Opportunities and Challenges with WSN's in Smart Technologies: A Smart Agriculture Perspective

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Abstract. Study of a smart environment is very common these days. The techniques for building smart applications, consist of manufacturing devices and sensors, which can communicate with each other to monitor their surrounding conditions. These conditions may be environmental conditions like pollutant gases, radiations, noise and waste etc. Basically, useful information is generated by the sensor nodes deployed in the environment and decision implementation is done by the controller to control the conditions according to requirement of the users or applications. Wireless sensor networks are able to accumulate the information from the environment. This may be done with the help of tiny sensors nodes which can communicate with the other sensor nodes wirelessly and are not harmful to the environment. These tiny sensor nodes operate on low power to perform various operations like sensing and any type of calculations. The communication process between the sensor nodes also consumes low power which will ensure the long life of the networks. The architecture of the sensor nodes gives the advantage to program the micro-controllers associated with these, depending upon the applications. There are numerous of applications of wireless sensor networks which include applications in healthcare, defense, smart cities, event detection and underwater monitoring applications. Also in the field of smart agriculture, sensors play a vital role in different applications like soil quality checking, precision agriculture and irrigation control. In this chapter, a study of wireless sensor networks for smart applications is conducted. The main focus of the chapter is on smart applications in agriculture. The chapter answers questions like how to design and develop smart techniques for agriculture, how can the wireless sensor networks help in precision agriculture.

Keywords: WSN · Sensor · Smart environments · Smart agriculture · Smart applications

1 Introduction

To monitor physical or environmental conditions, such as sound, temperature, vibrations, pollutants or motion and pressure autonomous sensor nodes have been used by wireless sensor networks. All the data collected by the sensor nodes is transmitted to

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the main base station with the help of network. With the use of these inexpensive, tiny and smarter devices more and more area can easily be covered for the investigation, all measuring environment parameters can be covered. It has enabled the continuous timed monitoring. Now collection of data can be done in real-time. Sensor nodes are used to gather data, store and then sharing the same data on network. As wireless sensor network has a very wide range of applications in almost each and every sector in this article smart agriculture has been focused.

In smart agriculture, precision farming is a technique to manage very large fields. More sophisticated sensor nodes with sensing abilities to biological and chemical parameters are required. This may increase the productivity in the fields and will be helpful for the farmers to achieve more with less efforts [1]. Precision farming is the capacity to deal with so many varieties in the productivity of crops within the fields and to increase it, so that it can help in maximizing the financial properties. This technique is also used to minimize the wastage, environmental impacts by using the automatic data gathering with sensor nodes deployed with in the fields. The gathered information is helpful in managing the fields and decision-making capability also increases. Researchers have introduced so many new and smart technologies in precision farming, few of them are GPS, Remote Sensing and GIS [2]. Whereas to make precision farming more effective characteristics of soil is required. Characteristics' values may be recorded using sensor nodes which are deployed in the fields. These sensor nodes consist of Sensing unit, Controlling unit and the actuator unit. These sensor nodes are deployed very densely [3] so that the exact and effective data can be collected to address various issues. Sensor nodes do not require any special care, these can be deployed randomly, which means no predetermined position is required. These sensor nodes can easily communicate with each other and are able to transmit the gathered data to the end user or base station. Routing capabilities of the sensor nodes make WSN so important. In wireless sensor networks base station is where user collect the processed and aggregated information. Communication in between sensor nodes and base station can take place using WIFI, Bluetooth and internet connectivity.

This chapter will discuss the possible applications of WSN in smart precision farming which will help the readers to enhance research in this field. The issues and challenges will be discussed and last five to six years of literature will be elaborated to find out current state of art in this research area.

1.1 Wireless Sensor Networks (WSN)

Number of sensor nodes in WSN is much larger than any of traditional wireless networks. A major difference between WSN and other traditional networks computing devices including PC's, PDA's and other embedded devices is that in WSN main emphasize is on power management. WSN is a data centric approach but traditional wireless networks are address centric because of large number of nodes in WSN. Sensor nodes are much cheaper than nodes in other wireless networks. WSN uses broadcast communication approach but traditional wireless networks use point-to-point communication. Traditional wireless network like Mobile Ad hoc Networks are designed for distributed computing while WSN are designed to gather information. A unique characteristic of WSN is that data collected by adjacent nodes and some

consecutive readings sensed by sensors are highly correlated which gives opportunity to develop efficient protocols. 802.11-like MAC in traditional wireless networks consumes two to six times more energy than S-MAC for traffic load with messages sent every 1–10 s (Fig. 1).

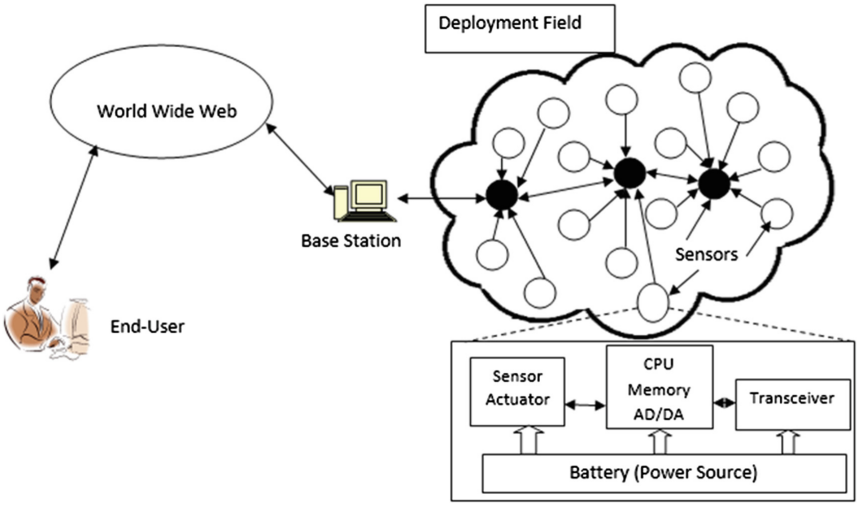

Fig. 1. WSN architecture.

In basic architecture of WSN, in sensor unit data gathering and processing operations are completed. All the important and useful data are transmitted to the base station. Transceiver unit is responsible for the reception of the instruction from the base station and to transmit the gathered data to the base station. Power source is the backbone of any device and as in WSN sensor nodes are deployed in an open environment, it is really tough to replace or provide a continuous power supply. There are many solutions to this problem provided in literature like solar power etc. but still the power sources used in sensor nodes are batteries. Analog to digital Converter (ADC), microcontrollers used in WSN, understands binary and some of the analog sensors are used whose outputs are analog and this output needs to be converted to the digital signals. In sensor node GPS is placed which helps to find the location for randomly deployed sensor nodes [4]. Most of the sensor nodes are common to all applications like temperature sensors, humidity sensor etc. otherwise, sensors can be designed according to application requirements. In this chapter sensors available for smart agriculture or used in smart agriculture will be studied. Also, various techniques used in smart agriculture, issues and challenges present in smart agriculture will be discussed.

1.2 Internet of Things (IoT)

Internet of things is a technology which connect physical electronic devices through internet. These devices are capable in gathering and exchanging data (information) over

a network as these devices are equipped with unique addressing. IoT is based on embedded system technology as it contains both hardware and software, this allows IoT devices to communicate in both the states (inside and outside environment). IoT is based on three layers system, which are sensing (perception layer), network layer (MAC & Routing) for the data transfer, and application layer related with the output [5, 6]. Internet is used as human to human communication whereas IoT is internet for machine to machine communication. IoT may be used in abundance of applications which includes smart cities, smart buildings, agriculture, defense and healthcare etc. (Fig. 2).

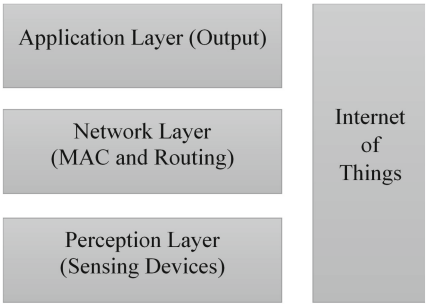

Fig. 2. Architecture of IoT systems.

Smart agriculture is one of the most potential area of research and almost whole world is getting influenced by the applications of WSN and IoT solutions for it. These solutions include precision equipment, geo-positioning, actuators, sensors, UAV's (drones), robotics and automation etc. [7, 8]. IoT offers so many options for smart farming like useful data collection regarding crops and soil, crop control and automatic farming methods. As the sensors used in are capable of providing useful information to the farmers regarding their crops yield process, moisture level, soil nutrition, pest infestation and information regarding above said parameters can be very useful for the farmer to increase his productivity (Fig. 3).

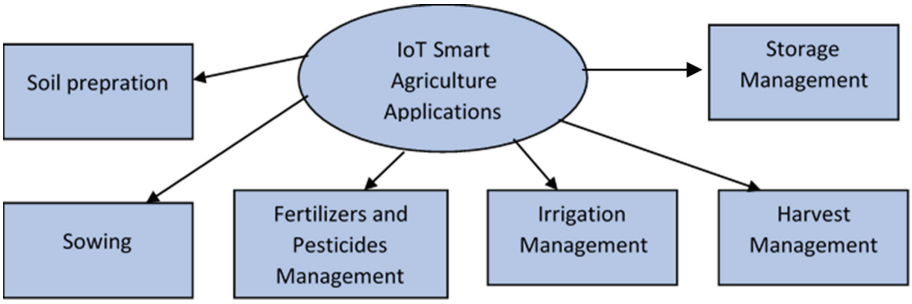

Fig. 3. IoT applications in agriculture industry.

2 Literature Study Process

Most of the papers included in this chapter are from last five years, until unless it seems to be important to include some of oldest papers. The research questions are designed, and the relevant research works are referred accordingly.

2.1 Research Questions

The chapter's main focus is to provide answers to the questions related to use of WSN in smart agriculture. Major research questions that will be answered in this review are:

RQ1. What are the possibilities to use WSN and IoT in agriculture?

RQ2. What are newly developed sensors to be used for making smart agriculture a revolution?

RQ3. What are various issues and challenges researchers may face, when they are working with WSN in agriculture?

2.2 Information Source

Due to wide scope of this book, it was suggested that, different research databases can be extracted for existing work on smart agriculture with WSN. So, in this chapter mainly five databases are considered in searching, to generate the state of the art in use of WSN and IoT with agriculture. These databases are

1. IEEE Xplore (www.ieeexplore.ieee.org)
2. ACM digital library (dl.acm.org)
3. Science direct (www.sciencedirect.com)
4. Google Scholar (www.scholar.google.com)
5. Springer (www.springer.com)
6. Taylor & Francis Online (https://tandfonline.com/)

The papers considered for the review in this chapter are only from high impact research journals and conferences. These articles are indexed in SCI, Scopus and Web of Sciences databases. The searching keywords were related to sensors, WSN, IoT, Precision agriculture, Smart agriculture, Crop management, soil management, monitoring crops, irrigation control and other related words.

3 Review of Literature

This article is concerned about the research in smart agriculture using sensors and IoT, published in reputed journals during last five years. The literature survey includes crop monitoring research, sensors to be used in smart agriculture and communication technologies for smart agriculture. These categories of literature are summarized in upcoming subsections.

3.1 Crop Management with WSN

Agriculture is the backbone for the humans as it is one of the main sources of food. Agriculture has a great role in the growth of countries' economy. This field offers a huge amount of employment for the people. So, the growth in production of agriculture products is also very important. Traditional methods are still in use and are not so much effective in the productivity of the agriculture output [9]. In order to address all the issues in agriculture it is necessary to introduce automation with the help of WSN and IoT. The table below present some the recent research on crop monitoring technologies using WSN and IoT [10]. In the following table the findings of authors from last five year in the area of crop monitoring are discussed. The papers discussed in the following table are from reputed databases only and also only last three years are considered for this review (Table 1).

Table 1. Crop monitoring research during last three years (2017–2019)

Sr. No.	Title	Author	Year	Crops	Findings
1	IoT based smart crop-field monitoring and automation irrigation system [11]	R. Nageswara Rao, B. Sridhar	2018		Irrigation system is developed with low complex circuit. Temperature sensor and moisture sensor is used in the development. This type of sensor nodes can be very useful in the field to monitor crops and will be able to keep a check on the irrigation of the specific crop which will help in the overall production of the crops
2	Effective Utilization of IoT for Low-cost Crop Monitoring and Automation [12]	Petcharat Suriyachai, Jakkapong Pansit	2018		Authors have developed an IoT-based device for the monitoring crops as well as for the automation also. Low cost sensor node has been used and clustered wireless sensor network is created to collect the data

(*continued*)

Table 1. (*continued*)

Sr. No.	Title	Author	Year	Crops	Findings
					with the help of IoT cloud-based platform. Moreover, authors have also provided a weather API to provide the weather forecast, if the system receive the notification regarding the rain possibility, the system will avoid all its schedules to water the plants. AA Batteries are used in the sensor node if the sensor nodes batteries are low a line message will be sent to the user to change the or replace the batteries. Google API will help in to find the location of the sensor node
3	IOT Based Crop-Field Monitoring and Irrigation Automation [13]	P. Rajalakshmi, S. Devi Mahalakshmi	2017		Researchers have designed and implemented an automatic system for irrigation and this system reduced the water consumption to a greater extent used in this research paper. Authors claimed it a cost effective and beneficial. This system is useful for green houses. Authors are currently working

(*continued*)

Table 1. (*continued*)

Sr. No.	Title	Author	Year	Crops	Findings
					on Data mining algorithms for the predictions of crop water requirements
4	Agro-tech: a digital model for monitoring soil and crops using Internet of things (iot) [14]	Mr. O. Pandithurai, S. Aishwarya, B. Aparna, K. Kavitha	2017		In this paper authors claimed that their embedded hardware kit & software will work as a helping hand to the farmers. Their system can detect the soil and crop parameters and the data will be transferred with the help of the IoT to the software which AGRO-TECH on the basis of the data sensed by the soil sensor irrigation system will start and stop its working. This system generates weekly reports and gsm-based system will inform user if in any case a emergency situation occurs
5	IoT enabled Plant Sensing Systems for Small and Large Scale Automated Horticultural Monitoring [15]	Sherjeel Khan, Muhammad Mustafa Hussain	2019	Barley Plant, Lucky Bamboo	In this paper authors have shown high performing sensor which is lightweight platform that can be placed on a plant leaf to monitor the surrounding climate around the plant Furthermore they have demonstrated a strain sensor fabricated Used to check the growth of

(*continued*)

Table 1. (*continued*)

Sr. No.	Title	Author	Year	Crops	Findings
					the plant growth can be checked in micrometers. This system can be used for a large area as authors have demonstrated in this paper they have also developed a drone made up of flexible sensors Wings of the drone what made up of biodegradable paper to soften the landing of the drones Light humidity and heat sensors are mounted on the drones to monitor the growth of the crop
6	A Novel Framework for Smart Crop Monitoring Using Internet of Things (IOT) [16]	Kamal Kumar Ghanshala, Rahul Chauhan, R.C. Joshi	2018		Authors have proposed a 4 level framework For crop monitoring the proposed system is based on soil nutrients and IoT devices. Edge computing and cloud computing techniques were used as these can be accessible to monitor the stored data from anywhere. Whole system is designed to achieve the proper utilization of fertilizers in an effective manner to achieve the high yield from the fields

(*continued*)

Table 1. (*continued*)

Sr. No.	Title	Author	Year	Crops	Findings
7	Agricultural Crop Monitoring using IOT- A Study [17]	Dr. D. K. Sreekantha, A. M. Kavya	2017		According to the authors IoT has enabled user to monitor their crops, due to which farmers are able to increase their productivity and hence their profits are also increased. Sensor of different type are used to monitor crops and collect important information
8	Rice Crop Monitoring System - A IoT Based Machine Vision Approach [18]	P. Tanmayee	2017	Rice	In this paper author have done their research by collecting periodic images of the crops. The system developed by the authors, help farmers to reduce the need of pesticides it also reduces the human interface. The system is able to detect the disease in early stage but as the system is on wireless some time delay may occur

3.2 Sensors Used in Smart Agriculture

Sensors/Sensor nodes are compact in size, cheap and easily available. A sensor node mainly consists a microcontroller, transceiver, power source, memory, ADC (analog-to-digital converter) and finally one or more sensors [36]. The microcontroller is the brain of the sensor node which processes all of the data gathered and also controls the functionality of all components mounted on the node. The transceiver transmits the collected data as well as receives the data to and fro from the base station or control

section using wireless transmission media like RF (radio frequency), optical communication (laser) and infrared. Sensor nodes produce a measurable response to any physical change that occurs around them. Conditions like temperature, humidity, pressure etc. can be detected by the sensors easily. Following table presents the details about sensors used in various research papers during last five years. From the table one can know the possibility of using sensor nodes and type of microcontrollers in smart agriculture applications (Table 2).

Table 2. Sensors used in research on smart agriculture during last five years (2015–2019).

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
1	Acquisition and Mining of Agricultural Data Using Ubiquitous Sensors with Internet of Things [19]	M. R. Suma, P. Madhumathy	2018	DHT11, Standard Soil Sensor	ATMEL ATmega328P, Raspberry Pi3	The system was successfully developed and executed in targeted area. Major hardware used to create the system are like Arduino, Raspberry Pi 3 model software's used are Django Web Framework, for communication purposes standard 433 MHz RF link is used. Authors have noticed major problem in communication system the mode they have used is half duplex communication mode. They have suggested that with the proper hardware these problems can be reduced, however they are satisfied that by having these problems they have successfully implemented the

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						system and achieved results
2	IOT Based Smart Agriculture System [20]	G. Sushanth, S. Sujatha	2018	LM35 Temp, humidity, moisture and motion sensor	Arduino Uno R3, ESP8266 Node MCU, GSM Module	Hardware used the authors to develop system are Arduino UNO R3, ESP8266 Node MCU, GSM Module, capacitive soil sensor LM35 temperature sensor, Humidity sensor, Motion sensor, after collecting all the desired information from the sensor it is transmitted to the IoT gateway, farmer will get notified through a SMS and the decision logic unit will decide the necessary action to be taken according to the data collected by the sensors and sent to the cloud web server and maintained in a database
3	Secure smart agriculture monitoring technique through isolation [21]	George Suciu, Cristiana-Ioana Istrate, Maria-Cristina Dițu	2019	Rain Gauge, Wind Speed and Direction, Temperature and Humidity, Pyranometer, Leaf Wetness	Raspberry Pi 3B+	In the proposed system farmers can get various information mainly regarding crop, soil and weather to monitor their crops. With the help of specific algorithms

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						developed using python data sent to the cloud platform will be analyzed. Processed results will be sent back to the farmers to improve the agricultural process. This system will allow farmers to remotely access the irrigation system to their fields. Moreover, same device can be used to disaster management also. ADCON RTU is used for the transmission proposes
4	Smart Farming – IoT in Agriculture [22]	Rahul Dagar, Subhranil Som, Sunil Kumar Khatri	2018	Water Volume Sensor, Soil pH sensor, Soil Moisture Sensor, Air Temperature Sensor, Motion detector Sensor	ESP8266 Node MCU	IoT has so many useful applications in different domains of agriculture. In the proposed system authors provided a solution for the problems like wastage of water and electricity. Water flow sensor is used to control the irrigation to the fields moreover, the flow of the water can also be measured. Other issue they

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Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						have addressed is insecticide, fertilizers and pesticides. In this paper authors have proposed greenhouse so they have claimed that use of greenhouse will reduce the outer interference of the insects and as they are using soil sensor, pH sensor all information is stored to a cloud which can further enhance the decision making power on the basis of data collected by the sensors
5	Design of IoT Blockchain Based Smart Agriculture for Enlightening Safety and Security [23]	M. Shyamala Devi, R. Suguna, Aparna Shashikant Joshi, Rupali Amit Bagate	2019	Temperature Sensor, Pressure Sensor, Illuminance Control, Wind speed, Air Control CO2, Pressure Control, Pollution Control Moisture Water Control, Smoke, Fire Control, PH Control Node		New architectural framework is introduced which is claimed to increase the performance of security and data transparency. Furthermore, authors are trying to enhance architecture to predict the performance of the parameters
6	Sensing and Visualization in Agriculture with Affordable	Takashi Okayasu, Andri Prima Nugroho, Daisaku Arita, Takashi	2017	SHT71 Sensirion Temperature humidity sensor, Solar radiation	Arduino Ethernet, Raspberry Pi	Several ICT systems related to sensing, visualizing and analysing for the

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
	Smart Devices [24]	Yoshinaga, Yoshiki Hashimoto, and Rin-ichiro Tachiguchi		sensor BH1603FVC, Soil moisture content sensor WD-3-W-5E, Night Vision Camera		advancement of agriculture has been introduced. System can make decision according to the farmers need according to the valuable information stored in SD Card. These developments can be improved according to farmers need, environmental factors and situations
7	Smart Irrigation: Towards Next Generation Agriculture [25]	A. Rabadiya Kinjal, B. Shivangi Patel and C. Chintan Bhatt	2017	Soil moisture sensor HL-01, HL-69	Node MCU	Proposed system is utilized when analysis of used water and irrigation cycle is required. According to the experimental results farmer can easily take decision to water his fields in a season
8	Low Cost Weather Station for Climate-Smart Agriculture [26]	Sonam Tenzin, Satetha Siyang, Theerapat Pobkrut, Teerakiat Kerdcharoen	2017	4 Cloud-based stations and 1 Davis Vantage Pro2	PIC24FJ64, Raspberry Pi	Authors have designed and installed the low-cost reliable microclimate weather station called Cloud-based station. Comparison has been made in between two installed weather stations which are cloud based stations and Davis vantage pro2 on the basis

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						of their study they have shown that cloud based weather station is equivalently efficient to measure parameters like air temperature, relative humidity and wind direction in the end they have stated that cloud based weathers station will be more preferable on the basis of its cost
9	AgriSys: A Smart and Ubiquitous Controlled-Environment Agriculture System [27]	Aalaa Abdullah, Shahad Al Enazi and Issam Damaj	2016	Temperature, humidity, pH, soil moisture and thermocouple	Fuzzy Controller MIMO. Simulation on LabVIEW	Researchers have done Simulation using LabVIEW and proposed a system "AgriSys" The system has an easy-to-upgrade bank of inference rules to control the agricultural environment. Systems working is based on the input of several sensors like temperature, humidity & pH. The system provides high increase in the productivity
10	Smart Drip Irrigation System for sustainable Agriculture [28]	Kavianand G, Nivas V M, Kiruthika R, Lalitha S	2016	Temperature, humidity, moisture, soil pH and soil nitrogen sensor	ARM 9 Processor	The aim kept in mind by the authors is to design a fully automatic drip irrigation system

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						using ARM microcontroller and GSM. Their system provides R-T feedback which is helpful in controlling the activities of the irrigation system effectively. Depending upon the moisture content system will automatically turn on and off. The system will provide the required information regarding th pH content of the soil moreover, they have used a soil nitrogen level sensor this will provide farmers information regarding the nitrogen level of the soil
11	A Model for Smart Agriculture Using IoT [29]	Prof. K. A. Patil, Prof. N. R. Kale	2016	Temperature and Relative Humidity, Light Intensity, Barometric Pressure, Proximity sensing and Buzzer Ubi-Sense mote (M)	WINGZ	In this paper a system is proposed which is agricultural model in integration with ICT. By using the proposed approach, received updated information allows the ranchers to receive the useful information

(*continued*)

Table 2. (*continued*)

Sr. No.	Title	Author	Year	Sensors Used	Microcontroller	Findings
						regarding weather, temperature, humidity, pressure
12	A Smart M2M Deployment to Control the Agriculture Irrigation [30]	Alberto Reche, Sandra Sendra, Juan R. Díaz, and Jaime Lloret	2015	Soil moisture sensor (VH400), soil temperature sensor (THERM200)	Arduino Board	A real deployment of a smart M2M system is done in this paper to have control on the agriculture irrigation, humidity and temperature Sensor are used as a function of the weather parameters and based on the smart algorithm developed by the authors, the system takes decision which one of the sprinkler should be enabled on and which one should be turned off. The system developed by the researchers from this paper allows ranchers to water their crops more effectively and reduces the water wastage

3.3 Potential Area of Applications of WSN and IoT in Agriculture

IoT basic component description is provided in Sect. 2 and it uncovers its extraordinary capacity of dealing with the applications of the agriculture and ongoing patterns of the PA (precision agriculture). Developed IoT devices are of low cost and tiny in size along with daily advancements in sensor technology has contributed in a great manner toward agriculture field [31]. Various types of sensors like radiation, pressure, wind, climate

stations, climate sensors, temperature & humidity sensors gives stress to the point that it is all about sensor and sensor information streams, which are deployed to the open environment for observations, sensing, thinking, learning mining, and controlling the devices according to the need. Additionally, recently, there is a growing enthusiasm for high gauge and safe rustic things. This example has yielded the prerequisite for interoperable, flowed, solid, and exact co-appointments conspicuousness structures. The IoT gathering of headways gives all the correct gadgets to building and keeping up such structure and organizations, uncommonly expected to help supply chains in cultivating and floricultural regions [32]. Wired and wireless sensor have been utilized for the agricultural applications in recent decade. Recognizing the earth wherein age occurs, and, even more starting late, the responses of the plants to the air is huge for taking the privilege and continuously accurate decisions, redesigning productivity and nature of the cultivars. The standard WSN have starting late progressed to IoT welcoming Wireless sensor frameworks, by grasping progressively ordinary measures with respect to correspondence, empowering remote access to the web and realizing wise counts for meta-treatment of the data significance to improve checking or conceivably control. Adaptable devices, with high computational limits, favorable structure factor and simplicity, would these days have the option to be used, on batteries, and work for huge parcels, with or without the assistance of force gathering modules. Likewise, at present introduced devices have sufficient resources for help all the more mentioning sensors, for instance, picture sensors, and the assistance of continuously propelled frameworks organization shows, such TCP/IP, growing the standard WSN arranging capacities. A terrible portrayal of composing on checking and control could be Monitoring and, at times, creation of early cautions, by methods for streamlined rules. This fuses multi-point checking for getting and immersing climatic slants in nursery advancement [33] Detecting is of high centrality in agriculture. WSNs have been commonly used in air and soil checking associations both in open field and in controlled condition cultivation. Controlled condition agribusiness Greenhouses have been seemed to show colossal climate vacillation, which impacts the proficiency of the plants. Nursery improvement is dynamically outrageous, in like manner, when in doubt, it requires higher exactness to the extent watching and control a few assessments have concentrated just on confined and remote checking. A great part of the time, data is taken care of and addressed in various graphical ways [32]. Despite the high-exactness checking, there have been studies presenting structures which circuit meta-getting ready strategies with data proceeded onward remote establishments through the web. Utilizing outstandingly surveyed conditions, yield and climate models, such structures produce assessments of the environment just as reap status all together for the cultivator to settle on better decisions or get early alarms [33].

3.4 Challenges in Smart Agriculture

Adoption, utility and applications [34] of WSN and IoT in agriculture is not without multitude of challenges and the requirement of addressing difficult research problems. Some of the challenges researchers may face during their research in smart agriculture are discussed in following subsections. These challenges may also act as future perspective for research in precision agriculture using WSN and IoT.

3.4.1 Data Analysis

Data science becomes the most important and popular field of research in computer science. Data analysis is very important in almost all of the applications of WSN and IoT. The decision made by the users, while applying WSN to certain applications, depend on the data collected by the sensors. The challenges in smart agriculture also include this problem [37]. The issue impose problem of integration of sensor nodes to analytic application which can further make decisions or drive automation activities. If integration is successful than it will be cost effective for the farmers and may contribute to increase the production.

3.4.2 Hardware Systems

WSN and IoT in smart agriculture faces many difficulties. The foremost problem is living the hardware in the open environment and expect it to work in harsh environmental conditions also. These harsh conditions may harm the normal embedded systems which expose it's electronic components to the open conditions like high sunlight based radiation, outrageous temperatures, downpour or high dampness, solid breezes, vibrations and different risk. These conditions may damage the electronic circuits inside the devices [38]. The end-gadget ought to stay dynamic and limit trustworthy for huge misfortunes relying upon the compelled influence resources of batteries. Along these lines, appropriate programming instruments and low-control capacities are required, since the progressive battery substitution or reset of the stations, for example in a large-scale open field course of action, isn't straightforward.

3.4.3 Security Issues

Like any other industry, ranchers need to think about security and safety of the technology used by him in proper manner. The PA concept brings the agribusiness into the risk of data theft and hacking. Moreover, ranchers do not have proper knowledge of data protection in this field [39]. Developers of IoT devices uses IoT devices to collect the information and data analysis to make agriculture practices more efficient. However, ranchers are still using traditional methods for agriculture which do not have data security concept.

3.4.4 Networking Challenges

Odd situations of the nature offer great difficulties to the equipment, and to the system layer. Remote communication is used in the field of agriculture to overcome the cost of the wires which are used in wired devices [40]. Nature is known to be one of the fundamental contemplations which lead to low remote association quality, through the multi-way multiplication effects and its promise to establishment uproar Real-world game plans, has shown that the presentation of standard handsets is affected by temperature sogginess human closeness and various preventions inside the space in which a remote center point attempts to pass on. According to this information collected by the sensor can be transferred with the utilizations of the powerful and dependable enhancement done in technological development as per the challenges and requirement of the rustic conditions [35].

Despite of above challenges nowadays, many manufacturers of farm gadgets provides complete solutions in integration with IoT devices. In their business it plays vital

role. As these Precision agriculture solutions provides ranchers a huge set of data to enhance their farming and knowledge by gathering real-time data. As these devices are this much important these devices should have capabilities for data storage, security, deep analytics and device management on the data received from the remote sensing techniques, on-field deployed sensors and images from drones. This will generate data to educate farmers and scientist with capabilities of better decision-making.

4 Conclusions

Internet of things involving agricultural machinery, can be utilized to manage standard farming fields, whereas ranchers still needs to play the role of both scientist and the person to keep an eye for unforeseen situations. Farmers can feel relaxed by investing in digitalization treatment of the plant diseases and monitoring the livestock. New ITC devices can be useful in tackling crop diseases and pest controls. As there is a lack of knowledge about these ITC devices in farmers. Agriculture industries still needs to convince ranchers towards the benefits of these technological advancements of IoTs. Internet of Things provides farmers a platform to exchange information and establish connections and cooperation's. This can further be important that they may develop an informal communication system which can play a vital role in advancing the formal communication system.

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