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Internet of Things in Agriculture: Revolutionizing smart Farming for sustainable Field Monitoring

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Abstract : The scope of smart computing is linked to Internet of Things which poised to advancement in traditional frameworks and introduce a new era of ubiquitous computing. IoT's wide-reaching impact spans numerous areas including the facilitation of smart health services, augmentation of educational experiences and reshaping commercial operations. In this context, agriculture emerges as a crucial domain for Internet of Things integration, motivated by the necessity of ensuring food security amidst a growing global population. This study elucidates the shift from traditional methods to Internet of Things based solutions in agriculture specifically soil moisture, environment monitoring and supply chain control. The main focus is on precision agriculture, Internet of Things based data for real time analysis to improve crop yields and quality.

***IndexTerms* -Agriculture, Internet of Things Wireless sensor Networks, Monitoring**

I.INTRODUCTION

In future smart computing is poised to rely completely on Internet of Things and playing a important role in transitioning from conventional technique setups in society to the paradigm of "next generation everywhere computing". All around the world, Internet of Things is fully involve in research, daily life and laying groundwork for the extension of various devices like smart health facilities, intelligent living environments and improved educational experiences in schools. Furthermore, it is becoming important in commercial sectors like industrial, transport, agriculture and business supervision [1].One of the most important and extensively studied areas within Internet of Things is agriculture given its critical role in ensuring food security amidst a rapidly growing global population. Initially, ICT-based techniques were used in field but falling short of providing long term solutions. Consequently, researchers now preferring Internet of Things as a different technique in agriculture which includes applications similar to soil moisture monitoring, location monitoring for parameters like temperature and soil moisture level, supply chain and structure management.

The upcoming of agriculture lies in precision agriculture with an expected growth. Information produced by installed sensors in field can be leveraged for data analysis to increase crop yields. Consequently, Internet of Things -based smart farming holds the promise of resolving several agricultural challenges. The objective of research is to present a functional device enabling farmers to access real-time data. In second section, importance of Internet of Things based applications in smart agriculture including their merits and demerits. In third section sensors, Microcontroller and hardware modules used in developing the device will be discussed by using images of prototype model. The working process of device is discussed in fourth section.

II.Smart Farming based on Internet of Things

Smart farming is a new farming concept based on Internet of Things technology to surge the yield in agriculture. To rise the crop yield and superiority of crop farmers can efficiently use fertilizers and resources like water. Farmers can collect the information or data about field and crop whole day without any physical presence but farmers should have knowledge about the diverse apparatuses to measure standard environmental conditions for crops. IoT based system is automated system which can work without any manual supervision and can make decisions to overcome various problems which they face during farming. If user or farmer is not available in field, IoT based system has capability to reach and inform the farmers regarding updates. Researcher are working on various smart farming techniques based on IoT, as a result the expected advantages of this technique are remote monitoring, water and resources protection, smart management allows better livestock farming, crop estimation, good quality and enhanced quantity and real time data for convenient perceptions.

Agriculture is basically based on nature and man prediction or controlled nature like rain, sunlight and drought, fertilizers, and pest controls etc. The smart agriculture required internet connectivity 24 hours. In developing countries, rural areas did not satisfy this requirement.

Faults in sensor nodes and data processing stages can cause errors which may lead to excess practise of resources. Smart farming based devices need farmers to comprehend and study the working process of technique which is main contest in implementing smart agriculture farming at great scale.

Wireless Sensor Networks

The wireless sensor networks collection of several sensor based on wireless communication in field. The main task of sensor is to accumulate data like soil moisture temperature and humidity with low vitality and memory [15]. Many researchers are focusing on the demerits of various approaches as number of routing protocols [16][19], and intelligence based approaches[17],[18]. Wireless sensor networks have numerous applications like medical, education, military, agriculture, monitoring systems etc.

III. Hardware and Software specifications

3.1 Introduction to system

The proposed device monitors the specific parameters of playhouse and provides the readings from various sensors like temperature, humidity, soil moisture, pH value to user or farmer of the current situations, by this farmer can make fast decision. These fast decisions made by farmers are useful to rise the yield in farm and they can appropriately use natural resources. This makes device environment friendly and will improve the crop yield and superiority of crop by regular monitoring the farm. This is Internet of Things based which is useful to record various parameters and seen on smart phones.

3.2 Various Modules used in system

3.2.1 Microcontroller ESP-32
3.2.2 Sensor for Temperature and Humidity
3.2.3 Sensor for Soil Moisture
3.2.4 pH meter
3.2.5 Power supply
3.2.6 Relay
3.2.7 Contactor

3.3 Implementation of system

The main motive is to design this device which can by easy to handle and easy to install in farm by farmers. By using IoT, this system becomes automated. There is an internal vision of the designed system In Fig. 1 where all sensors and ESP32 is connected and the battery provides power supply.

Fig 1- designed system

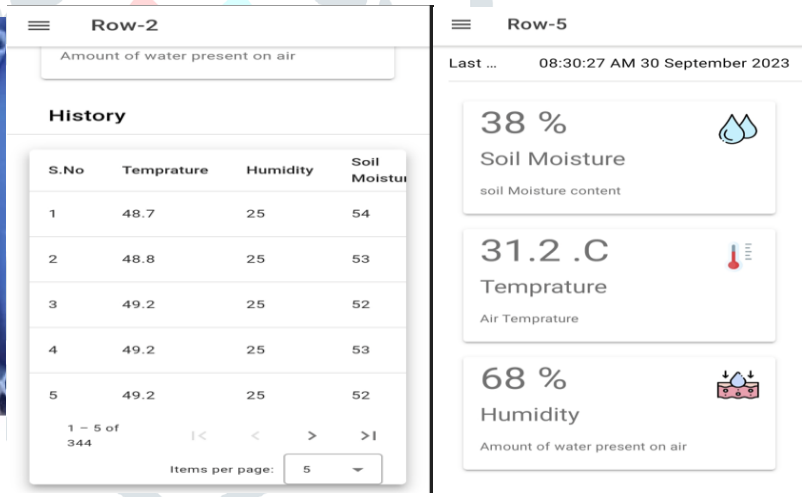

Fig 2- Snapshot of mobile app temperature and humidity and soil moisture

You can see a photograph of app window In Fig. 2 which is displaying soil moisture, humidity and temperature. We have different readings from various sensors of various parameters to generate graphs for more examine the data.

3.3.1Micro-controller ESP-32

This micro-controller has wireless connectivity it supports both Wi-Fi (802.11 b/g/n at 2.4 GHz) with robust security. Compatible with development environments like Arduino IDE and ESP-IDF, it supports wireless firmware updates via OTA and it boasts a compact form factor generally measuring around 25.5mm*18mm. It features an internal PCB antenna for Wi-Fi and BLE connectivity.

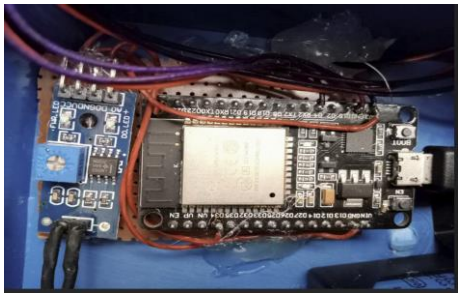

Fig 3- Microcontroller ESP-32

3.3.2 Soil moisture Sensor

This sensor is used in agriculture to check the level of moisture in soil. This is useful in irrigation schedules for crop by giving the information regarding moisture level. The sensor is associated to wireless network for real time monitoring of soil moisture level from remote location. This collected data then transmitted to cloud platform.

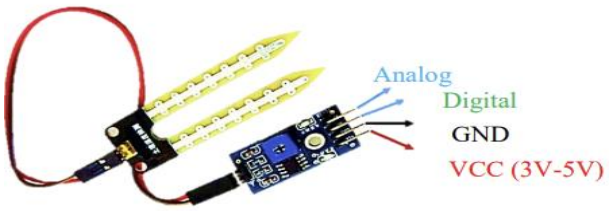

Fig 4- Soil moisture Sensor

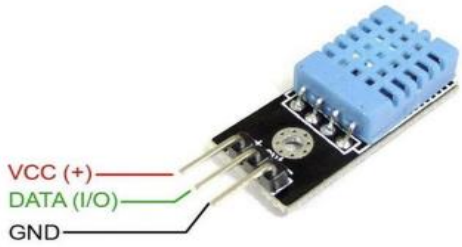

Fig 5- DHT-11 sensor

3.3.3 DHT-11 (Temperature and Humidity sensor)

This sensor is used to sense information about Temperature and Humidity. As we all know Temperature is vital parameter of environment to start or sowing any crop in field. When temperature reaches up to maximum level it becomes harmful for crop. Hence, we use DHT-11 sensor to get the temperature and Humidity readings. This sensor takes data from its surrounding. The collected is analog then converted into digital form for data processing.

3.3.4 Relay

Relays are electrically power-driven switches that is used to control circuits with high voltage or current using signals with lower voltage or current. In smart agriculture monitoring which is IoT-based relays are used to control and automate number of tasks like irrigation lighting and freshening system depends on the data composed by the sensors. Relays provide electrical isolation between the control circuit and the load circuit. Relays can control high voltage and high current loads with a low voltage control signal and generally used in Internet of Things projects to control devices, automate processes, and ensure safety.

3.3.5 Motor

In smart agriculture monitoring system, a water motor is linked to provide water to crops automatically depends on information which is provided by sensors. By using a water motor with sensors that measure soil moisture, temperature and humidity, the irrigation system is automated to enhance the moisture level of crops only when it is needed, improving the efficiency and reducing waste of water usage. A water motor is controlled remotely by use of microcontroller, contactor and other control circuit, allowing farmers to start or stop the irrigation. Overall, Water motor is an important equipment in the smart agriculture monitoring system as per it shows a dynamic part in irrigation on right time, in the right quantity. Micro-controller automatically turn on the water motor when percentage of moisture level is below 30% and turn off automatically when water motor will run for 15 minutes continuously.

IV.Software Specifications

Arduino IDE

The Arduino IDE an Integrated Development Environment which is software application which provides a programming environment for writing, compiling, and uploading code to Arduino boards. The Arduino IDE offers a user-friendly interface that streamlines writing and uploading of programs to Arduino boards. It is accessible for numerous functional systems, including Windows, macOS, and Linux, making it accessible to a extensive range of users.

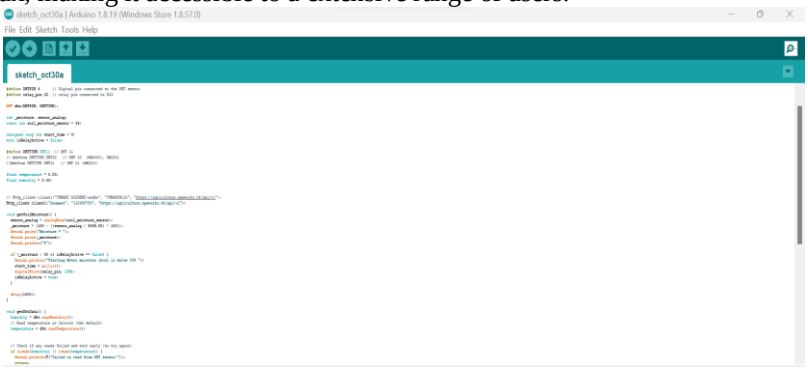

Fig 6- Arduino IDE

Fig 7- physical implementation

V. Benefits of Proposed System

1. This indicates to optimizing agricultural works to operate efficiently by reducing wastage of resources. By using advanced techniques in agriculture farmers can have fast decision-making support which leads high productivity and efficiency.
2. By employing precision agriculture techniques farmers can implement targeted interventions to control pests and diseases effectively. Moreover, sustainable farming promotes natural pest control and soil health.
3. By the implementation of Precision agriculture techniques and smart monitoring systems farmer can optimize crop growing conditions and improve soil health. By precisely monitoring farmers can focus on their cultivation process to provide specific needs of crop to get high yield level of crop.
4. By the implementation of Precision agriculture techniques and smart monitoring systems farmer can optimize water usage in field by accurately assessing soil moisture levels, weather conditions.
5. Farmers can remotely monitor and access various aspects of their collected data from field via smart phone or computers. The devices are installed in poly house or in field to accumulate data continuously on mobile apps.

VI. **Results & Conclusion**

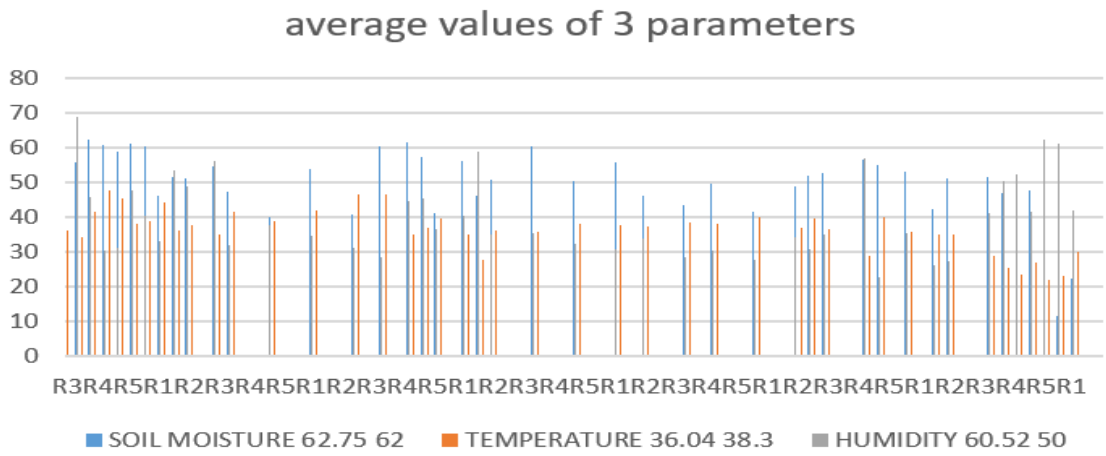

Fig 8- graphical representation of collected data of Soil moisture, temperature and humidity

Internet of Things is fundamentally reshaping society norms towards a vision of universal computing. Its influence extends into commercial field like manufacturing, transportation, agriculture and business management showing us indispensable role in contemporary innovations. In agriculture, Internet of Things stands as a encouragement of progress tackling critical challenges in securing food supplies amid a growing global population. While traditional agricultural techniques relied on ICT methods shifting towards Internet of Things based solutions. This transition unravels a numerous of applications in agriculture with efficiency and sustainability. The forthcoming of agriculture lies in precision farming supported by Internet of Things with estimated growth. Internet of Things based smart farming holds the possible to significantly enrich agricultural yield while minimizing resource wastage.

The main motive of this study is to introduce a practical IoT-based device for farmers, empowering access to vital real-time data for informed decision making. Through a study of IoT applications in smart farming. By implementation of this device underscores its capacity to revolutionize agricultural practices, offering benefits like resource optimization, pest and infection control and improved crop yield and quality.

The proposed IoT-based smart farming system shows a significant stride to a more sustainability and efficient agricultural ecosystem. By connecting the power of IoT farmers can rise above traditional constraints, accompanying in a time of precision agriculture that ensures food security for future generations.

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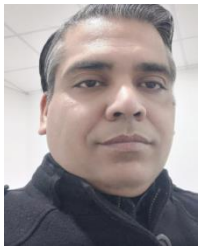

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