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Current research on Internet of Things (IoT) in Agriculture

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Abstract: IoT, a sensation in modern-day technology, has a major impact on the rapidly growing technological aspects. It's making people's life easier and also enabling us to do things that were previously seen as miracles. It helps in solving many complex real-time problems. One such major application in the field of agriculture can turn out to be productive and profitable. This paper explains a variety of techniques infusing IoT in agriculture, that helps in productive and predictive results in that field, thereby leading towards precision agriculture. A low-cost power supply and unambiguous farming can be possible with using IoT system. Wireless Sensor Networks (WSN) in which sensor nodes learn and adopt over the sensing time, gives simplicity, low energy usage. This is aimed to be deployed on a large scale by predicting using big data techniques from centralized data analysis.

Keywords: Internet of Things, Wireless Sensor Networks, predictive farming, precision agriculture.

I. INTRODUCTION

With a tremendous rise in the population globally there is a massive surge in the demand for food production. To meet the demands, there is the need to upgrade our current technology in this domain. These enhancements can range from replacing the legacy components used, to the changing of software. The solution is to organize a central location to collect the data through monitoring and recording the pertaining conditions of the farm. There are dedicated sensors for getting the job done which are spatially dispersed by the Wireless sensor network.

The major factor in play here is to keep up the consistency in retrieving real-time data. This information is communicated through secure and wireless channels. The real time data is captured through sensors installed at various agriculture lands and then uploaded to cloud platform.

Rendering services due to WSNs are not merely enough. The requirement for more persists. So is the requirement of knowing the soil fertility in order to have a proper growth and productivity of the farm With the expansion of the services to a large scale, the requirement for availability of farm related data anytime and anywhere, the concept of centralization of data is gaining attention and an implied cloud computing platform entered a pact here. A novel extension to this would be a proper understanding of the acquired data and required improvements. The continuous data stream is to be analyzed and presented in a meaningful and attractive manner as not all are technologists with in-depth knowledge.

A. Raspberry Pi

Raspberry Pi is a mini sized computer capable of serving all the functions a personal computer does. The Raspberry Pi uses a Debian based free OS called Raspbian and is optimized for Raspberry Pi hardware.

Fig .1. Raspberry Pi

Sensors used here are of major importance in defining the basis of the system. A briefing of the sensors used is as follows:

B. pH-sensor

pH sensor measures the alkalinity of water underneath which works on the basis of internal acid-base titrations and hydrogen ion activity.

Fig .2. pH- Sensor

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C. Fiber-optic sensor

In our system, fiber optic sensors are used to determine the color of the soil solution thereby defining the N, P, K values of the soil as those elements depend on the color of the soil.

Thereby the values of N, P, K in soil are calculated individually from the color results and then they are compared with standard thresholds to define if they are rich or deficient in those nutrients and accordingly fertilizers are chosen.

It can be designed and customized as per our needs and requirements, to suit the necessary actions to be performed.

Fig .3. Fiber Optic Sensor

D. DHT11 sensor

The **DHT11** is most widely known and regarded as the **Temperature and humidity sensor.** The main components of the sensor include the Negative Temperature Coefficient and a microprocessor, used to measure temperature and to generate the values of temperature and humidity, respectively. To reduce the complexity of the sensor it is factory tapered beforehand and easily integrable with other microprocessors.
The sensor is capable of measuring temperatures that varies from 0°C to 50°C and humidity that varies from 20% to 90% with the approximate accuracy of ±1°C and ±1%. This kind of sensor majorly constitutes a part of almost all the farming systems because understanding the needs of the farm in terms temperature and humidity and regulating them according to the needs fairly contributes to smart farming methodologies.

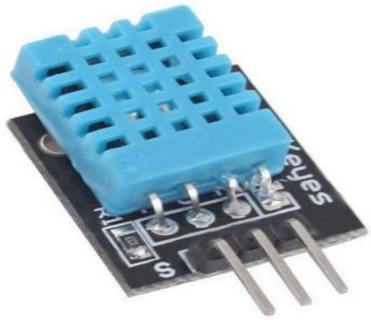

Fig .4. DHT11 Sensor

E. Soil Moisture sensor

The moisture level of the soil is yet another attribute that determines the wellness of the farm. This sensor measures the moisture content through the determination of wetness level of the soil such that the required watering intervals of the soil can be calculated to serve the moisture requirements of the soil there.

In cases where there is excess of water in the field, it suggests a certain amount of water needs to be drained to avoid damage to crops.

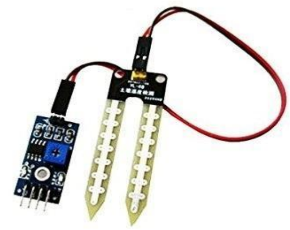

Fig .5. Soil Moisture Sensor

Along with the soil moisture sensor, if a servo motor is connected, the deficit of moisture levels leads to the motion in the servo motor which indicates the requirement to water the field at that time which is like an instant alert as it is a regular activity.

F. Rainfall Sensor

Rainfall is a factor that governs the watering needs in order to keep the soil at a threshold level of moisture as excess of it can also be vitiating.

If it is raining in the farm, then the watering activity to that farm can be stopped for that interval and accordingly when the requirement rises it can be watered which results in conservation of water and circumvent imprudent drenching.

Fig .6. Rainfall Sensor

G. The Camera Module

The camera module is not a sensor but is an official module from the raspberry pi foundation which in integration with Raspberry Pi pertains the capability to capture real-time images of the crops in the farms. This module is of great importance to monitor the field visually at any time. The image data collected here is stored in the cloud to process them and monitor the crop growth. In addition to that, one element that resists the proper growth is the disease. The images can be processed for any unusual conditions like pests and insects. Accordingly required measures can be taken like using pesticides and insecticides.

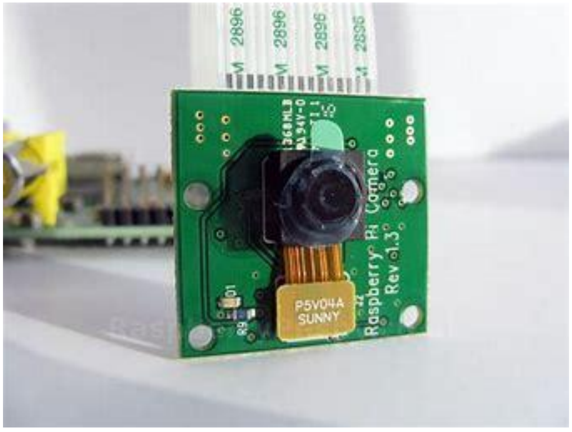

Fig .7. Camera Module for Raspberry Pi

H. Wireless Sensor Network

In the modern networked world, everything can be interlinked to be accumulated and accessed anywhere. A wireless sensor network is deployed in the field of agriculture in integration with IoT with an intention to bring in webwork connecting interrelated components. In this model, nodes are installed at various points in the farm such that the data from all the nodes is collected and clustered in a cloud to be accessed anytime. Wireless sensor networks are deployed widely across many farms that are meant to be highly smart and automated.

I. ThingSpeak

The central basis for all the data collected from our system is the cloud. Thingspeak also provides a profound analytic platform that provides services that allows to aggregate, visualize and analyze the raw live feed deployed on cloud**.** This platform provides conjugate visualizations of data uploaded by various devices to ThingSpeak**.**

II. RELATED WORKS

Technology can be applied across various aspects of agriculture for the well-being of farms. One of the major aspects that plays a major role in defining farm's productivity is the content of micronutrients in the soil. The N, P, K contents of the soil are measured using the soil solutions of samples. The measured values of N, P, K are sent to the nearest crop research institute for verification. The model gives 90% accuracy as there is only a slight difference in the values that were observed. The institute in turn recommends the required content of fertilizers to be provided to fill the requirements of the soil. Here, analog values weren't considered, only auto recommended values were considered [1].

WSN is a device that has the capability to sense the data from the place of deployment to the required destination as desired by the user. The terrestrial deployment of WSN makes it an on-land system and keeps it easily customizable. It is also beneficial in terms of cost reduction and optimizes power consumption thereby communication with distant nodes becomes simpler. The nodes communicate through radio frequency signals and ISM bands. The Global System for mobile communication helps the user to stay intact with the nodes in the farm at any instant [2].

Colorimetry is the technique of identifying the contents through the color they produce through various reactions. This principle can be used to determine the fertility of a soil sample. The soil is made into an aqueous solution by treating it with various extracting reagents. The solution is then subjected to photodiodes which are a part of the color sensor. The output given by the sensor is measured against the existing criteria and is classified based on the output value to obtain a relative ranking. The Naive Bayes classification algorithm is used to verify the results obtained. This algorithm classifies the soil solutions into 3 categories high, medium and low based on their intensities [3].

Soil nutrients are measured using an optical fiber which works on the principle of colors that are emitted by a soil solution when treated with reagents. The sensor we use is constructed using multimode, plastic optical fiber that contains seven fibers which are arranged in a circular manner having the receiving fiber as central fiber and the rest six fibers are transmitting fibers. The light is incident on the aqueous solution of that of the soil sample with the means of multimode optical fibers. The reflected light is cataloged by the receiving fiber which will then be converted to an electrical signal. The status of nutrients present in the soil is then calibrated using the electrical signal output [4].

FarmBeats, a Microsoft product which is a full stack approach, including the cloud and sensors, to rectify the problem. This aims to enable data driven agriculture. The combined knowledge of the farmer about the farm along with our data can help increase farm productivity, and it reduces the cost drastically [5].

Remote monitoring and Automation, a revolution in agriculture led to the proper usage of resources in a timely manner and thereby cutting the costs. The field can be controlled through our smart device thereby reflecting automation which is a characteristic of smart farming.[6]

The early onset of diseases in crops can be determined from visible symptoms. With the help of several existing algorithms that enables us to detect, classify, and quantify the crop diseases through analysis of images. Image processing on the collected images is done in the following steps. First step is to capture the image using a camera and to further segment the image k-means clustering technique is used. By using three variations of edge detection techniques, the image is then processed. The three different techniques are canny, prewitt and sobel algorithms. In the three edges detection methods we render to the usage of canny edge detection algorithm since it provides gives reliable and effective detection. The IoT toolkit that is be provided consists of the required sensors and a camera to monitor the crops by regular image capturing. [7] A central maintenance system and comprehensive study of sensor data aids in the accurate prediction. Data collected from various agriculture fields and stored in a cloud server. Previous agricultural fields data and their predictions stored in a cloud- server and applied data analytics to do analysis. This helped to collect crop data, after which certain predictions can be made thereby aiding in decision making. [8]

The current proposal is a combination of all the above systems by making few fixes and overcoming the limitations posed by each of them.

III. PROPOSED SYSTEM METHODOLOGY

The system we propose is a nexus of all the facets associated with the farmland. The basic thong is the integration of all the sensors and modules with the microprocessor Raspberry Pi. This basic connection constitutes a node in the wireless sensor network. Then many such nodes are installed each covering a portion of the farm to get parameters from all over. This fabricates a wireless sensor network in the farm. The system seems much simpler but actually is a complex of all the components. At the farm level a number of nodes are installed, and they continuously collect the data from the farm and that data is streamed to the thingspeak cloud where the data can be accessed anytime and the visualization and analysis for the live data is available in the IoT thingspeak analysis platform.

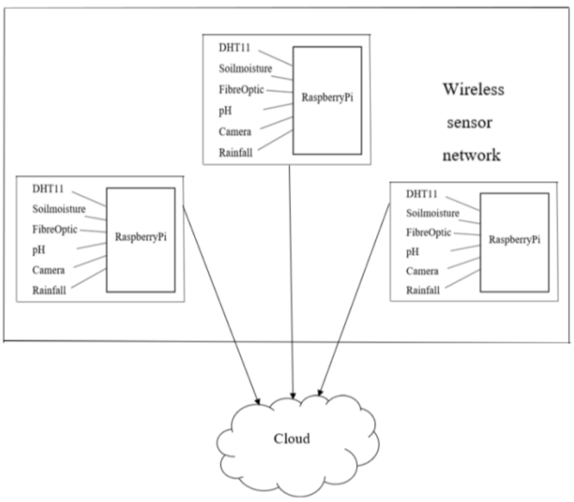

Fig .8. Implementation of WSN with sensors

The real time deployment of the wireless sensor network and cloud upto the user end clarifies the purpose of the system.

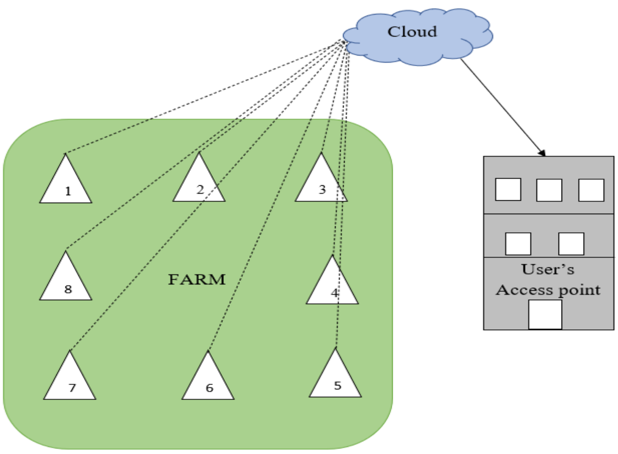

Fig .9. Data transmission to the user through cloud

The data from each node in the cluster is directed to the cloud where the entire data is accumulated and aggregated to make final decisions about the conditions and parameters of the farm.

IV. RESULT AND DISCUSSION

This proposal undubitably transforms the future of agriculture through the scope to make scalable and extensible augmentations of various traditional and modern age computing techniques. Adding on this remains an archival value for any further extensions in advanced eras which can be made and provides a generic framework for the developments intended towards smart agriculture. The key outcomes include

1. Collection of sensor data from wireless sensor networks periodically.
2. Accumulating the data in the cloud and aggregating the data thereby showing the analysis of data in various formats like graphs and charts.
3. Considering the micronutrients contents to determine the fertilizers that needs to be used.
4. From the images captured through the camera module, the growth of the crop is monitored. Through image analysis and processing any abnormalities and diseases to the crops can be figured out.

V. CONCLUSION

The system showcases the ability to focus on an entire range of parameters by ascertaining various determinants that have the potential to define a farm. The integration, the visualization, the centralization, the analysis all of these makes it complete taking into consideration the farm as a whole. The sensors used form the basis for all these by their ability to sense their intended parameters. The cloud makes it an anytime, anywhere to use service.

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