Journal for Research | Volume 04 | Issue 01 | March 2018
ISSN: 2395-7549

IoT based Digital Agriculture Monitoring System & Their Impact on Optimal Utilization of Resources

Prosanjeet J. Sarkar
PG Student
Department of Electronics & Communication Engineering
Ballarpur Institute of Technology, Bamni
Ballarpur (M.H), India

Satyanarayana Chanagala
Principal
Ballarpur Institute of technology Bamni
Ballarpur (M.H), India

Abstract

Although precision agriculture has been adopted in few countries, the greenhouse based modern agriculture industry in India still needs to be modernized with the involvement of technology for better production and cost control. In this paper we proposed a multifunction model for smart agriculture based on IoT. Due to variable atmospheric circumstances these conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniform condition at all the places in the farmhouse manually. Soil and environment properties are sensed and periodically sent to cloud network through IoT. Analysis on cloud data is done for water requirement, total production and maintaining uniform environment conditions throughout greenhouse farm. Proposed model is beneficial for increase in agricultural production and for cost control and real time monitoring of farm.

Keywords: IoT, Cloud Computing, WSN Network, Data Mining, Automation

I. INTRODUCTION

Precision agriculture is an agriculture management system which is based on information technology uses like sensors and modern advanced monitoring technique to get land and crop data completely, correctly and timely [1]. Humidity and temperature are considered to be the climate control parameters. Humidity affects growth of greenhouse crops. Internet of things are most popular for last few years and applications are being developed in different areas using this technology. For the implementation of agricultural technologies, real time monitoring and low cost is critical. In this regard, Arduino based system presents a good option for the technology development and implementation because Arduino is an open source hardware and all developed programs can be easily accessed from Arduino website. Real time monitoring provides reliable, timely information of crop and soil status.

This project introduces a 24x7 hours real time monitoring for humidity, temperature, moisture and rain status in order to optimize crop production and monitoring soil status. The project has been implemented using Arduino UNO, Ethernet Shield, Blynk libraries and Blynk application. Following technologies are uses in the field of agriculture are also introduced and are used for improvement in this sector.

A. The General Concept of IoT

IoT is a kind of network that can connect objects with network for information exchange and communication using agreed protocol [2]. IoT can make billions of networked embedded devices also called smart items. These devices are capable of collecting information about themselves, their environment, associated devices and communicate this information to other devices and system via all the connecting through internet [3]. Applications are developed based on IoT enabled devices for monitoring and control in various domain including process, home appliances, health monitoring applications, smart home, smart cities, smart agriculture etc.

B. Sensors & Wireless Sensor Networks

Sensors are available for sensing and analyzing the various different parameters that are required in agriculture domain. Many applications have been developed which utilizes sensors in agriculture. Sensor networks bridge the gap between cyberspace and real world, and thus their design is the key to connecting agriculture to the IoT [4]. Sensor networks must work in the targeted environments and operate for a long period without the need of battery replacement and low cost.

C. Cloud Computing

The sharing of resources with cheap is provided only through cloud computing. Service provider offers services like platform as a service (PAAS), infrastructure as a service (IAAS) and software as a service (SAAS) with low cost [5]. Cloud computing is also used to store the agricultural data.

D. Big-Data & Big-Data Analysis

Big data is a massive amount of data collected from the different sources and for longer periods of time like sensor data, social networking data and business data. The major challenges are capture, storage, analysis and research [6]. Big – data is helpful in agriculture domain for maintaining supply chain management of agro products to minimize the production cost.

E. Mobile Comuting

It has affected enormously our day to day life due to its availability and has a low cost of information exchange. It is used in every filed including agriculture sector. System based on mobile computing has been proposed for sending time to time sessional update to farmers regarding agriculture and weather information [7].

II. EXISTING METHODOLOGIES

As on date, many researchers have discussed new methodologies to get farm house data remotely and also discussed about systems which can monitor and control farmhouse parameters remotely. The systems developed are based on SCADA in 2006, to control and acquisition of agricultural parameters and also future calculation of crop production. It works on hierarchical three layer model that is field layer, control layer, supervision and management layer. However this requires heavy calculations. In the existing system, there is a low cost wireless technology with the use of microcontroller and CAN protocol for measuring agricultural parameter. However there is one common problem as some systems cannot support an embedded JVM [8].

To measure remotely the greenhouse environment such as temperature and humidity by using FPGA and GSM, which provides real time monitoring, timely information of crop and soil status results in the possibility of taking decisions for crop production improvement [9]. In this data can be sent from node to node which makes a star topology based on Bluetooth. Using this system agriculture parameters like temperature and moisture are monitored. This system provides low cost wireless solution for real time monitoring of agriculture field data [10]. However star topology has some inherent problems hence mesh topology is adopted, Zigbee based system normally works on mesh topology which connects all the nodes to each other resulting in a smart sensing platform for monitoring environmental parameters such as temperature, pressure, relative humidity and sunlight. This platform works for 24 hours and real time data can be observed in GUI based application in PC [11].

Several other researchers worked on GSM based smart wireless sensor network which remotely senses and control irrigation system. Using this system real time field monitoring, controlling of sites, this made it possible to develop a system based on feedback mechanism [12]. Also researchers made systems by using mesh topology and GSM, in which data are collected from different nodes and store it and take action if it is needed. This system is vey low cost, user friendly and uses to reduce the water supply and improve the production [13]. But this system cannot solve the problem of more human interaction, less calculation, GUI and taking actions according to sensor parameters.

III. DESIGN & IMPLEMENTATION

The purpose of this system is to improve the level of agriculture information process and enhance the intelligent management and able to take decisions about agricultural production. According to the requirement and characteristics of agriculture production, we can design the system which works on hierarchical structure. This system mainly includes the three layers: data collection, data transmission and data analysis and process.

Nowadays, with the rapidly increasing research on IoT and its applications, IoT contributes to information's overall sensing, reliable transferring and intelligent operation, which makes it the main method of data acquisition and transmission. Since the agricultural production involves different stages and process, such as irrigation, crop growth, usage of fertilizers, crop storage, selling of the crop. There are many methods to collect data about the above processes more precisely.

The main function of data transmission layer is to ensure that the information from collecting layer can be reliably transmitted to internet through network infrastructure, such as mobile communication network, wireless sensor network etc. Wireless sensor network is one of the most suitable technologies for capturing real time data. Therefore, connecting WSN to the internet in order to publish real time data in standard way so that they can analyze these data, allowing to take decisions in remote premises, and finally implementing these decisions back in the real world through sensor.

Data base and data mining are the main processing and analyzing technologies. Data mining is the process of analyzing data from different perspectives and summarizing it into useful information and this improve the efficiency of analysis. And for processing, the cloud computing technology has been used. The intelligent cloud computer platform can ensure that enormous data of internet is analyzed in real time sense, processed, managed and controlled and thus creates an efficient and reliable decision service.

A. System Architecture

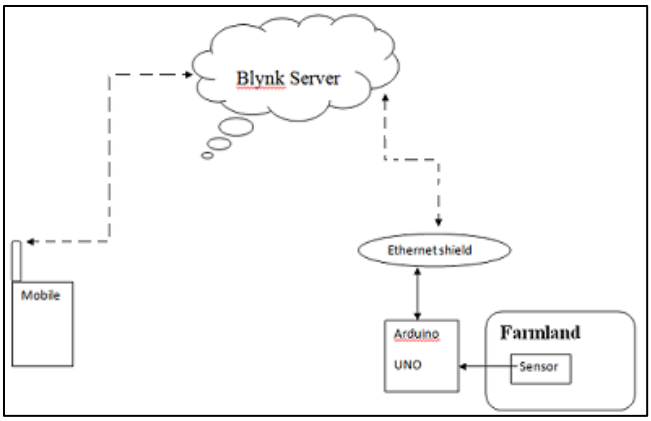

Fig. 1: System Architecture

Fig1 illustrates the complete architecture of the system. In a targeted environment, the sensor node measurements include temperature, relative humidity, and moisture and rain drop concentration. According to gate way access protocol, the gateway repackages and sends the collected sensor data to the Blynk server, Blynk server is responsible for all the communication between Smartphone and hardware (sensor node + gateway) it is also used as an open source, which stores the data into data base.

B. Hardware

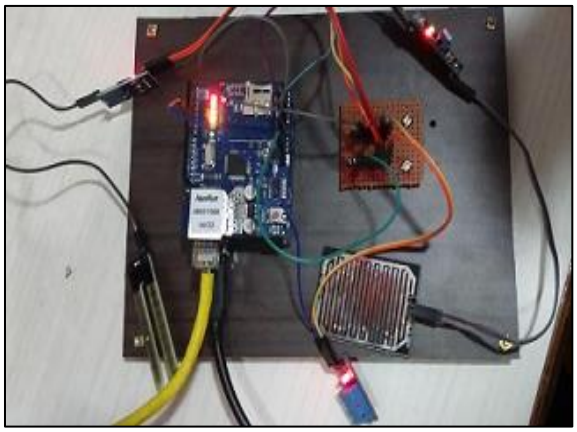

Fig. 2: Complete Hardware of Project

1) Sensor Node

Although there are sensor networks products and even a complete solution for agriculture in the market, we decide to develop a customized sensor node due to three reasons:

1) The prices of the existing products are much higher.
2) Compared with integrating various agricultural sensors into existing products, customized hardware will allow us to optimize the design to meet special requirement of the project.
3) The experience from academic and our previous research prove the feasibility and flexibility of building sensor network system on top of customized open source hardware and software. This allows us to leverage the maximum result from open source communities.

Microcontroller unit communication unit and sensor constitute the core of a sensor node. Among platform supported by open source communities, Arduino UNO + Sensors are the most popular combinations. We adopted Arduino because it is an open source prototyping platform which is user freindy. Arduino was born at the Ivera Interaction Design Institute as an easy tool for fast prototyping tool. In Arduino UNO used ATmega 328 microcontroller which is based on ATmel Corporation.

Sensors were selected according to the specification given by agronomist. In this project we interfaced Temperature, humidity, moisture and rain drop concentration sensors. We generally prefer analog sensors to interface ADC of microcontroller, this analog sensor helpful for measure the each moment change in the environment. Moreover, each sensor node can have send data to microcontroller and same data transmitted to the user GUI through Ethernet shield (Gateway) and also response getting from user to microcontroller and controlling various equipments like irrigation and ventilation.

2) Gate Ways

A gateway, which is typical embedded system based on Wiznet W1500 Ethernet chip that provides a new stack capable of both ICP + UDP, which act as an intermediary between the sensor network and the internet. Each gate way is connecting with each sensor node through SPI protocols. The Arduino Ethernet shield connects Arduino to the internet in mere minutes. Just plug this module onto your Arduino board, connect it to your network with an RJ45 cable and follow few simple instructions to start controlling your farm through internet.

C. Software

Fig. 3: Logo of Blynk App & Libraries

There are many open source software platform for sensor nodes. We chose Blynk, because it was designed for the IoT. It can control hardware remotely; it can display data, can store data, analyze and do many more things.

All sensor nodes (Arduino UNO) dumped or loaded Blynk libraries. In this libraries having all the source code for popular hardware platform enable communication between with the server and process all the incoming and outgoing command. Blynk app is a smart or android phone based application where user is allowed to create amazing interfaces for projects using various widgets. This application used to send the data and also read the data and perform actions according to the data read, it is very user-friendly application.

Sensor networks usually employ proprietary protocols and communicate with outside world through gateways. We believe that a common access interface on the gate way is crucial for the further integration of services on the IoT. All the gateways are assumed to be capable of TCP/IP communication on top of which was designed an application protocol for the common access to the sensor networks of agriculture applications. The protocol includes simple access authentication, sensor data retrieval and simple management of sensor networks. Our backend system (DSS, database and web server) is integrated with the sensor network through the communication server that implements the protocol.

IV. RESULTS

Ethernet shield is configured as dynamic so when you connect LAN cable to Ethernet shield it get automatic IP address, so there is a necessicity that router must be configured as dynamic.

In this mobile application user have to draw five wedges for indicating moisture, rain drop concentration, temperature, humidity and motor status it is shown in fig.4.

Fig. 4: Mobile App Showing Agriculture Parameters

In the application screen moisture wedge is line graph, rain drop concentration is bar graph, temperature and humidity is status graph and motor is toggle switch virtually. Motor button is only one wedge that can transmit data and all are remaining wedges receives data from farmhouse or farm filed and display respective graph. Fig. 4 shows the temperature 32 degree centigrade and humidity 27 which are actual values present at that time when project was deployed in the farm filed.

Fig. 5 indicates that moisture is slightly changes from its initial value and it is indicating use of yellow color line. Rain drop sensor is made completely dry and this is indicated in the weidge for no rain.

Fig. 5: Display of Moisture Sensor Variations

In fig.6 and fig.7 we artificially drop some water droplet on the rain drop sensor and also changes moisture level of environment and this change data of filed get display on the screen. Also we can remotely start the motor of filed for the irrigation purpose by using motor wedge. Temperature and humidity of the filed remain constant. All result are taken from single node only and all the sensors connected to this node respectively.

Fig. 6: Display of Rain Drop Sensor Output Variations

Fig. 7: Display of All Parameters of Agricultural Sensors

V. CONCLUSION & FUTURE WORK

As an important constituent part of the IoT, sensor network provide us with a new multidisciplinary model to observe and interact with the physical world that was unobtainable before. This paper reports on the sensor networks design that enables connecting to the IoT. The connection sets up links among agronomist, farms and crop regardless of their geographical differences and thus improves the production of agricultural products based on observing the agricultural parameters and take decisions, based on parameters. Sensor nodes are required with reliability, cost effectiveness along with application specific features. In this work we designed the customized sensor node that senses agricultural parameters and display the same on the screen. Our future work will be focusing on interfacing different soil nutrient sensors with Arduino UNO and analyze the result to get correct and better result, it will reduce the production cost, utilization of water and fertilizer. The collecting of data from various farmlands, analyzing the data based on data mining algorithms suitable for agriculture. Big data analysis can also be used for getting the desired outcome. These outcome data can be sent to farmers and agro industries to know the requirement of seed, fertilizer and water according to the data.

REFERENCES

[1] Jiuyn Ye, Bin Chen, Qingfeng Liu, and Yu Fang, "A Precision Agriculture Management System Based on Internet of Things and WebGIS,"
[2] Weimei Zhang, "study about IOT's Application in "Digital Agriculture" Construction," ICECE, pp. 2578-2581, 2011.
[3] Duan Yan-e, ""Design of Intelligent Agriculture Management Information System Based on IoT," Fourth International Conference on Intelligent Computational Technology and Automation, Volume-1, pp. 1045-1049, 2011.
[4] Junyan Ma, Xingshe Zhou, Shining Li, and Zhigang Li, "Connecting Agriculture to the Internet of Things through Sensor Network," IEEE International Conference on Internet of Things, and Cyber, Physical and Social Computing, Volume- , pp. , 2011.
[5] Mitsuyoshi Hori, Eiji kawashmia, Tomihiro Yamazaki, "Application of Cloud Computing to Agriculture and Prospects in Other Fields," FUJISTU Sci. Tech. J., Vol-46, pp. 446-454, 2010.
[6] Steve Sonka, "Big Data and the Ag Sector: More than Lots of Numbers," International Food and Agribusiness Management Review, Vol-17, 2014.
[7] Sumitha Thankachan, S. Kirubakaran, "E-Agriculture Information Management System," International Journal of Advanced Research in Computer Science and Software Engineering, Vol-3, 2013.
[8] Pedro M. Mestre A. Silva, Carlos M. J. A. Serodio, and Joao L. Monteiro, "Ubiquitous SCADA System on Agricultural Applications," Industrial Electronics, Vol-4, pp. 2978-2983, 2006.
[9] Wael M El-Mendany, "FPGA Implementation for Humidity and Temperature Remote Sensing System," Mixed Signal, Sensors, and System Test Workshop, pp. 1-4, 2008.
[10] Yue Shaobo, Cai Zhenjianng, Suo Xuesong, Meng Qingjing, Li Tingjiao, and Wang Kezheng, "The Application of Bluetooth module on the agriculture expert," IIS, Vol-1, pp. 109-112, 2010.
[11] M. Haefke, S. C. Mukhopadhya, and H. Ewald, "A Zigbee Based Smart Sensing Platform for Monitoring Environmental Parameters," I2MIC, pp. 1-8, 2011.
[12] Pavithra D. S, and M. S. Srinath, "GSM based Automatic irrigation Control System for Efficient Use of Resources and Crop Planning by Using Android Mobile," IOSR Journal of Mechanical and Civil Engineering, Vol- 11, pp. 49-55, 2014.
[13] G. V. Satyanarayana, and SD. Mazaruddin, "Wireless Sensors Based Remote Monitoring System for Agriculture Using Zigbee and GPS," Conference on Advance in Communication and Control System, pp. 110-114, 2013.