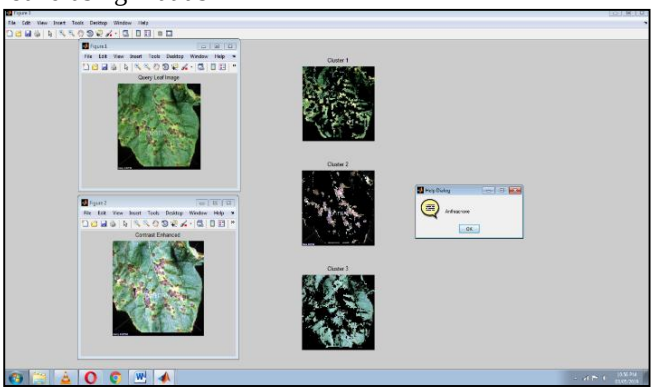

Fig. 3: Image processing of Plant leaf for disease detection in Matlab

## VI. CONCLUSION

The system should collect the data from all the three sensors i.e. Humidity and temperature from DHT11 sensor, soil moisture from a digital soil moisture sensor, light intensity from light sensor, depending on the output of these sensors the actuators will be actuated, to actuate water pump for providing water supply, for increase or decrease in humidity the cooling fan will be switched on and off, light bulb will control light intensity as well, Raspberry pi, it should collect images from the Raspberry pi camera and user can perform image processing for diseases. All this data should be sent to the user by using Internet of things.

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