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An IoT Based Smart Solution for Leaf Disease Detection

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***Abstract*— Internet of things is a system consists of actuators or sensors or both that provides connectivity to the internet directly or indirectly. Internet of Things (IoT) advances can be used in smart farming to enhance quality of agriculture. Agriculture, the backbone of Indian economy, contributes to the overall economic growth of the country. But our productivity is very less as compared to world standards due to the use of obsolete farming technology, and nowadays people from rural areas migrate to an urban area for other profitable businesses, and they can't focus on agriculture. Innovation in farming is not new but IoT is set to push smart farming to next level Internet of things is a system consists of actuators or sensors or both provides connectivity to the internet directly or indirectly. This paper includes various features like detection of leaf disease, server based remote monitoring system, Humidity and temperature sensing, Soil the Moisture Sensing etc. It makes use of sensors networks for measurement of moisture, temperature, and humidity instead of manual check. Various Sensors are deployed in various locations of farms, to control all these sensors it has been used one controller called Raspberry PI (RPI). Leaf disease can be detected camera interfacing with RPI. Immediate status of a farm like a leaf disease and other environmental factors affecting crop like humidity, temperature and moisture is send using WIFI Server through RPI to the farmers. The paper presents the study of IOT techniques to engross the use of technology in Agriculture.**

Keywords*— *Smart Agriculture, Leaf disease detection, IoT, Smart Farming, Humidity & tempreture monitoring, Soil moisture monitoring.

I. INTRODUCTION

Agriculture is the primary occupation of Indian villagers. From the advent of agriculture, there has been much mechanical and chemical advancement that has occurred to improve the yield and help farmers tackle issues like agriculture and crop diseases. But there has been little to less digitization done in this field. With the boom of IOT, there is a hope for creating a digital system for agriculture which will help the farmer make informed decisions about his farm and help him tackle some undesired situations in advance. So, it will help to improve the quality of crops and also it will be beneficial for farmers. Early Detection of Disease which is a great challenge in agriculture field. An earlier large team of experts are called by the farmers to chalk out the diseases or any harm which occurred to plants, even this practice is not known to every farmer and therefore the experts cost much and also it is time-consuming. Whereas Automatic detection is more beneficial than this long process of observations by the experts, Automation technique of the disease detection where the result comes out to just monitoring the change in plant leaves makes it cheaper and accurate. And thus, Image processing technology for early detection of diseases which occurred to plants and can aware farmer at the early stage and save other plants from diseases.

The present study also focused on the integration of sensor monitoring techniques with IOT. It has been achieved by interfacing different sensors to Raspberry Pi -3 module. To avoid severe loss in agriculture various Sensors is used to measure parameters like soil moisture, temperature, and humidity, fertilizer and contributes to the productivity of the farm. Website has been designed through which farmer is able to look at the current status of the crops. Uses of new internet technologies are also giving comfort to handle agricultural work.

II. LITERATURE SURVEY

Existing method of monitoring the farm is manual method, farmer themselves check the parameters like soil moisture, humidity, leaf disease. [1] Shows the survey about smart agriculture to increase the productivity of crops and overall farm. With use of IOT and sensors, monitoring of farm can be done. One can find the condition of the farm from their house or any place. Various Surveys regarding change of atmosphere, Disease detection and diagnosis, fertilizer calculator, Soil, and crop water estimations are done in this paper. [2] It describes the novel methodology of smart farming technique. It uses some mechanical machinery, Sensors, and electronic circuits. IR sensor, Optocoupler, crane system is used to develop smart system. [3] This system is made from various sensors like soil moisture, temperature, humidity and obstacle sensors. A robot is developed using a microcontroller which is used to monitor the farm. [4] This describes the mobile application model used by farmer which provides the status of the farm. Hardware's used in this model are PIC microcontroller, sensors like soil, temperature, humidity, and PIR. GSM module is used for wireless communication which has the sim card which is used to communicate with the owner. [5] It describes how to detect leaf disease by using application of texture statistic for disease detection of plants. Firstly, convert captured RGB image into HSV then apply masking to mask green pixels in the image. After masking Segmentation is applied and these segments are used for texture analysis and lastly, texture parameter is compared with ideal texture parameter of the leaf. [6] This Paper presents the study on Image processing techniques processed on various types of crops like fruit crops, vegetable crops, commercial crops, and cereal crops. The Proposed methodology is for identification of fungal disease symptoms on various types of crops. The database is maintained for storing fungal disease

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texture on crops. The system used to remotely monitor the crop using GSM and sends a notification to the owner so that further loss can be controlled. [7] Arduino is core component used in this stem. Using ZigBee, wireless network system is designed. Designing sensors network, each mode has connected a group of sensors and these are connected to Arduino and ZigBee. Using Intelligence values which are transmitted by ZigBee are measured and find the flaws in agriculture. [8] This paper presents a technique to detect leaf disease using image segmentation; also it classifies the plant leaf diseases. This algorithm includes steps like image segmentation. Then using expert techniques classify the diseases. [9] This paper represents the technique which includes a comparison of an uploaded image of diseased leaf and database images. If same feature image is found then find the related information of the image and detect the disease of a plant leaf. [10] This paper presents the AgroTick application which includes technologies like cloud computing, embedded firmware, hardware unit and big data analysis. This application is also used to share knowledge regarding farming

III. PROPOSED WORK

In the farm, various sensors are deployed like soil moisture sensor, Temperature - Humidity sensor and camera for detecting diseases on a leaf. Data collected from sensors and send it to Raspberry PI through wired or wireless devices.

In server-side data is verified and matched with ideal values of data like temperature value, humidity value, and soil moisture value. If difference occurred with respect to predefined threshold value then notification send to the farmer on his mobile or website. Output of sensors are generated in the webpage and farmer

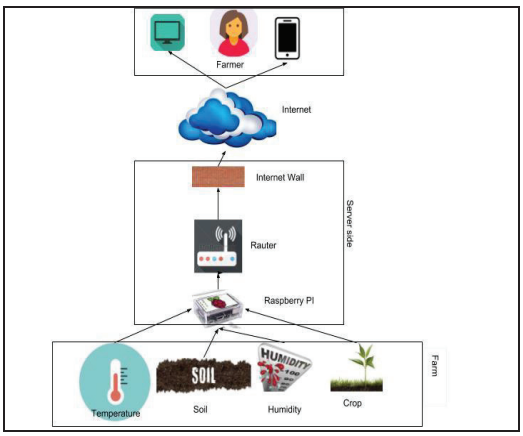


Fig 1. Architecture of Prototype

Get detailed information about his crop and atmosphere of his farm from anywhere.

Crop disease detection is done by using Image Processing. The camera is placed near crop so that image of a leaf is taken by the camera. Captured image is sent to the server and using Image processing techniques leaf disease is detected, Status of a leaf is sent back to the farmer on the web page & mobile phone on the app.

IV. RESOURCES USED

A. Raspberry PI

Raspberry Pi is one of the most popular controllers in industry. It is like a mini computer which consists of USB port, input-output pins, WIFI port, HDMI port, SD card reader and much more functionality.

The Raspberry PI has a Broadcom BCM2835 on a chip (SoC), which includes an ARM1176JZFS 700 MHz processor, Video core IV GPU, and was shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but it uses an SDcard for booting and persistent storage. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language in raspberry Pi board.

Various types of sensors can be connected together, Input from sensors are saved in raspberry pi through accessing sensors using python or java programming, in this prototype python programming is used.

Installation of raspberry pi:

a) Installation of OS (Raspbian OS for Raspberry PI)

b) Installation of OpenCV for Image processing

c) Installation of all drivers required for camera

Sensors Interfacing with Raspberry pi

d) Soil moisture

e) Temperature and Humidity

f) Usb port Camera

B. Sensors :

1) Temperature & Humidity:

In this system DHT11 sensor is used to measure Temperature and humidity both. This is low cost sensor; it shows digital output on terminal of temperature and humidity. It shows good results when humidity is between 20-80% with 5% accuracy and 0-50°C temperature with ±2°C accuracy. Results can be get after 2 seconds.

In this system DHT11 is connected to the Raspberry PI using connectors and output is send to the server, on server side this output is saved into database file and simultaneously shown on the farmers mobile.

Here the DHT11 sensor and its interface to Raspberry PI circuit design is given below in figure 2.

2) Soil Moisture:

Soil Moisture sensor measure the water content in soil using capacitance.

This sensor gives the analog as well as digital output. It works on principle of open circuit, that is if, soil is wet then current is pass from one terminal to another terminal, and circuit completes, hence it shows low value of voltage, and when soil is dry current the current will not pass through the circuit and

will act as a open circuit, hence the output is maximum. The Soil Moisture sensor is platinum coated for high efficiency, it is anti-rust, and sensor has a long life.

In this system, Soil Moisture sensor output is shown on farmers mobile by clicking on soil status bar.

Soil Moisture sensor is connected to Raspberry PI using connectors and using python programming Input Output pins of raspberry PI is access, whether output is high or low is shown on terminal, this output is send to the server and store this results into database file and also shown on farmers mobile.

Here the moisture sensor its interface to Raspberry PI circuit design is given below.

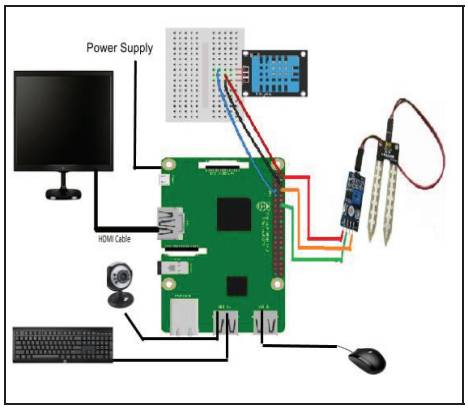


Fig 2. Circuit diagram of model

A. SOFTWARE USED

1. Operating System

   Raspbian is free operating system used for raspberry pi. Its installation guide is available on raspberry pi official website. Reason for choosing Raspbian is OpenCV installation and working is Very easy in this OS.

2. SERVER

   An Apache server is used for getting data and send it to the website.

3. LANGUAGES

   Python: Python is a basic language of processors and controllers such as Arduino, raspberry PI, etc. All the coding related to sensor would be done in this language. This language is very easy to implement because it's coding look like basic C language. System has been using 3.3 versions of python IDE.

4. OPEN CV

   OpenCV is C++ library for image processing and computer vision.

5. IMAGE PROCESSING

   Image processing is the technique which processes the image and can find whatever we want by applying various methods which include in OpenCV libraries, for example, masking, segmentation, and feature extraction etc.

V. TYPES OF LEAF DISEASE

1) LEAF DISEASE DETECTION

There are many Types of plant disease according to survey major types of diseases are as follows:

a) Black Spot:

Symptoms of Black spots are:

i) The yellowish color on leaf

ii) Drop of Leaf in premature stage

iii) Decline in growth of leaf

Fig 3. Black spot Deaseas

b) BOTRYTIS BLIGHT

This type of disease is mainly caused by fungi. Symptoms of BOTRYTIS BLIGHT are:

i) Brown color spots on leaf

ii) Dropping of buds from plant

Fig 4. Botrytis Blight Deaseas

c) LEAF SPOT

i) Symptoms of LEAF SPOT are:

ii) Spots on the leaf are generally brown

iii) But depending on the type of fungus spots color may vary

iv) Concentric rings and dark circles may find

Fig 5. Leaf spot Disease

d) POWDERY MILDEW

This disease throws the needed nutrients away from the plant.

Symptoms of POWDERY MILDEW are:

i) White or gray layer on leaf and stem of plant

ii) Yellowness of leaf

iii) Premature leaf drop

Fig 6. Powdery Mildew Disease

e) Rust

Symptoms of rust disease are:

Defoliation of leaves of plants

i) Rust is generally brownish-yellow color

ii) Dieback of branches

iii) Stunted growth of plant

Fig 7. Rust Deaseas

Detection of plant disease using Image Processing:
According to the survey, almost 99% plant disease symptoms is showed on the leaf of the plant, by considering any leaf of the plant health of the plant is detected.

VI. IMPLEMENTATION AND RESULTS

With the help of Image processing technique, condition of plant can be detected. To detect the condition following steps are used:

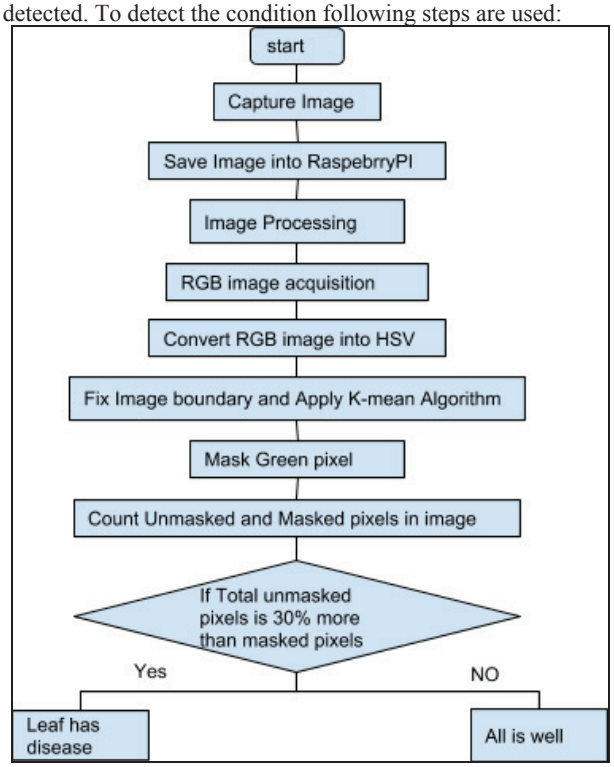


Fig 8. Steps to detect condition of leaf

1. RGB image:

Basically, the Human eye perceives the rays from an environment and identifies the color. This identification of color is through wavelength sensitive cells of an eye there are three different types of cells one for Red color one for Green color and another for Blue color. This is the reason why the color image is stored in three different color types of matrix. This type of color matrix is called RGB

2. K-mean

K-mean clustering is the technique which separates the image into k numbers of cluster or types according to data input based on k centroid.

This algorithm is mainly used when distinguish between colors are present.

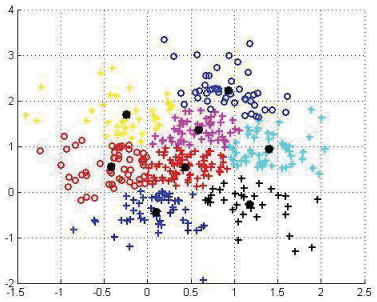


Fig 9. Data point plotted using K-Means

Here in this image black dots are centroid of various types of color in image. The basic k-means algorithm is fairly straightforward. Given a set of n data points, k initial cluster centers are selected. Each point is then assigned to the cluster center that it is closest to. The cluster centers are then updated to be the average of all the points assigned to that cluster. This process repeats until the clusters are stable, and is summarized in Algorithm

3. HSV image:

HSV is the cylindrical coordinate representation of RGB model points. Full form of HSV is H for hue S for saturation and V for value, sometimes HSV is also called as HSB (B for Brightness).

In python programming conversion of image into HSV is:

hsv = cv2.cvtColor(res2, cv2.COLOR_BGR2HSV)

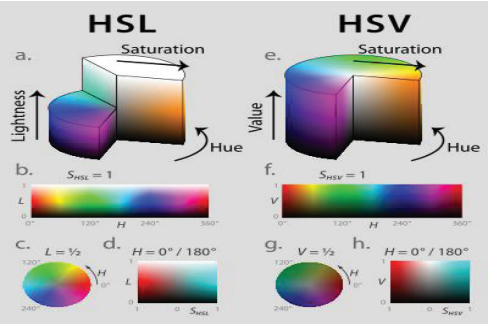


Fig 10. HSV Model

4. Masking of Green pixels:

Masking is highlight particular type of color range in the image. In the procedure of detection of leaf disease masking of green color plays a major role. By masking green color, other colors are found which diseased parts of the leaf.

5. Counting of unhealthy pixels in leaf

Logic behind this algorithm is, by going horizontally in leaf image find first and last green pixel in image and then count unhealthy pixel under this green pixel

If a number of unhealthy pixels are greater than 30% of healthy pixels then leaf has the disease.

Web Application of Disease Detection:

This is index page of website, which contains 3 main options that are Home, Status, and Contact. In Home page it shows mandatory information about crops and information about model. In Status page, it shows live status about soil, temperature, humidity and crop diseases. And in Contact page, it shows contact details.

Through this page, clicking on Soil status soil moisture status is shown, and clicking on Crop disease status, crop status is shown and clicking on Temperature and humidity status, live status is shown

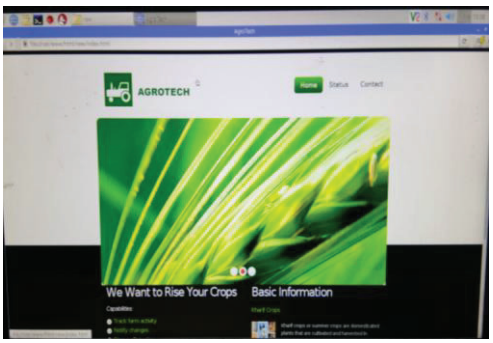


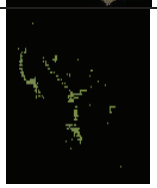
Fig 11. Steps to detect condition of leaf

VII. RESULTS AND CONCLUSION

The sensors and raspberry PI are successfully interfaced and wireless communication is established using IOT. Leaf disease detection is successfully done by using Image processing techniques. All observations and tests are completed and this proves that this is the solution for smart agriculture. This system definitely improves the yield of the crops increases the overall income of the farmer.

Following are the results of leaf disease detection:

TABLE I: Different Leaf Disease Detection

Captured Leaf	Segmented Leaf	Masked Leaf	Experimental Result
			Leaf has no disease
			Leaf has disease
			Leaf has no disease
			Leaf has disease

Following are the observations:

TABLE II: Observations of Leaf Disease Detection

No of Leaf	Naked Eye result		Experimental result	
	Diseased	Healthy	Diseased	Healthy
10	3	7	3	7
20	7	13	8	12
30	9	21	8	22
40	13	27	15	25

VIII. LIMITATIONS

To find disease of leaf Image Processing is used so, Sun light is the main factor which affects the result. In night the images cannot be captured, or if sunlight is too sharp to capture the image or sometimes light get reflected and color of leaf is not recognizable by camera, then results may differ. Another main thing is power supply to server; if there is no power then whole system is unable to do tasks. Camera resolution is also another important factor of this system.

IX. FUTURE WORK

For future development, it can be developed for the large-scale system. Also, the system can be integrated with other sensors like fertilizer, a buzzer for enemies, and can check the quality of soil for a particular type of crop growth. However, some technical and business issues need to be addressed in smart farming domain for the IoT-based productions and services for producers.

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