Wireless Sensor Network for Soil Parameter Monitoring

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Abstract— The Wireless Sensors Network (WSN) is these days broadly used to fabricate different types of supportive networks to beat numerous issues in reality. A standout amongst the most intriguing fields having an expanding need of supportive networks is precision farming (PA). This paper speaks about WSN as the most ideal approach to take care of the agricultural issues identified with cultivating assets advancement, basic leadership support. Utilizing the essential standards of Internet and WSN innovation, exactness horticulture frameworks dependent on the web of things (IOT) innovation particularly on the equipment design, organize engineering and programming process control would help being developed of accuracy water system framework.

Key words: Wireless Sensor Network, Precision Agriculture, Crop Monitoring, IoT

I. INTRODUCTION

Agriculture is the backbone of Indian economy, with more than 65% of the population dependent on it. Agricultural and its allied sectors like forestry and fisheries employs more than 50% of total workforce of India and contributes nearly 17-18% to country's GDP (gross domestic product), according to Economic Survey of India 2018.Today, India ranks second worldwide in farm output. Agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. Food security, nutritional security, profitability and sustainability are the main principles of present and future agricultural development.

The goal of this paper is to address the problems faced by small scale farmer during the growth stages of different types of vegetable crops and provide solution to same problem which would requires minimal production costs and ultimately, increase crop yield. Different technologies which can used to solve this problem are wireless sensor network(WSN) and Internet Of Things(IoT). The wireless sensor network(WSN) can be used improve the productivity of crops [2]. WSN's consist of several sensor nodes which can be deployed across small fields. The end user can receive the data from all sensor node and can do processing of the same data to take some decision like turning on/off water pump or can identify particular region in the field where more pesticides should be sprayed. The figure 1 represent the deployment of WSN in star topology across small field.

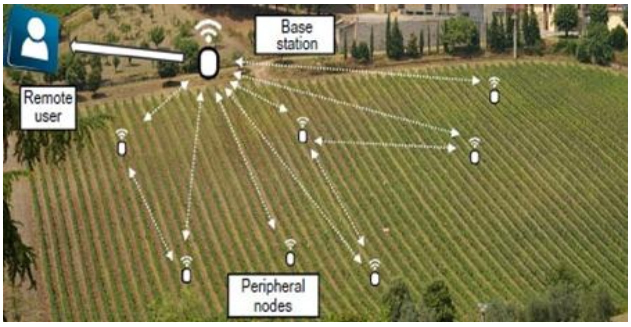


Fig. 1: WSN Deployed in Star Topology

II. RELATED WORK

In this section, we focus on how to use the IoT and smart technologies in the agriculture-based applications. In [2] author has proposed a smart wireless sensor network, so the author designed an architecture to collect data from several nodes in an agriculture environment. Then analyse the collected data and display their results to its end users. In [5] author has presented a method based on wireless sensor networks in potato farming that it monitors and understands individual crop and requirements. Therefore, the farmers can potentially identify the various fertilizers, irrigation, and other requirements. The authors propose an irrigation management model to estimate agricultural parameters using mathematical calculations and intelligent humidity sensors. Devices used for monitoring are laptop computers or PDA. In [6] has introduced a smart system based on wireless sensor network in a red bayberry greenhouse using soil moisture and temperature sensors. This system can collect the temperature, humidity, illumination, and voltage of the greenhouse, or making system more efficient, accurate and fast.

Since all the author put more emphasis on WSN so let us discuss about the same. WSN network comprise of many sensor nodes deployed in a wireless senor environment. The sensor node can be used to measure different parameter like temperature, humidity with minimum power consumption and limited memory [10]. The architecture of a typical sensor node is shown below:

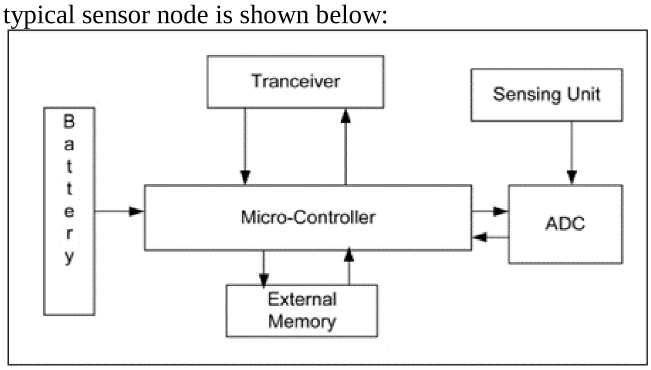


Fig. 2: Sensor Node Architecture

The fundamental parts of a sensor node are control unit, memory unit, microcontroller unit and Communication unit. The node sense a physical events and convert them to advanced flags by ADC unit. At that point they handle gathered information and procedure them by microcontroller unit. This unit is comprised of preparing and memory subunits. They can store vital information in their capacity. Also, they bolster vital their activities from a couple of hours to months or on the other hand years by means of intensity unit. The sensor node are additionally ready to convey together or server/base station as brought together or decentralized models dependent on different topologies, for example, tree, star and mesh. This is acknowledged through the correspondence unit. The sensor node can convey together in the point-to-point or multi-hop models [8]. These are the most profound contrasts with the exemplary sensor hubs. These hubs moreover broadly conveyed in 1m up to 100meters region, low correspondence transmission capacity, constrained memory and calculation control.

The qualities of remote sensor hubs are convenience, versatility to the vast size of arrangement, the portability of nodes and signal strength. Since these systems are keen on data with respect to the physical marvel rather than data from a solitary sensor, the disappointment of a solitary hub ought not influence the general task of the system. By the by, the adaptation capacities is a significant structure factor in the systems [9]. Should know about another factor is cost. The most fundamental highlights of these systems are shabby. In this way, they are nearly utilized as ease sensor hubs. Scientists are presented new sensor gadgets with various programming and equipment properties. In this paper, we utilize our Xbee module as sensor node. The other factor is vitality and system lifetime. The sensor hubs have low battery level. Different techniques, for example, advanced steering conventions, topology control, and power the executives conventions are pursued to accomplish this point.

III. Proposed System

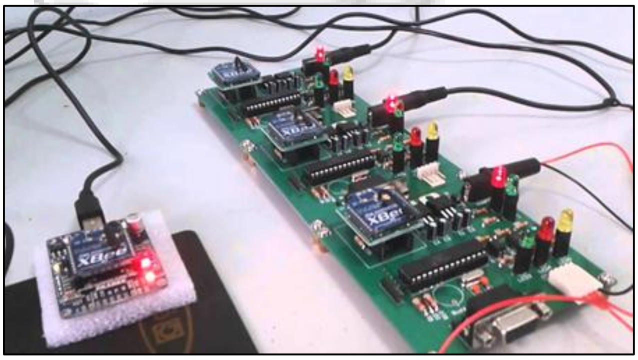


Fig. 3: WSN using ZigBee S2C module

In our proposed system we have four sensor nodes where each sensor node comprise of Arduino Uno as microcontroller and ADC unit, DHT22 to measure soil temperature and moisture value and ZigBee S2c module for transmitting the sensed data to the remote user at base station. The DHT22 senses the soil temperature, moisture and this data is then given to the ADC unit of the Arduino Uno which converts the sensor value into its corresponding digital format. Then the data given to ZigBee for transmission. Here ZigBee connected to each sensor node are configured as Router so that even if one of the link fails then corresponding node can transmit it data using different communication link. We deployed our WSN in star topology so that we all data can reach to user end within 2 hops only. The base station ZigBee is configured as Co-ordinator whose main function is to establish links with all nodes, allocate necessary resources, start/end communication of data. In both cases Zigbee works as Full Function Device(FFD) which they can perform all set of function that are defined by IEEE 802.15.4 standards.

– Some of the features of Xbee S2C modules are:
– Range (indoor) = 200ft.
– Range (Line of Sight) = 6000ft.
– Transmission Frequency = 2.4GHz - 2.5GHz.
– No. of channels: 16 in direct sequence.
– Data rate = 250 Kbps.
– Transmit Power = 2mW(normal mode).
– Operating Temperature = 0^0 C - 80^0 C

As we know that main problem of WSN is very high-power consumption so to improve the efficiency of our system all Zigbee modules are operated in hold mode which means that sensor mode will transmit data after a defined interval of time and for rest of time interval they will remain sleep condition.

Once all the sensed data is transmitted successfully the Co-ordinator ZigBee will receive it and can will displayed in XCTU software. Here all nodes including Co-ordinator are in doing communication with each other using API frames. Since all frame arrive at Co-ordinator in random manner, so in-order identify which sensor node has transmitted data we have assigned each sensor node an ID which is received at base station along with the sensed data. While receiving the data, we also need to visualize it and do this we have used serial communication between remote user's PC and Co-ordinator ZigBee and all the received is stored in Excel Sheet with following parameter:

– With Date & Time of received packet.
– ID of each sensor node.
– Temperature sensed by each node.
– Moisture % sensed by each node.

The generation of Excel sheet is an automatic procedure as soon as data is received by base station all data are stored in a excel sheet.

Once data is stored, so we need to classify this data according to ID of each node so as find out the latest value of soil temperature, moisture of particular region of field and this done using MATLAB GUI. After finding the latest values of soil parameters, make prediction like growth rate of crop in that region of field or crop may be more prone to any kind fungal, bacterial attacks.

IV. Results

The Data received by Co-ordinator ZigBee can be seen using XCTU software. The software represents the time at which data is received and API frame are received so we get 3 terms in RF data window. The first term represents the temperature sensed by sensor node, second term represent the moisture% sensed by the sensor node and third represent the ID assigned to each node. The format of data received in XCTU software is shown in figure 4.

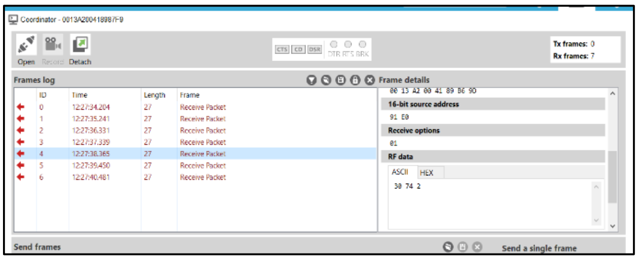
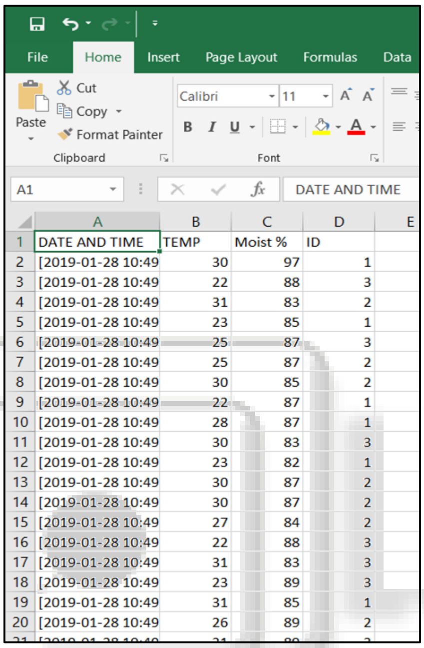


Fig. 4: XCTU Software

As soon data are received in XCTU software as stored in Excel sheet automatically in format as mentioned in the proposed system. The figure 5 represent the Excel sheet generated using Serial communication between Co-ordinator ZigBee and remote PC.



	A	B	C	D
1	DATE AND TIME	TEMP	Moist %	ID
2	[2019-01-28 10:49	30	97	1
3	[2019-01-28 10:49	22	88	3
4	[2019-01-28 10:49	31	83	2
5	[2019-01-28 10:49	23	85	1
6	[2019-01-28 10:49	25	87	3
7	[2019-01-28 10:49	25	87	2
8	[2019-01-28 10:49	30	85	2
9	[2019-01-28 10:49	22	87	1
10	[2019-01-28 10:49	28	87	1
11	[2019-01-28 10:49	30	83	3
12	[2019-01-28 10:49	23	82	1
13	[2019-01-28 10:49	30	87	2
14	[2019-01-28 10:49	30	87	2
15	[2019-01-28 10:49	27	84	2
16	[2019-01-28 10:49	22	88	3
17	[2019-01-28 10:49	31	83	3
18	[2019-01-28 10:49	23	89	3
19	[2019-01-28 10:49	31	85	1
20	[2019-01-28 10:49	26	89	2

Fig. 5: Automatic Excel Sheet Generation for Sensed Data

Now, we need classify sensed data according to the ID assigned to each sensor node and then get latest value of soil temperature, moisture for each region of field. Depending upon latest value of sensed data we make prediction about growth rate crop. To perform this we have implemented a GUI in MATLAB in which we first upload Excel sheet and it displays the latest value of sensed data along with graph representing the variation in data for defined interval of time and then it make prediction about the growth rate of crop . The MATLAB GUI is shown below:

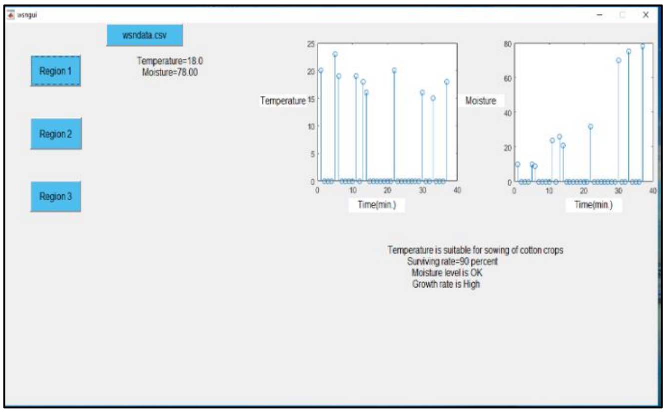


Fig. 6: MATLAB GUI

V. CONCLUSION

Our sensing system combined with ZigBee S2C module has been tested and is quite effective. We have tested our system with varying temperature, moisture condition and checked the accuracy of data received which was found to be 100%. But in case we need deploy the sensing unit in very large field then we need increase the number router nodes which ultimately increase the propagation delay. Also sensing node must be able tolerate sudden weather damage like rain, storm etc.

REFERENCE

[1] Wang, N., Zhang, N., & Wang, M. Wireless sensors in agriculture and food industry- Recent development and future [4]. perspective. Computers and electronics in agriculture, 50(1), 2006, 1-14
[2] G. Mendez, M.A. Yunus and S.C. Mukhopadhyay. "A WiFi-based smart wireless sensor network for monitoring an agricultural environment". IEEE Conference in Instrumentation and Measurement Technology Conference (I2MTC), pp. 2640-2645, 2012
[3] Keshtgary, M., & Deljoo, A. An efficient wireless sensor network for precision agriculture. Canadian Journal on Multimedia and Wireless Networks, 3(1), 2012.
[4] Oliveira, L. M., & Rodrigues, J. J. Wireless Sensor Networks: A Survey on Environmental Monitoring. JCM, 6(2), 2011, 143- [2]. 151.
[5] K. Shinghal and S. Neelam. "Wireless Sensor Networks in Agriculture: For Potato Farming". Available at SSRN: https://ssrn.com/abstract=3041375, 2017.
[6] X. Jianfa. "An environment monitoring system for precise agriculture based on wireless sensor networks". IEEE International Conference Mobile Ad-hoc and Sensor Networks (MSN), pp. 28-35, 2011.
[7] Namrata Dave, "Feature Extraction Methods LPC, PLP and MFCC In Speech Recognition," International Journal for Advanced Research in Engineering and Technology Volume 1, Issue VI, July 2013.
[8] K. Sohraby, M. Daniel and Z. Taieb. "Wireless sensor networks: technology, protocols, and applications". John Wiley & Sons Book, 2007.
[9] F. Akyildiz and M. C. Vuran. "Wireless sensor networks". John Wiley & Sons Book, 2010.
[10] S. Lachure, A. Bhagat and J. Lachure, J. "Review on precision agriculture using wireless sensor network". International Journal of Applied Engineering Research, 10(20), pp.16560-16565, 2015.

