E-ISSN: 2583-9667
Indexed Journal
Peer Reviewed Journal
https://multiresearchjournal.theviews.in

Received: 11-04-2023
Accepted: 19-06-2023
Published: 15-07-2023

INTERNATIONAL JOURNAL OF ADVANCE RESEARCH IN MULTIDISCIPLINARY

Volume 1; Issue 1; 2023; Page No. 1029-1034

Design of IoT Based Wireless Sensor Network for Agriculture Field

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DOI: https://doi.org/10.5281/zenodo.19344741

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Abstract

The development of a wireless sensor network Technology for precision agriculture as part of the Internet of Things (IOT) and real time application to track environmental conditions. Wireless Sensor Networks (WSNs) such as TSL2561, DS18B20, XBee and ESP8266-01 are regarded as an excellent technology for gathering and processing information in the agricultural area such as environmental parameters (temperature moisture, PH, humidity and light intensity) with cheap cost and low energy consumption among the numerous technologies for agriculture monitoring. WSN is able to provide field data that has been processed in real time from sensors that are physically dispersed across the field. One of the sectors that has recently focused on WSNs is agriculture and farming, which is searching for this financially crucial innovation to update agribusiness yield standards and boost productivity. In recent years, Wireless Sensor Networks (WSNs) have attracted a lot of attention.

Keywords: Agriculture, Environmental, Wireless Sensor Network (WSN), Wireless Sensor Network (WSN)

Introduction

The country's economy depends heavily on agriculture, which also provides a significant number of jobs for the populace. However, weather and climate have a significant impact on agriculture. Low crop yields, for instance, may be caused by variations in temperature, humidity, soil moisture, and carbon dioxide. Monitoring environmental factors is essential to controlling crop growth and raising agricultural output yield. Sensing data is crucial for decision-making as well as for assessing how agricultural practises affect the environment.

Environmental monitoring research using wireless sensor networks (WSNs) has recently expanded in scope. In order to give efficient and financially feasible solutions for a variety of applications, including health monitoring, agricultural, environmental monitoring, and military operations, the Wireless Sensor Network (WSN) is the best option. WSN is a cutting-edge invention that synchronises sensor data, automation control, digital network transmission, information storage, and information processing. The WSN market is predicted to grow from $0.45 billion in 2012 to $2 billion in 2022.

Additionally, agriculture will benefit far more than previously from the development of Internet of Things (IOT) technology, notably sensor technologies and cloud services. Small sensor development, data storage, and transmission are now possible because to recent technology advancements, which provide benefits in terms of cost, size, power, and adaptability.

We are recommending a low-cost WSN device that can measure several environmental factors including temperature and air and soil humidity as a result of these benefits. In the next section, we will discuss the fundamental parts of the systems. Then, in the parts that follow, we show the software design. Here, a wireless farm monitoring system for environmental sensing is the method used.

The system can accommodate several nodes concurrently. The results of this research will be used to introduce a point-to-point network with an expandable node count at this time. The content of the paper is organised as follows: the effects of technology on wireless sensor networks and the internet of things. With the advent of radio networking and electronic development in recent years, the history of telecommunications has shown the protocol overview of the network and the benefits and drawbacks of each kind of technology in relation to the intended use. The choice of communication protocols and how they will directly affect this project will be explained in the last portion of this chapter. The OSI model will be followed by the index order.

choosing equipment and technology for implementation monitoring. The electrical properties of the components, general device information, and manufacturer recommendations are the important factors to take into account while building a wireless sensor network.

Wireless Sensor Networks helps the farmers to change the traditional agriculture to modern agriculture. WSN helps the farmers in different aspects. Wireless Sensor Networks use distributed sensors to gather the information and transmit the gathered information using wireless networks. In WSN micro sensors are used and global positioning system (GPS) is used in the sensors to find the exact location. It is mainly used to monitor the environmental changes as well as climatic change, temperature, humidity, soil test. Sensor networks are very small, cheap and can be used even in rural areas. Wireless Sensor Networks use three types of topologies. They are star, cluster tree, mesh and by using these topologies connection can be done. WSN use some components like battery, radio, microcontroller, analog circuit and sensor interface.

Crops must be developed with low cost and with less time this helps the farmer to earn high profit. Using WSN the human effort can be reduced in agriculture. Agriculture is basic of life for all the human for the food and other raw materials. Agriculture is main source for growth of economy. Many uneducated people get employment in agriculture. Unfortunately, farmers use traditional method which reduce the yield of growth. But when the automatic system is implemented in agriculture, it used to increase the yield of crop. The most of the paper use Wireless sensor network to collect the data of farm land using sensors and sent it to server using some wireless protocols.

Literature Survey

Mohammad Samunul Islam, Golap Kanti Dey *et al.* [2019] [1] Although economy of the 21st century is exceedingly reliable on industrialization, agriculture works as an unavoidable driving force for economic growth of the country like Bangladesh where advancement of wireless technologies, computational techniques and system engineering have rendered new opportunities to promote our existing agricultural system. This paper work depicts the design and implementation of a solar energy based precision agriculture (PA) with wireless sensory network (WSN) via Internet of Things (IOT) architecture to meet the demand of finding highly efficient methods for smart agricultural monitoring and management system. Our proposed system will provide valuable data about salt water intrusion, soil moisture, water level, humidity, temperature as well as the general condition of the crop field to the farmers in a user friendly, easily accessible manner with real time data communication via IOT. We can monitor the crop field conditions by using smartphone and will be able to take the necessary steps remotely on the basis of present conditions.

Tanmay Baranwal, Nitika Pushpendra, Kumar Pateriya *et al.* [2016] [2] described by the agriculture sector being the backbone of the Indian economy deserves security. Security not in terms of resources only but also agricultural products needs security and protection at very initial stage, like protection from attacks of rodents or insects, in fields or grain stores. Such challenges should also be taken into consideration. Security systems which are being used now days are not smart enough to provide real time notification after sensing the problem. The integration of traditional methodology with latest technologies as Internet of Things and Wireless Sensor Networks can lead to agricultural modernization. Keeping this scenario in our mind we have designed, tested and analyzed an 'Internet of Things' based device which is capable of analysing the sensed information and then transmitting it to the user. This device can be controlled and monitored from remote location and it can be implemented in agricultural fields, grain stores and cold stores for security purpose. This paper is oriented to accentuate the methods to solve such problems like identification of rodents, threats to crops and delivering real time notification based on information analysis and processing without human intervention. In this device, mentioned sensors and electronic devices are integrated using Python scripts. Based on attempted test cases, we were able to achieve success in 84.8% test cases. Index Terms-Internet of Things (IOT); Agriculture; Security; Raspberry Pi; Sensors; Wireless Sensor Network

Priyanka Kanupuru N.V. Uma Reddy *et al.* [2018] [3] analysis of Internet of Things has a major part in utilization of advanced technologies for better management of agricultural requirements. Man power and changing environmental conditions are considered to be the major issues in present day agriculture. The traditional methods employed in the cultivation has to be modified in order to meet the present day demand for agricultural products. Therefore the agricultural automation is required, which can be achieved using Wireless Sensor Network and Internet of Things. This paper summarizes the existing smart systems with Wireless Sensor Network based sensor monitoring techniques by considering environmental parameters such as temperature, moisture, PH, humidity, light intensity which are very useful in efficient decision making for yielding high productivity. This survey also helps in understanding the recent technological developments in Internet of Things for building an efficient smart agricultural system.

P.Lavanya & Sudha *et al.* [2018] [4] Wireless sensor network (WSN) are most widely used in many applications because of its wide range. The IOT based WSN are designed through IOT protocols for the purpose of multi-hop transmission, collision-free transmission, and high energy efficiency. Today the world deal with major problem in agriculture. The challenges of agriculture get increased day by day and the cultivation and yielding of crops pays an biggest issues for a farmer. In order to overcome all these impacts of agriculture we had proposed with a system called IOT based WSN which includes of Sick sensor and weather sensors. In this paper, we briefly study about wireless sensor network and internet of things and its protocols. The detail description of wireless sensor network includes its architecture, applications, etc. The internet of things has defined architecture and protocols with its related applications. With the help of internet the sensor can pass its collected information to its users.

Devi Kala Rathinam. D. Surendran D Shilpa. *et al.* [2019] [9] studies of Agriculture is the back bone of India and nearly 70% of people in our country depend on agriculture. The yield of agriculture should be increased rapidly to fulfil the food requirements of population throughout the world. Now days Wireless Sensor Network (WSN) used for solving

many real time problems. WSN plays vital role in many field like transport, medical, military, mobile phones, home appliances and so on. Agriculture is one of the important sources for all living things. But nowadays agriculture crops are affected due to many environmental changes. To overcome this WSN takes important role in the field of agriculture. In agriculture WSN used for monitoring, measuring temperature, irrigation system, measuring water supply and so on. WSN helps the farmer to produce the crop with high quantity and reduce the cost of yield. Agriculture gets affected by climatic change, environmental change, and natural disaster. Using WSN the soil and water management can be done. Here wireless sensors are used so the cost of implementation is very low. In this paper wireless sensor nodes are used to monitor the crops. The temperature, humidity and some other theft detection can be made using sensors. This helps to increase the productivity of agriculture. The human effort is reduced by automatic process and it encourage the farmer to develop the farm land. The location of the farm land can be send using GPS. Some components like sensor, Wi-Fi.

Design of IoT Based Wireless Sensor Network for Agriculture Field

In this chapter we are going to explain about Design of the solution. Using the network protocol 6LoWPAN the selection of the element in chapter 2 will be used to develop the network over IPv6. The border router will be implemented with the raspberry pi 3 B, this element's main objective on the network is to establish a gateway for exchanging information from the IPv6 to IPv4.

Hardware Component

Within this section will be introduced and discussed within depth the physical devices used in the project. To fully understand its limitations and implications when implementing the network design in a scenario of real-world testing.

Zolertia Re-Mote

The Remote is a low-power wireless module designed to assist WSN developers in testing and deploying their own applications and prototypes with the best interaction between development time and flexibility in hardware. Zolertia Re-mote is shown in figure 1.

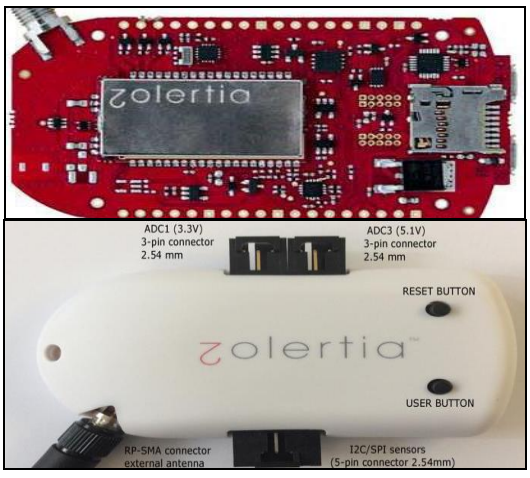

Fig 1: Zolertia Re-Mote and some of its features

The platform is based in the Texas Instruments CC2538 ARM Cortex-M3 system on chip (SoC), with an on-board 2.4 GHz IEEE 802.15.4 RF interface, running at up to 32 MHz with 512 KB of programmable flash and 32 KB of RAM, bundled with a Texas Instruments CC1200 868/915 MHz RF transceiver to allow dual band operation.

Temperature and Humidity Sensor (DHT22)

DHT22 Sensor is chosen for temperature and humidity measurement. It uses a capacitive humidity sensor and a thermistor to measure the surround in gair and spits out a digital signal on the data pin (no analog input pins needed). Simply connect the first pin to 3-5V power on the left, the second pin to your data input pin and the pin to the ground on the right. While using a single wire to senddata, it is not compatible with Dallas One Wire. DHT22 sensor and Pins shown in figure 2.

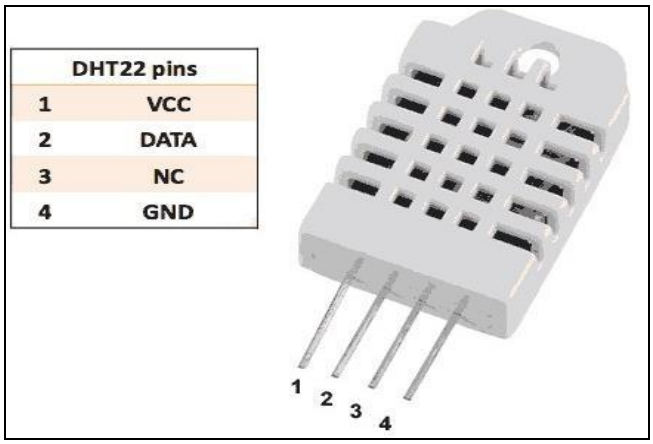

Fig 2: DHT22 Sensor and Pins

Raspberry PI

Raspberry Pi (RPI) is a single board computer (SBC) built by the Raspberry Pi Foundation in the United Kingdom. The Raspberry Pi is a very Inexpensive computer that runs Linux, but it also includes a series of GPIO (General purpose input / output) pins allowing you to monitor physical computing electronic components and explore the Internet of Things (IOT). There are some commercial models of Raspberry Pi, the model used in this Project is Raspberry Pi 3B (figure 3.) installed with Raspbian.

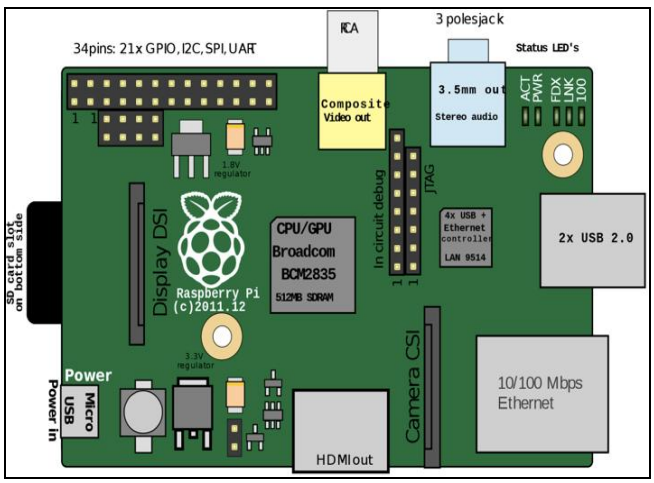

Fig 3: Raspberry Pi 3B and some of its features

Design and Results

In IOT Based irrigation system it executes overall task into multiple steps. When we run this system, it shows two different modes- the mode number is 1 and 2. If we press 1, then the system will work manually. So, the system can control manually where we can turn motor switch on and off by using android device. When we press 2, then the system will be working automatically by analyzing WSN values. If the crop field needs irrigation, then the motor will be start automatically. When water fulfils the field condition then the motor will be automatically off. Each and every step of the proposed smart PA based monitoring system is monitored and can be managed by using android phone. However, another great significance of the auto mode is that when the proposed system finds any salt water intrusion in the crop field then salinity sensor detects it and send a comment to the system to off this motor because salty water is very harmful for plant. The system can print current status of the crops field continuously.

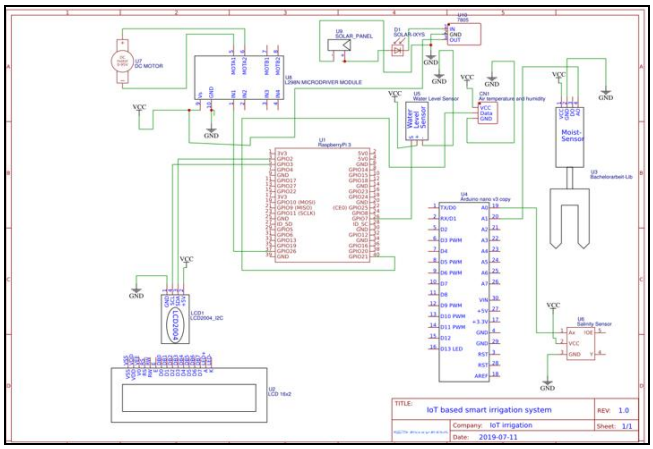

Fig 4: IOT Based WSN Model for Agriculture Field

The monitoring method is more flexible and recognizable than conventional methods. This will improve the agricultural production and efficiency of environmental parameters measurement through WSN technologies. We tried to provide proper soil nutrient, irrigation water and pesticides and fertilizers

Also implementing our system user getting economic benefit, optimized water usage as well as agriculture inputs.

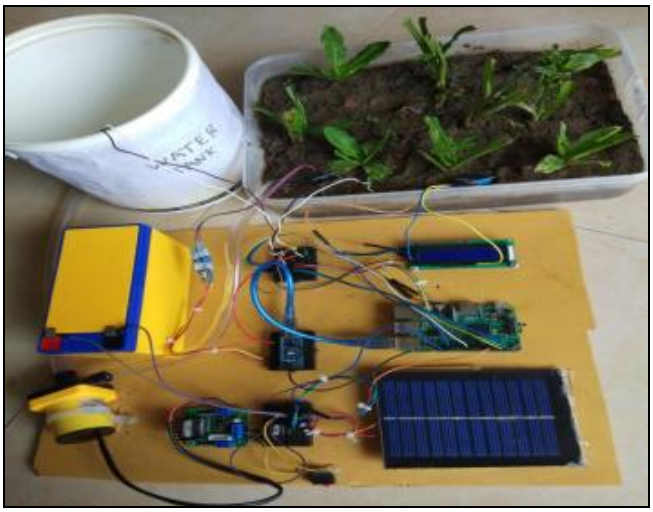

Fig 5: Experimental Setup of IOT Based WSN for Agriculture Field

Figure 5. Experimental deployment of WSN Based Smart crop field monitoring system Cloud computing makes the access to data as well as storage more easy. To be precise the future work in this as include IOT for additional automation.

Results

Our Experimental set up of IOT based WSN sensor for field of Agriculture has been successfully implemented and the setup has been examined for shorter version as well as in real life applications.

We have used our Experimental setup on the various districts of Bihar & we have the analysis the humidity, soil moisture & salinity with temperature.

North Eastern Part (City-kahara, District-Sahara, State: - Bihar, Country-India) (Experiment carried out on 05thJanuary to 31st January 2022) where we had environmental temperature reading, soil temperature, humidity, soil moisture and salinity value.

Table 1: North Eastern Part (City-Kahara, District-Saharsa, State: - Bihar, Country-India) (Experiment carried out on 05thJanuary to 31stJanuary 2022)

Date	Temperature in Celsius (°C)	Time	Relative humidity (%)	soil moisture (mV)	Salinity value for normal water (%)	Salinity value for salty water (%)
05\01\2022	18	10:05	73	997	37	88
11\01\2022	20	13:00	72	992	38	90
18\01\2022	25	14:35	72.5	998	36	91
21\01\2022	26	16:07	73.5	981	35	87
25\01\2022	27	8:05	73.2	999	34	85
28\01\2022	26	10:15	73.01	987	38	86
31\01\2022	22	12:25	73.05	996	32	84

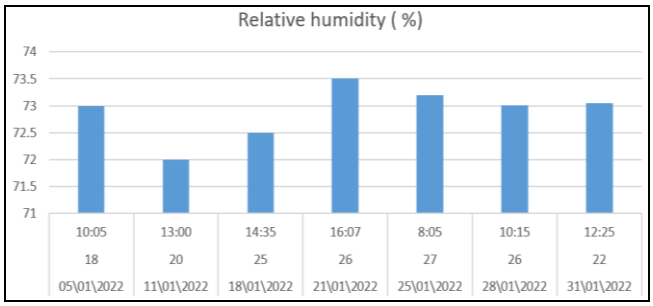

Fig 6: Graph between Relative Humidity & Temperature

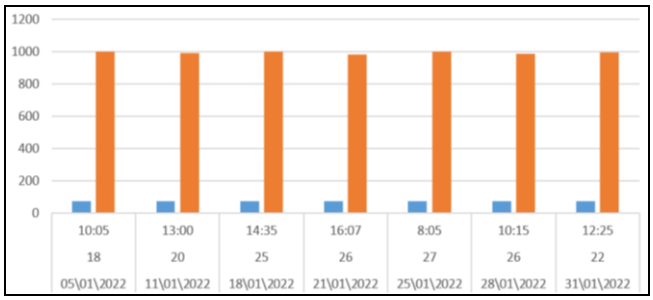

Fig 7: Graph Between soil moisture & Temperature

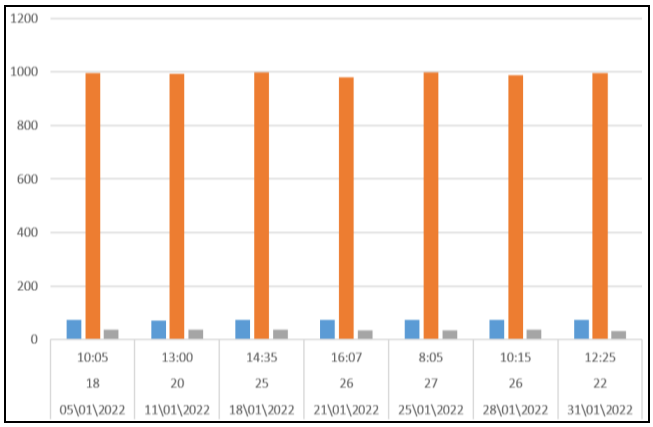

Fig 8: Graph between Salinity value for normal water & Temperature

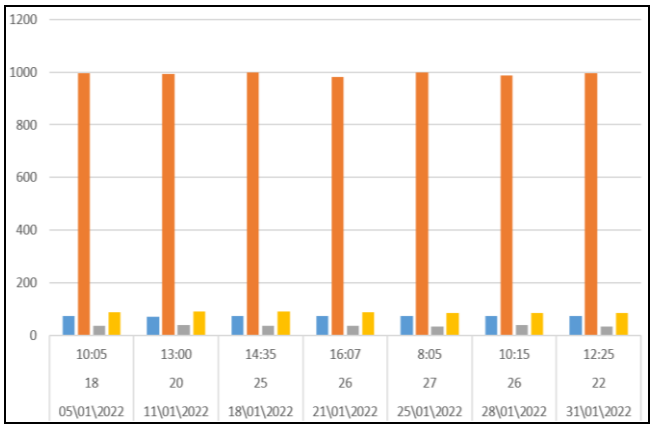

Fig 9: Graph between Salinity value for salty water & Temperature

North Eastern Part (City-Bhimnagar, District-Supaul, State: - Bihar, Country-India) (Experiment carried out on 04th May to 30 th May 2022) where we had environmental temperature reading, soil temperature, humidity, soil moisture and salinity value.

Table 2: North Eastern Part (City-Bhimnagar, District-Supaul, State: Bihar, Country-India) (Experiment carried out on 04th May to 30th May 2022)

Date	Temperature in Celsius (°C)	Time	Relative humidity (%)	Salinity value for salty water (%)	Salinity value for normal water (%)	Salinity value for salty water (%)
04/05/2022	18	08:05	53	71	32	71
08/05/2022	19.5	10:30	52	73	32	73
13/05/2022	29	12:05	51	74	33	74
18/05/2022	26	13:30	52	72	34	72
23\05\2022	27	14:20	52	74	34	74
26/05/2022	25	15:30	54	76	32	76
31\01\2022	22	16:10	53	75	35	75

Conclusion

Weathering parameters having more impact as compare to soil and nutrient during the crop growth. In this regard there is need to adopt context-based precision agriculture system which is used wireless sensor network will capture real time temperature, relative humidity, soil moisture and rainfall. Monitoring the agricultural environment has grown to be a crucial component of protection and control that enables real-time system and control interaction with the outside world.

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