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# A Survey of Futuristic Approach on Smart Agriculture Technologies Using Internet of Things

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***Abstract*— Farmers have already begun to employ high-tech farming techniques and technologies. With the evolution of precision agriculture wireless sensor networks are of great use in the field of agriculture for measuring temperature ,humidity, soil PH, light intensity etc. With the emergence of Internet of things (IoT) farmers can use their smart phones or computers to remotely monitor their equipment, crops, and livestock. This paper conducts a survey on smart agriculture technologies in order to formulate an understanding of different techniques for smart and sustainable agriculture. Here it also addressed a simple conceptual model based on IoT and Wireless Sensor Network.**

***Keywords*— Cloud , Crop , IoT , Smart Agriculture , Wireless Sensor Network.**

## I. INTRODUCTION

This Agriculture plays an important role in the country's food security and economic growth. Precision agriculture is a trend nowadays, which is also called as satellite farming or site specific crop management (SSCM) [1] , is a farming management concept based on observing, measuring and responding by collecting information from the crop field regarding atmospheric and soil conditions of crop growth. Collecting environmental information is a crucial task if it is to be done manually. Also inadequate soil testing labs in the states of the country make new farmer's unaware of the soil characteristics. So now what is the significance of IoT in agriculture? The answer is Manual data collection processes from the crop field or farm makes it difficult for farmers to achieve optimum levels of efficiency. This is where IoT (Internet of Things) is playing an increasingly important role.

Several techniques using IoT has been already in rise. In this paper, a survey on smart agriculture is carried out to know the recent IoT based developments in agriculture is explained in section II, Section III describes a conceptual model for IoT and Wireless sensor network based agriculture.

## II. LITERATURE SURVEY

An agricultural application of wireless sensor network for crop field monitoring is proposed in [2][3][4].

These systems constitute sensor nodes to measure temperature, humidity and paper [2] in addition contains an image sensing node to take images of crops. Parameters like temperature, humidity and images of crop growth were taken to make expert judgments in time. These methods have low power consumption and have stable running and high precision environment monitoring for crop growth. Paper [5] proposed a cloud IoT Based greenhouse Monitoring System. The system can monitor a variety of environmental parameters in greenhouse effectively using devices such as temperature sensor, light sensor, relative humidity sensor and soil moisture sensor. The coordinator node collects environmental information from the crop field every 30 seconds and are being logged and stored online using cloud computing and Internet of Things. This facilitates the system to provide the owner with the details online irrespective of their presence onsite. [6][10] proposes an IOT Based Crop-Field Monitoring and Irrigation Automation system. In their work, a system is developed to monitor crop-field using sensors and automate the irrigation system according to the sensed data. The data from sensors are sent to web server database using wireless transmission. The irrigation is automated if the moisture and temperature of the field falls below the brink. The automated irrigation system provides a web interface to the user so that the user can monitor and control the system remotely. [12] Conducted a study on Smart Irrigation systems to know the IoT based development in agriculture .

A survey on smart drip irrigation system is proposed in [7]. In this, Drip Irrigation system is completely automated which reduces human efforts by using an android mobile application which remotely controls the drip irrigation system based on the values from the different sensors deployed in the field to monitor the environmental conditions.. [8][9][11] Proposed smart irrigation systems using Internet of Things. They have used WSN networks with sensors place in field to measure the soil humidity, tank/well to measure the water level .These sensed data are send to smart gateway through a network, here[9] used a gateway called Generic IoT Border Router Wireless Br 1000. From the gateway, the data is then send to a web service through a network.

This web service uses intelligent software application to automatically analyze the data and according to this data the farmer can formulate a decision. [15] Proposed a Sustainable Agriculture using Eco-friendly and Energy Efficient Sensor Technology. This paper presented automated farm monitoring and irrigation techniques which incorporate wide range of sensors to remotely sense and monitor various parameters of the soil like temperature, moisture, fertility and regulate the supply of water and fertilizer to the land based on the requirement. A Smartphone Irrigation Sensor [22] is proposed. Here they designed and implemented an automated irrigation sensor to use in agricultural crop field. The sensor uses a Smartphone to capture and process the digital images of soil nearby the root zone of the crop, and estimates optically the water contents.

In order to perform various agricultural activities like weeding, spraying, moisture sensing, bird and animal scaring [13] proposed a IoT based smart agriculture system. For this purpose they have developed a GPS based robot. In addition to this, they have presented a smart irrigation with smart control and intelligent decision making and a smart warehouse management system.[14] proposed an Optimized Equipment for measurement of Soil Parameters and Conservation of Water in Agricultural Fields. They have mainly focussed on automatically controlling the water flow to the agricultural field based on the temperature sensor values. In addition to this, Rain detection sensor is also used to sense the weather condition, this will be intimated to farmer's smart phone for his references through GSM. [16] Proposed a system for monitoring Pest Insect Traps Using Image Sensors & Dspic. Here, they have used distributed imaging devices which are operated through a wireless sensor network that is able to automatically acquire and transmit images of the trapping area to a remote host station. The information regarding pest accumulation is send via call/message to the farmer's mobile. This method only detects pests doesn't suggested any method to control the same. An Automatic Pesticide Sprayer for Agriculture Purpose is proposed in [17]. In Paper [18] , Design and Development of Automatic Weed Detection and Smart Herbicide Sprayer Robot is presented**.** In this paper, an image processing algorithm is used to take images of the plantation rows at regular intervals and upon identifying the weeds in the image, the herbicide is sprayed directly and only on the weeds by the robot. [19] Proposed a Smart Beehive for Agriculture, Environmental, and Honey Bee Health Monitoring.

In this method they have deployed a wide range of sensors for monitoring the multidimensional conditions such as oxygen, carbon dioxide, pollutant levels, temperature, and humidity within and outside a living beehive. From the results obtained they have developed an algorithm for automatically determining the status of the bee colony. A Smart Irrigation Controlling System for Green Roofs Based on Predicted Evapotranspiration is proposed in [20]. Green roofs are beneficial in number of ways for buildings. Crops in green roofs are exposed to direct solar radiation and strong winds. This paper proposes a novel irrigation controlling method for green roof based on predicted evapotranspiration. The system is capable of predicting the evapotranspiration and deciding the amount of water to be irrigated based on that.

A Sensor Network Data acquisition and Task Management for Decision Support of Smart Farming [21], presents a conceptual model and system design for decision support of smart farming with network sensor applications in order to perform necessary tasks required for farmers using Internet of Things (IoT).In paper [23] Development of IoT based Smart Security and Monitoring Devices for Agriculture is proposed. Identification of rodents, threats to crops and delivering real time notification based on information analysis and processing without human intervention is focused here. In this, sensors and electronic devices are integrated using Python scripts. Based on attempted test cases, they were able to achieve success in 84.8% test cases. An experiment for Implementation of IoT and Image Processing In Smart Agriculture [24] describes an approach to combine loT and image processing in order to determine the environmental factor or man-made factor (pesticides/fertilizers) which is specifically hindering the growth of the plant. IoT sensing network takes the readings of the crucial environmental factors and the image of the leaf lattice, it is processed under MATLAB software by the help of histogram analysis to arrive at conclusive results.

In paper [25] , it facilitates Smart Sensors Based Monitoring System for Agriculture using Field Programmable Gate Array. They developed a smart sensor for monitoring agricultural environment using field programmable gate array (FPGA) which comprises of wireless protocol, different types of sensors such as temperature , soil moisture and relative humidity sensors, microcontroller, serial protocol and the field programmable gate array with display element. The sensed data in agricultural environment is provided into microcontroller, interfaced with the wireless Bluetooth module.

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A wireless transmitter receiver module pair helps in transmitting and receiving the data which is then fed to FPGA using a serial communication protocol UART. Data are displayed on a LCD unit to monitor the system.

A Smart Sensor for Precision Agriculture Powered by Microbial Fuel Cells is proposed in [26]. They have presented a smart, ultra-low power, cheap and energy neutral system capable to monitor periodically and remotely the level of phreatic aquifers. The LoRATM radio chip is used to transmit acquired data kilometres away also in a noisy environment keeping low the complexity of the network .The device power supply is generated in a eco-friendly and zero emission manner by means of a terrestrial Microbial Fuel cell . In paper [27] Smart Agricultural Solutions to Farmers for better yielding using IoT is addressed. The approach uses the combination of IoT and cloud computing that can promote fast development of agricultural modernization and helps to realize smart solution for agriculture and efficiently solve the issues related to farmers. A Smart and Ubiquitous Controlled Environment Agriculture System called AgriSys is proposed in [28]. AgriSys mainly looks at inputs, such as, temperature, humidity, and pH of the crop field. In addition, the system deals with desert-specific challenges, such as, dust, infertile sandy soil, constant wind, very low humidity, and the extreme variations in diurnal and seasonal temperatures.

Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing & Big-Data Analysis [29] is used for developing a smart agricultural model. Here, Soil and environment properties are sensed and periodically and are sent to Agro Cloud through IoT (Beagle Black Bone). Big data analysis on Agro Cloud data is done for fertilizer requirements, best crop sequences analysis, total production, and current stock and market requirements.Proposed model is beneficial for increase in agricultural production and for cost control of Agro-products. In paper [30] Sensor based Automated Irrigation System with IOT: A Technical Review is conducted to give an understanding on the same. They have focused on minimized human intervention with the automated irrigation .In this, whenever there is a change in temperature and humidity of the surroundings the sensors senses the change in temperature and humidity and gives an interrupt signal to the micro-controller.

Microcontroller in the system promises about increase in systems life by reducing the power consumption resulting in lower power consumption. It is considered to be used at Cricket stadiums or Golf stadiums and also in public garden area for proper irrigation.

## III. Proposed Conceptual Model For Smart Agriculture

By analysing the literature survey, a conceptual model for smart agriculture is proposed here. Before that, let us know the overall structure of IoT. IoT basically has a three layer structure [14] constituting many physical devices in practice. The first layer is the perception layer which in agriculture represents the crop field or livestock where sensors or transponder chip may be deployed to monitor environmental conditions or the location of livestock.

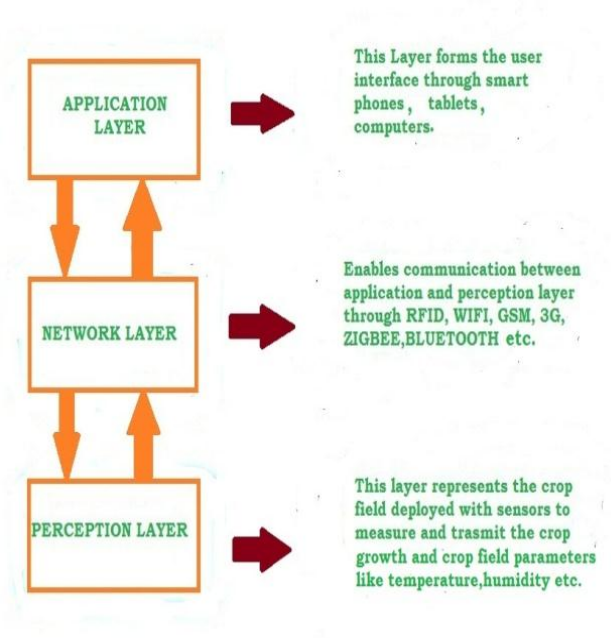


**Fig 1 : Three layer structure of IoT.**

The second layer is the network layer which represents the communication technologies like RFID, GSM, Wifi, 3G, UMTS, and Bluetooth Low Energy, Zigbee etc. The third layer is the application layer which enable user interface like smart phones, personal computers or tablet. Figure 1 shows the three layer IoT structure.

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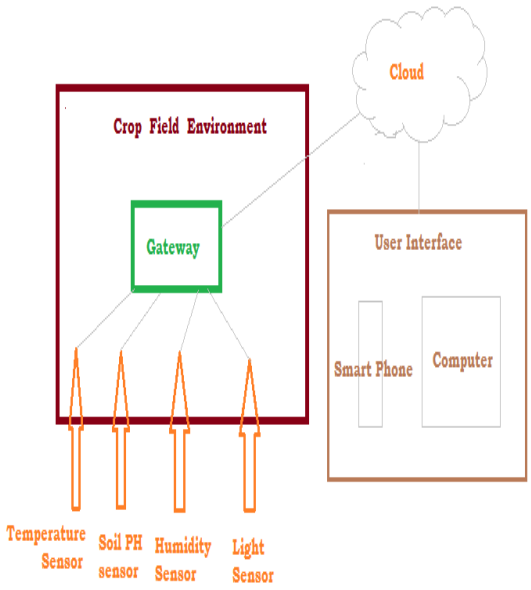


**Fig 2: Conceptual model for Smart Agriculture**

The conceptual model for IoT based smart agriculture is shown in figure 2. Several sensors are deployed in the crop field for measuring various parameters like temperature, humidity, soil PH, light intensity. Each device in the network will be assigned with an IP address for identification purpose. For example temperature sensor in the network will be addressed with object ID T1 within the communication Network. Addressing methods of IoT objects include IPV6 and IPv4.Identification methods are used to provide a clear identity for each object within the network., IoT sensors can be smart sensors, actuators or wearable sensing devices. The sensed data's from crop field are send to a cloud through a gateway which is connected to internet via Wifi or any other communication network. From the cloud the datas are send to farmer's smart phones or computers. By analysing this data farmers can take appropriate decision.

## IV. CONCLUSION

With IoT enabled technologies precision agriculture can be made more accurate and efficient. There are different domains in agriculture where IoT can be applied. First one is the Water and Energy: Water and energy are the most important inputs for agriculture and their costs can improve or break the agricultural business.

Water wastage due to leaky irrigation systems, inefficient field application methods and the planting of water intensive crops in the wrong growing location are of major concern. Pumps, boosters, lighting etc need electrical energy for its operation. With IoT water use can be made smarter for agriculture by monitoring and changing water volume, location timing and duration of flow based on data analytics. Also, IoT can result in more effective energy use for pumps, boosters, lighting and other purposes. The second one is the crop monitoring: In this area, application of fertilizers, pesticides based on crop and soil health, pest control are of major concerns. Efficient use of fertilizers and pesticides can be made by deploying sensors and image capturing devices in the crop field which is connected to internet for appropriate decision making through IoT.

**TABLE 1**
**VARIOUS PARAMETERS MEASURED IN DIFFERENT PAPERS**

| Parameters measured in each method | [4] | [5 | [6] | [8] | [10] | [13] |
|---|---|---|---|---|---|---|
| Soil PH | yes | yes | yes | Yes | Yes | yes |
| (Air Quality) Temperature | yes | yes | yes | yes | yes | yes |
| (Air Quality) Humidity | yes | yes | yes | yes | yes | yes |
| Light Intensity | yes | yes | yes | No | No | No |
| Rainfall | Yes | No | No | No | No | No |
| Water level | No | No | No | No | Yes | No |

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