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Smart Agriculture Monitoring System using IoT with Data Analysis

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ABSTRACT

To the emerging technologies around the globe, agriculture has become a major part which should now rely upon the advancements to keep the requirements of humans matched. By assisting farmers with essential equipment to predict the crop growth, availability of moisture in the soil, status of the soil, etc alongside the unpredictable environment around, IoT plays a crucial role in bridging the difficulties and bringing a novel solutions involving cost-effectiveness, sustainability, quality and most importantly a user friendly interface which can even be handled in remote areas. This work presents a smart agriculture monitoring system which monitors overall parameters for high precision crop control. This paper delivers a vision on the amalgamation of deploying sensors and connecting the farmers to the unpredictable weather conditions with accurate devices to tackle the real-time problems is presented in the article.

***Keywords*:** Internet of things, Raspberry pi, Android app, Agricultural sensors, Wi-Fi module.

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INTRODUCTION

Internet of Things is the novel permissive communication technologies model that may expand the present internet and implement intercommunication [1] over Wireless Sensor Network (WSN) and Machine to Machine (M2M) as shown in Fig. 1. The word IoT itself describes that it has two combined words. They are "Internet" and "Things (physical devices which can be connected to the internet)". It was coined by Kevin Ashton [2] who was a consumer sensor expert in the year 1999 dated 20th January. Fig. 2 describes the typical processes in an IoT [3] device.

A. Sense: Sensors, which detect anything related to their purpose of action. These sensors can be on-board or attached to the device.

B. Actuate: There are several types of actuators which allow taking actions upon the physical entities or devices.

C. Communicate: These modules are responsible for sending collected data to other devices or to the cloud server such as Amazon server, IBM server, Google server, ThingSpeak, ThingsWorx, Things Board, Xively and so on.

D. Act: These modules are responsible for making sense of the collected data.

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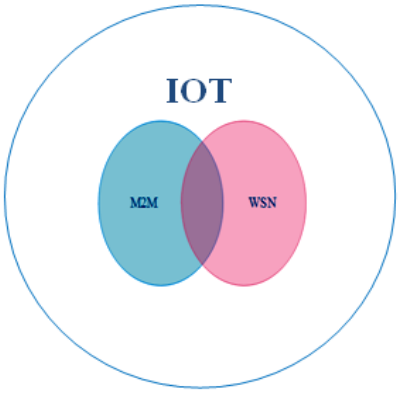

Figure 1: Working of IoT along with M2M for WSN

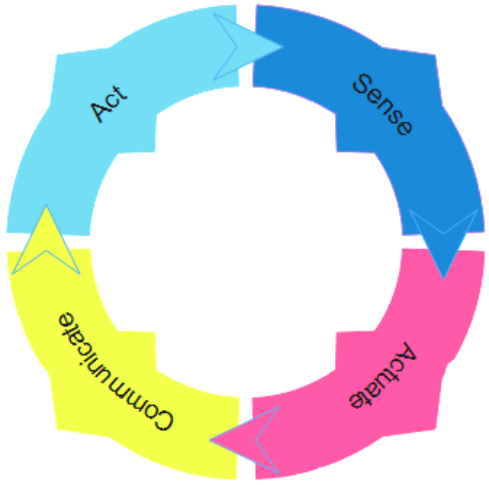

Figure 2: Definition and cycling process of IoT

Agriculture is the main domain of the India economy because it supplies the desired food grains and alternative required raw materials for us. IoT plays a key role in various agricultural fields like Smart Irrigation, Greenhouse control and so on. Nowadays, Smart irrigation is the main issue experienced by farmers in advance countries [4] such as India.

Address the agriculture issues with the help of innovative IoT applications by increasing the operational efficiency, sustainability, and cost-effectiveness for the production of agriculture. IoT sensors are providing data about the agricultural field like crop yields, pest control, and rainfall to the farmers. IoT is a good opportunity for the farmers for monitoring their increase in productivity, crop yields, the health of soil and crop, storage conditions. IoT sensors used for 24/7 visibility of soil quality monitoring [5] like soil health and crop health and so on.

Sensors used in Agriculture

Table 1 shows the various sensors electrical specifications used in [6] agricultural fields in order to get the information from field stations.

Table 1: Study of Various Sensors

Name of sensor	Electrical Specifications
Temperature sensor	Supply Voltage: +5 V, Temperature Range: 0°C - 50°C error of ± 2 °C
Humidity sensor	Supply Voltage: +5 V, Humidity Range: 20%-90% RH ± 5% Relative Humidity (RH) error
Moisture sensor	Supply Voltage: 3.3V - 5 V, Moisture Range:0%-100%

Related Works

Presently, the enormous technologies play a vital role in the Agricultural domain with an automated system and implemented different system designs for Smart agriculture, Precision farming and also Smart irrigation. Huge research is being done in agriculture. Some of the existing works are noticed below.

Karunakanth et al. [7] proposed IoT based Smart Irrigation System for Home based Organic Garden. The author implemented a system for home-based organic garden using different types of sensors like temperature, humidity, ultrasonic sensor, and soil moisture sensor and connected to Arduino/Raspberry Pi using IoT technology. The architecture has a high-cost design with the four sensors. Vanaja et al. [8] introduced a theory on IoT based Agriculture System Using Node MCU. The main aim of the system is to avoid water wastage in the irrigation process with low cost and efficient. The architecture consists of field areas, DHT11 sensor with Arduino Uno and Node MCU connected to the IoT cloud operated through a mobile app like Blynk. The system has experimentally proven by monitoring the values of temperature and humidity sensor values successfully. Rajeswari et al. [9] discussed a Smart Agricultural Model by Integrating IoT, Mobile, and Cloud-based Big Data Analytics. Here the main aim of the author is to enhance the crop yield production by taking the support of data mining technique which can help the former in terms of field information by using the emerging technologies such as IoT, WSN, Cloud computing, Big Data, Mobile, and Data mining. No hardware implementation was presented in this article. Ashwini et al. [10] discussed a Study on Smart Irrigation System Using IoT for Surveillance of Crop-Field. The author explained the system architecture for smart irrigation by using IoT. Here the system associated with different sensors such as soil moisture, temperature, and humidity. These sensors interfacing with Arduino board along with Zigbee module and finally the data will be processed with decision making to mobile application for the farmers or users. The system has low-cost implementation and also using three sensors. Srishti et al. [11] proposed a review on IoT based Smart Irrigation System. This system contains hardware and software components. The hardware block has made of embedded devices whereas the software is the webpage designed using php. The moisture sensing section contains soil moisture

sensing unit in which the information related to agriculture is displayed on the webpage. So the farmer can remotely monitor the entire irrigation process on the farm. A single sensor like soil moisture sensor interfaced with Arduino board and it has a low-cost design.

PROPOSED SYSTEM

The proposed system comprises of smart agriculture includes different hardware components such as temperature and humidity sensor (DHT11), moisture sensor, raspberry pi with Wi-Fi module, android mobile, and thingSpeak cloud. These IoT sensors are interfaced to raspberry pi with the help of MCP3008 (analog to digital converter) and the data will be transmitted to cloud. It provides the collected data and analyzed data to the farmer or end-user. They can access the data from cloud or database like thingSpeak, by using Android MIT App Inventor. Then only the farmers can analyze their crop yields, increase productivity, water management regarding the agricultural fields. As shown in Fig. 3, Fig. 4 illustrates the schematic diagram of Smart Agriculture system and workflow diagram of smart agriculture monitoring system as shown in Fig. 5 respectively.

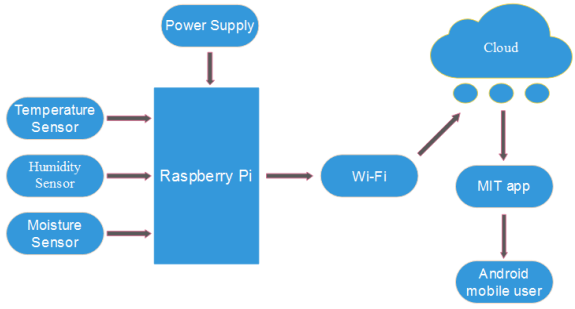

Figure :3 Block diagram of Smart agriculture system

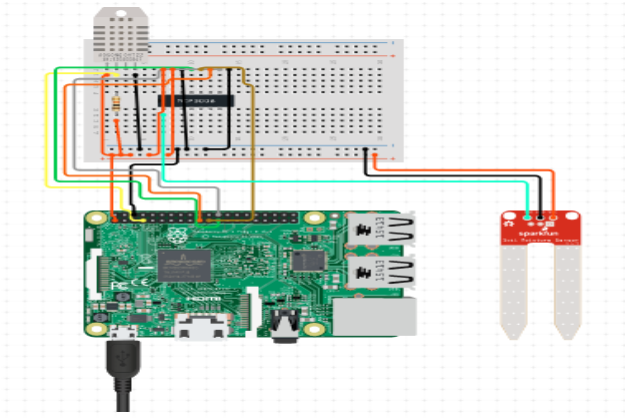

Figure :4 Schematic diagram of Smart Agriculture system

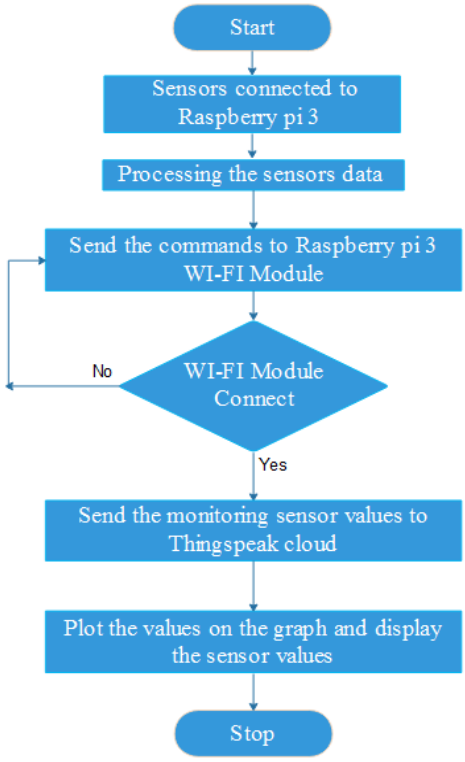

Figure 5: Workflow model diagram

App Development

MIT App Inventor for android is a free access web application at first supported by Google, and now handled [12] by the Massachusetts Institute of Technology (MIT). In this article one android app is developed for farmer awareness which gives information regarding their agricultural fields.

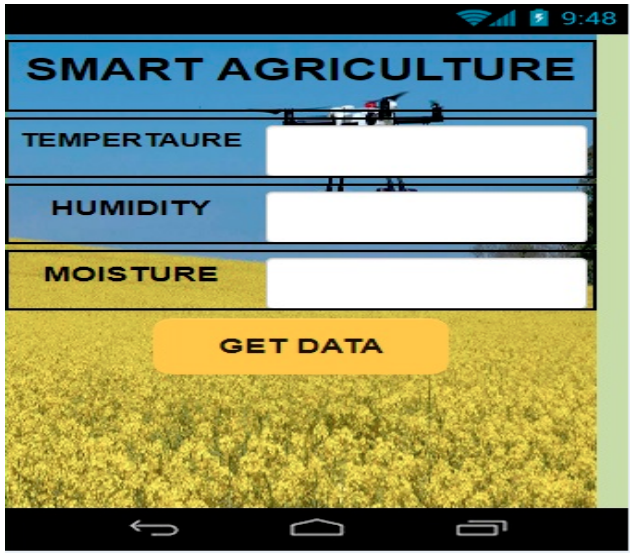

Figure 6: MIT app implementation

Hardware Development

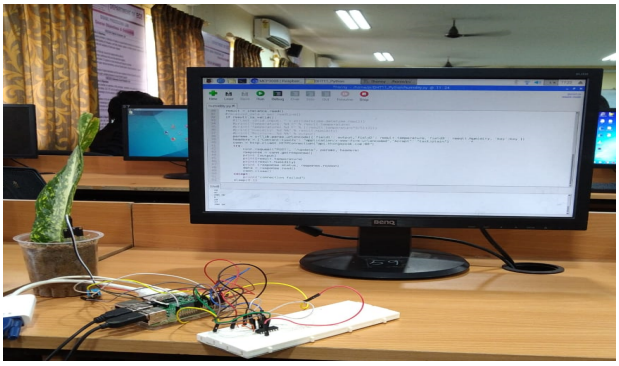

Figure 7 : Hardware implementation

As shown in the above Fig. 7 Required hardware components are

a. Raspberry Pi
b. Temperature sensor
c. Humidity sensor
d. Moisture sensor
e. Power supply
f. Breadboard

Result and Discussions

Table 2: Different Sensors Output Values used in Agriculture at Day Time (8:00 AM to 10:00 AM)

Days	Temperature (^{0}C)	Humidity (%)	Moisture (%)
1	29	75	100 (rain fall)
2	32	76	69
3	34	63	64
4	33	61	89
5	42	44	86
6	35	69	100 (rain fall)
7	37	64	95
8	36	64	100 (rain fall)
9	35	68	97
10	30	68	52

Table-2 shows the optimal growth of agricultural crop yields, plants at various agricultural field stations. Below three graphs illustrate the visualization of Smart Agriculture Monitoring System in ThingSpeak cloud using python programming.

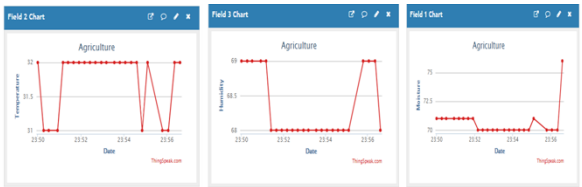

Figure : 8 Implementation of a). Temperature sensor values b). Humidity sensor values c). Moisture sensor value

Conclusion

In this article, the purposes for implementing IoT based agriculture field monitoring system have been justified with the optimum introduction of tools and measures which are taken for much better crop yield and the hassle-free user interfaces are deployed. Time to time advancements can be applied to this article like sending field information through MIT app to the farmers and alter the equipment as per the requirements. In this article, the hardware like raspberry pi with various sensors interfaced for flexibility to any agricultural field. It is a most streamlined method of presenting data which can be cast and monitored even in abnormal weather conditions. This sophisticated engineering solution acts as an important aid to the farmers and their existing problems.

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