Journal of Botanical Research
https://ojs.bilpublishing.com/index.php/jbr

ARTICLE

Using IoT Innovation and Efficiency in Agriculture Monitoring System

Muhammad Awais[1,2] **Wei Li**[1*] **Muhammad Ajmal**[3] **Muhammad Faheem**[3]

1. Research Center of Fluid Machinery Engineering & Technology, Jiangsu University, Zhenjiang, Jiangsu, 212000, China
2. Department of Farm Machinery and Power, University of Agriculture Faisalabad, Pakistan
3. School of Agricultural Equipment Engineering, Jiangsu University, Zhenjiang, Jiangsu, 212000, China

ARTICLE INFO

Article history
Received: 20 May 2020
Accepted: 11 June 2020
Published Online: 8 July 2020

Keywords:
Thing Speak
Internet of Things (IoT)
Sensors
Arduino and Stepper motor

ABSTRACT

Agriculture is undoubtedly a leading field for livelihoods in China. As the population increases, it is necessary to increase agricultural productivity. By capturing the support and the increment in production on farms, the need for freshwater used for irrigation increases too. Presently, agriculture accounts for 80% of overall water uptake in China. Unexpected overflow of water carelessly leads to waste of water. Therefore we created a programmed plant irrigation system with Arduino that mechanically supplies water to the plants and keeps it updated by transferring the message to user. Plant irrigation system employs the soil moisture sensor which controls a degree of moisture in the soil. If the humidity degree is lower, Arduino activates a pump of water to supply water to the system. The pump of water stops by design when the organism detects sufficient moisture in the ground. Each time the system is switched off or on, an electronic messaging is conveyed to the end-user through the IoT unit, informing the position of the soil moisture and the pump of water. A spray motor and the pump of water are grounded on the crane concept. Widely, this system is applicable for in small fields, gardens farms, etc. This design is entirely programmed and needed no human involvement. Furthermore, transmission of the sensor readings send through a Thing speak frequency to produce graphic elements for better inquiry. This study gathers the ideas of IoT (Internet of Things) with some engineering tools like machinery, artificial intelligence and use of sensors in an efficient way to respond current needs and extraction of resources by availing scientific methods and procedures that work on inputs. Moreover, this study further defines the engineering works that have been part of this field, but it requires more efficiency and reduction of energy as well as costs by adding more contribution of IoT in the field of agriculture engineering.

1. Introduction

Agriculture is an emerging field in this modern era, most of the researchers are working to overcome the hot issues of agriculture engineering that help to produce and yield favorable outputs, these maybe fulfil the continuous and changing needs of people. Irrigation is considered a vital alternative to China agriculture driven system mainly in the season of heavy rains and China is majorly focusing on utilizing IoT in their agriculture monitoring system [1]. Due to the potential health risks associated with pesticide use, the expense of producing new

**Corresponding Author:*
Wei Li,
Research Center of Fluid Machinery Engineering & Technology, Jiangsu University, Zhenjiang, Jiangsu, 212000, China;
Email: lwjiangda@ujs.edu.cn

DOI: http://doi.org/10.30564/jrb.v2i2.1900

pesticides has increased at an increasing rate in current years. The most fundamental benefit of pesticides is that these are easy to use and easily available, unlike substitute methods and related procedures that consume an extensive time to design and every so sometimes have no instantaneous result. The organism was designed and established to organize the wireless sensor network to estimate a regulation of level of water, temperature plus humidity, as well as the sensor node needed for an optimum agricultural atmosphere, as well as watching the management devices and analysis of the data collected through Sensor and store them on the management server and responding the attentive in emergency. This gathered data provides information on numerous environmental determinants. Observing environmental dynamics is not the entire resolution to escalate crop harvesting, there are many other features, are barriers in production [2].Therefore, mechanization must be executed in the field of agriculture to deal with these complications. Although implemented on a research level, farmers are not given as a product to take advantage of their sources. This document deals with the development of automatic agriculture system [3]. In recent years, researcher have attempted to develop automatic irrigation systems for sake of irrigation management by utilizing cloud computing and Internet of Things (IoT) technology, IoT can be defined as a network of physical objects that connect and exchange data wirelessly over the internet [4]. Using this data, field managers can direct resources, including materials, equipment, and workforce, to where they are needed the most, resulting in efficient agriculture operations, reduced costs, and increased profits [5]. The worldwide irrigation practices are classified by demand increase for productivity, shortage of water and poor performance for agriculture practice. These problems are solved by using automated irrigation systems.

The need for Automatic Irrigation

(1) Saving energy and resources for utilizing in precise way,

(2) Easily installation of system on the field.

(3) To apply right amount of water at right time for the sake of farmer's easiness to control farm irrigation and nursery.

(4) Valves are use in automated irrigation systems to turn on/off the motor.

(5) Pump or motor can be easily operated with sensor based controller and no need for any labor to operate or monitor irrigation systems. Crop efficiency includes improvement in reduction of the overwatering from the saturated soil, and avoiding wrong time of irrigation to save more water.

This Study is proposed to support aggressive water management for the agriculture land and aims to explain the different modern and sensor based irrigation management techniques and monitoring environmental parameters in an agriculture field and provide field managers with alerts and information on current condition while saving the data in a database for future reference, which includes information collecting using remote sensor collection, wireless sensor network, target controlling and data management scheme as shown in Figure 1. There is a very rare study on sensor-based irrigation systems and modern technologies in the previous works, this study will helpful to new researcher in this field to get more knowledge and provide more up to date and fill the gap through this review study.

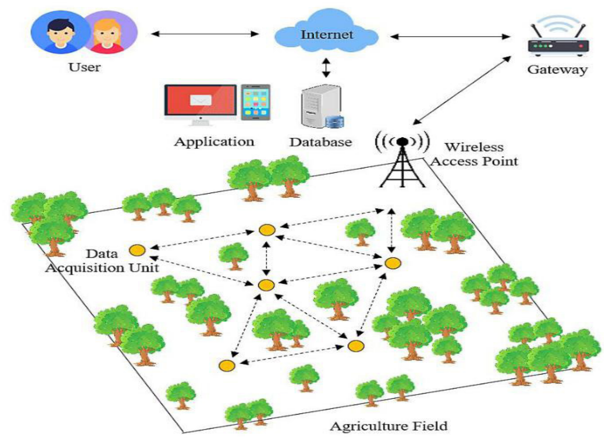


Figure 1. Wireless sensor network layout for automated irrigation system

Further More, this study gathers the ideas of IoT (Internet of Things) with some engineering tools like machinery, artificial intelligence and use of sensors in an efficient way to respond current needs and extraction of resources by availing scientific methods and procedures that work on inputs. In addition study further defines the engineering works that have been part of this field, but it requires more efficiency and reduction of energy as well as costs by adding more contribution of IoT in the field of agriculture engineering.

2. A Review of Literature

Suma et al., [6] have suggested a research, in this study wireless sensor networks are used to continuously record soil characteristics and environmental aspects. Many sensor nodes are distributed at multiple points on the battery. Set parameters are controlled via any Internet service or wireless device with actions are executed via interface sensors, a Wi-Fi connection, a video camera and a micro-controller. Recent advancements in wireless sensor

 DOI: http://doi.org/10.30564/jrb.v2i2.1900

network (WSN) technology have been able to overcome certain issues related to the wired sensor systems [7-10]. However, many wireless systems still rely on external power supply via cables, thus defeating the purpose of having wireless data transmission capability [11-13]. Some fully wireless data acquisition units use rechargeable batteries capable of powering the devices for several months, though these systems require extensive maintenance to charge or replace the batteries. This model was formed as a product and is intended for the well-being of the farmer. Kumar et al., recommended the study, in this study the micro-controller would transmit this info over the Internet via an IoT network in the form of the associated ESP8266 Wi-Fi section [14]. This improves automatic watering because the pump of water can be turned off or on with the information provided to the regulator. It is also employed to obtain the nitrogen content and chlorophyll Internet service contented of the Laser and the leaf controlling LDR. Krishna et al., recommended the research, in this study it was proposed that wireless robot is built with several sensors to measure diverse ecological factors [15]. The foremost properties of this unique intellectual wireless robot are that it can perform given tasks like scaring animals and birds, detecting humidity, moving backward or forward, spraying pesticides, turning the electric motor on and off. This projected wireless mobile robot has been field-tested, analyses have been examined and acceptable outcomes have been witnessed, indicating that it proposed organism is very valuable for intelligent agricultural structures.

3. Proposed System

Agriculture is a growing filed, therefore it requires several sensors and their implemented in this field, such as humidity sensor, temperature sensor, ultrasonic sensor as well as moisture sensor. Gathering if a data through employed sensors are linked to Arduino UNO, in the regulatory section, a gathered data is checked using a threshold standards. When the humidity level becomes lower, Arduino activates the pump of water to supply water to the system. The pump of water stops robotically if the system detects sufficient humidity in a ground, under the communication system an electronic message is conveyed to the end-user through the IoT section, informing the position of the soil moisture as well as the pump of water. These determinants comprise an occurrence of pests that possibly be handled via spraying a crop with the appropriate pesticides. The irrigation mechanism has been proposed for effective water controlling besides pesticide spraying on farms or fields. Parametric, such as humidity, temperature and moisture are measured via sensors. Pesticides and water are sprayed with a spray machine and a motor-pump. An ultrasonic sensor is employed to take care the plant growth; Plants possibly be viewed anytime and anywhere on the Web page through IoT. Currently, Think speak is regarded that is a system using iOS to regulate Arduino that maintains the electronic hardware. Plant development caring via an ultrasonic sensor also transferring the report to the web page by the IoT module. Irrigation will be performed robotically within a predefined time.

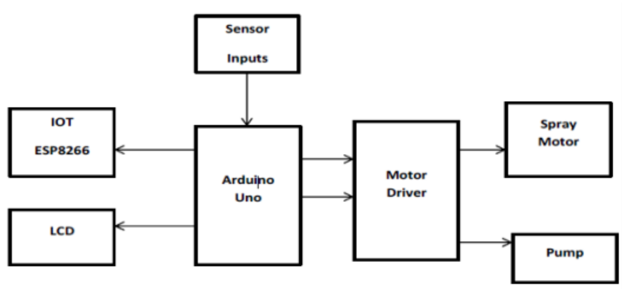


Figure 2. Block Diagram of Proposed system

3.1 Arduino UNO

A micro-controller employed here is an Arduino UNO. A UNO is a micro-controller board grounded on the ATMEGA 328P. ATMEGA 328P holds 32 KB of flash memory to store the code. This card holds six analogue inputs, 14-digital input/output pins, a 16 MHz quartz, an ICSP circuit, a USB port with a reset button. A UNO possibly be automated using an Arduino software.

Figure 3: Arduino UNO Sensors

3.2 Soil Moisture Sensor

The soil moisture sensor makes capable for assessment of the soil moisture content. As soon as a soil moisture input by a sensor holds greater value than a threshold, the low level (0 V) shall be a digital result, and if it holds lower than a threshold level, a greater level (5V) shall be the digital result. A digital pin helps to use straight read the existing soil moisture input to get, conditionally it is greater than a threshold or lesser than.

DOI: http://doi.org/10.30564/jrb.v2i2.1900

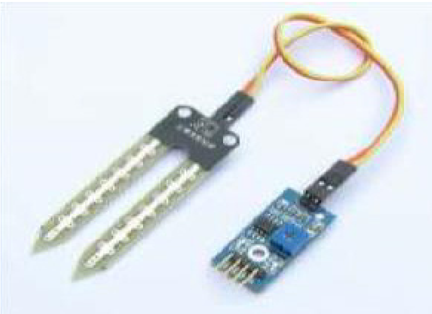


Figure 4. Soil Moisture Sensor

3.3 DHT11 Sensor

A DHT11 sensor tool is proficient enough to calculate temperature and humidity. It utilizes a thermal resistor and capacitive humidity sensor to gauge the pressure of air. This sensor is economical, consumes little energy and allows the transmission of signals up to 20 meters.

Figure 5. DHT11 Sensor

3.4. Ultrasonic Sensor

An enquiry component comprises a specific cable proficient of correctly detecting the surface level of almost all fluids, identifying water, oils and saltwater. A sensor component is an electrical isolated as well as insulated from the liquefied in which it is implanted also will not disintegrate over the time.

Figure 6. Ultrasonic Sensor

3.5 IoT Module

An IoT (Internet of Things) consists of an environmental settings in which animals, people or objects are allocated novel assessors and the capability to send data to a network bypassing the need for human resources, human interactions or Manpower with a computer. The IoT has grown from a MEMS (merging of wireless technologies) and an Internet. The idea possibly also be called an Internet of Everything. One important object in the Internet of Things, it can be somebody containing a heart rate analyzing system, the farmhouse animal using a transponder biochip, a car with integrated sensors to warn a driver if tire pressure becomes low.

4. Result and Discussion

4.1 Description of the Data Acquisition System for Specific Field

The data acquisition system includes the means to accurately determine the ambient conditions on agriculture field. For assessment study of a specific field, a total of three sensors, which include; an air temperature and humidity sensor, a light intensity sensor, and a soil moisture sensor, were utilized to capture four environmental parameters, namely temperature, humidity, surrounding light intensity, as well as soil moisture content. Furthermore, the flexibility of the system allows additional sensors including a pH sensor to determine soil acidity; UV sensor to determine ultraviolet light intensity; carbon dioxide and oxygen sensors to monitor the surrounding air composition; rain sensor to detect rainy weather; and water level sensor to detect flooding in the field, to be included in the system based on user requirements. The microcontroller was used to read the environmental parameters captured by the sensors, process the data, and upload the data wirelessly over a communication network to the cloud server.

In the cloud server, live information from all agriculture fields was collected and stored, as shown in figure 7. The data stored in the cloud server can be accessed remotely by clients using either browser on an internet enable device to access the IoT platform webpage or a custom mobile applications. This field information can be utilized to assist field managers in directing the resources to where they are needed the most, resulting in efficient agriculture and sensor based irrigation operations and reduced usages of resources, which leads to reduced environmental pollution, lower cost and increased profit. Additionally, the field information can be used as input data to operate sensor based irrigation on the field. The irrigation monitoring system developed for this assessment is cost-effective, multifunctional, and can be movable easily to any agriculture field via the plug-and-play method. This system is also powered via solar energy, making individ-

 DOI: http://doi.org/10.30564/jrb.v2i2.1900

ual data actuation units fully wireless and portable, thus eliminating the need for a cabling for power supply and data transmission, leading to reduce installation, maintained and relocation costs.

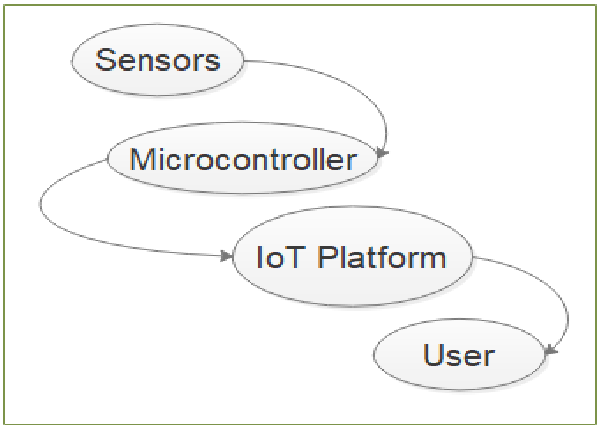
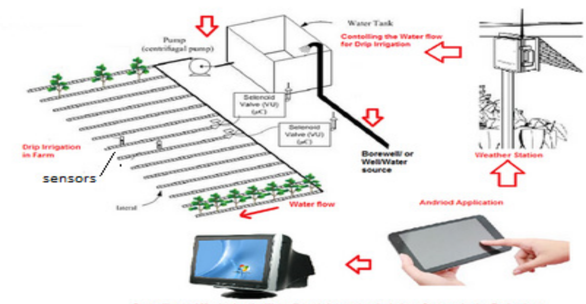


Figure 7. Block diagram of agriculture monitoring system

4.2 On-site and Functionality Analysis

Sprinkler irrigation system was designed for wheat crop for an area of 1 acre. Total area was divided in to four plots, each part consisting of a rain gun. The system was tested to ensure that it can capture the environmental data via sensors, broadcast the information to the IoT platform was accessed via an online webpage. The system was run for a few minutes to obtain multiple data entries. Sprinkler field was divided in four plots so four soil moisture sensors were installed in each field. This test was conducted to ensure that the device can perform as required under real-world daily usage conditions. The prototype and layout of data acquisition unit was switched on and staked into the ground of the research field as shown in Figure 8. All four plots were atomized by connecting them through Wi-Fi networking. An onsite website was developed which gives the current soil moisture readings of all the sensors installed in the field and save the recorded data. Sensors stands, board circuits and continues electric supply was managed using uninterruptible power supply.



(a)

(b)

(c)

Figure 8. On-site test for automated irrigation (a) layout sketch (b) Solenoid valves, GSM module and moisture sensor (c) Installed moisture sensor

The device was able to successfully capture broadcast and environmental data as expected. The light intensity sensors was also closed while water was poured into the ground to simulate a change in environmental conditions. The device managed to sense these changes without any issue as shown in Figure 9. All tested fields were atomized once again by connecting them through Wi-Fi network. An onsite website was also devolved which gives the current soil moisture readings of all the sensors installed in the field and save the recorded data. An account on Thing Speak was also made to make graphs of the recorded data. Sensors stands, board circuits and continues electric supply was managed using uninterruptible power supply.

DOI: http://doi.org/10.30564/jrb.v2i2.1900

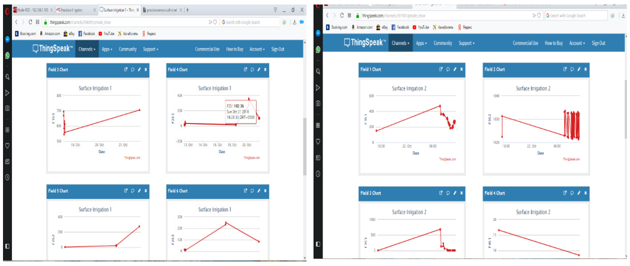


Figure 9. Humidity and Temperature relative to time

Hence, next the signal conditioning progression, soil temperature and the humidity values are transmitted by the Wi-Fi module of the irrigation system anticipated and then acknowledged by the user's device via the source code IoT server.

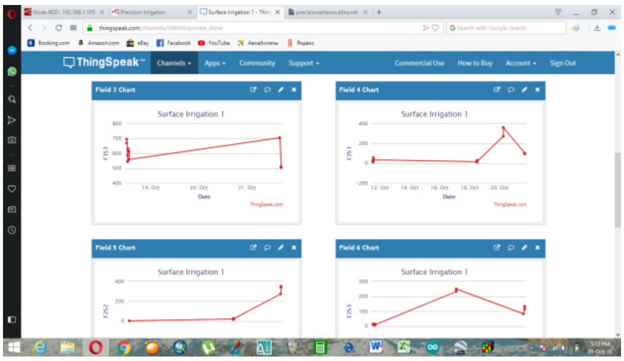


Figure 10. Soil Moisture analysis through Thing Speak

Thus, data is transmitted on the ground and the crop in real-time like humidity and temperature sensor. As a result, the temperature and the humidity signal displayed through a user is proportional to a time. When a signal deviates on the reference range of a projected irrigation mechanism, the analogous signal is then transferred to a field scheme via an end-user. When a soil moisture content becomes lower than the reference score range, a signal is communicated to an end-user via a Wi-Fi section. An IoT server whose signal acknowledges by an end-user device and a control is referred in a same way with further way Corrective measures are in progress.

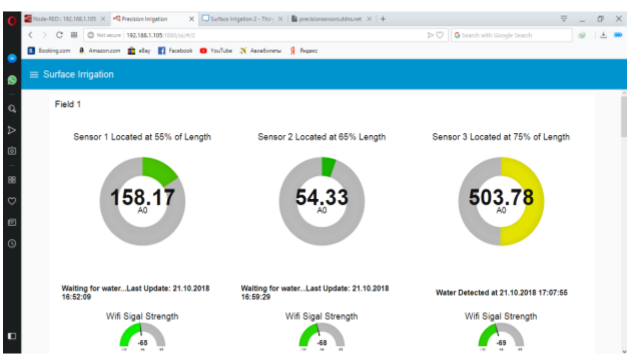


Figure 11. Height of a Plant and growth with passage of time

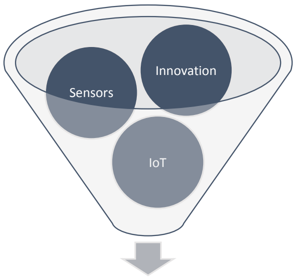
Given result, end-user possibly only understands a height of the installation. A height score is standardized to a matching height of a plant in a recommended irrigation mechanism. A moisture; humidity sensors and temperature are demonstrated on the Liquid Crystal Display (LCD) section linked to an Arduino UNO. An ultrasonic sensor is used for observation of plant growth. An IoT system is linked to an Arduino UNO. A pest sprayer with pump are powered by a motor. A stepper motor helps to utilize for backward as well as forward operations.

5. Conclusion and Future Enhancement

The objective of this research work was highlight the development of an improved agricultural monitoring systems that overcomes issues of previous systems, including cost, coverage ran log, and outdoor usability. A simple, low-cost, precision agriculture monitoring systems that is highly portable and rugged for outdoor use, self-powered to reduce the need of extensive cabling for power supply, while providing additional functionality that reduced agriculture workload and increases crop yield and profits was developed. In semi-arid regions of emerging countries, small farmers and marginal farmers (who have land b/w 4 and 6 hectares) are facing many problems regarding powered irrigation. Most of the time they are relying on seasonal precipitation for their productivity. The data acquisition unit consisting of sensors and microcontroller could successfully capture the environment parameter data such as temperature, humidity, light intensity, and soil moisture content. Next, by utilizing IoT technology, the information captured by the sensors was uploaded wirelessly to the cloud server to be viewed by users via an internet-enabled device.cThis information is useful for the field managers to distribute resources, produce predictive models for crop growth, and automate farming equipment. This leads to efficient agricultural operations and use of resources, reduced running cost and workload, and improved crop productivity. The WSN system developed in this research work provides an improved monitoring range while the rugged, weatherproof solar-powered data acquisition unit was found to be suitable for extended outdoor use Furthermore, the monitoring system test determined the accuracy of the data acquisition unit while the automation of control system via monitoring of environmental parameters was determined to be reliable at maintaining the conditions inside the small-scale greenhouse for optimum plant growth Consequently, a system becomes fruitful for monitoring structures for agriculture like moisture, humidity, temperature, a leaf growth, water-spray with pesticides through the motor-pump through an IOT module. This mechanism decreases a workforce and the manual labor. This configuration was performed via Ar-

DOI: http://doi.org/10.30564/jrb.v2i2.1900

duino UNO, soil moisture sensor, humidity and temperature sensor, IoT module and ultrasonic sensor.



A Thing-speak page possibly be established to handle a structure via any device (Mobile or Laptop). The mutilation caused by plant attackers is abridged and can even be utilized to enhance production. A whole system is linked under an ultrasonic sensor to watch plant growth; farmers can always monitor their plants anyplace on the web. In the future, novel materials, such as the corn processing robot, are advancing by combining and gathering data through software using robotics to inseminate corn, use seed crops as well as gather info to increase yields and harvests to decrease waste. IoT sensors that provide farmers having information on crop yield, soil nutrition and pest infestation are valuable for crops productivity and provide accurate information.

Acknowledgments

The work was sponsored by the synergistic innovation center of Jiangsu modern agriculture equipment and technology (No.4091600014).

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Zhao, J.-c., et al. The study and application of the IOT technology in agriculture. in 2010 3rd International Conference on Computer Science and Information Technology. IEEE, 2010.

[2] Sreekantha, D., A. Kavya. Agricultural crop monitoring using IOT-a study. in 2017 11th International Conference on Intelligent Systems and Control (ISCO). IEEE, 2017.

[3] Cuong, T.X., et al.. Effects of silicon-based fertilizer on growth, yield and nutrient uptake of rice in tropical zone of Vietnam. Rice Science, 2017. 24(5): 283-290.

[4] Deshpande, P., A. Damkonde, V. Chavan. The Internet of Things: Vision, Architecture and Applications. International Journal of Computer Applications. 975: 8887.

[5] Khanna, A., S. Kaur. Evolution of Internet of Things (IoT) and its significant impact in the field of Precision Agriculture. Computers and electronics in agriculture, 2019. 157: 218-231.

[6] Suma, N., et al.. IOT based smart agriculture monitoring system. International Journal on Recent and Innovation Trends in computing and communication, 2017. 5(2): 177-181.

[7] Patil, K., N. Kale. A model for smart agriculture using IoT. in 2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC). IEEE, 2016.

[8] Prathibha, S., A. Hongal, M. Jyothi. IoT based monitoring system in smart agriculture. in 2017 International Conference on Recent Advances in Electronics and Communication Technology (ICRAECT). IEEE, 2017.

[9] Sushanth, G., S. Sujatha. IOT based smart agriculture system. in 2018 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET). IEEE, 2018.

[10] Davcev, D., et al. IoT agriculture system based on LoRaWAN. in 2018 14th IEEE International Workshop on Factory Communication Systems (WFCS). IEEE, 2018.

[11] Abbasi, A.Z., N. Islam, Z.A. Shaikh. A review of wireless sensors and networks' applications in agriculture. Computer Standards & Interfaces, 2014. 36(2): 263-270.

[12] Roselin, A.R., A. Jawahar. Smart agro system using wireless sensor networks. in 2017 International Conference on Intelligent Computing and Control Systems (ICICCS). IEEE, 2017.

[13] Kavitha, B., et al.. Agricultural Crop Monitoring Sensors using IoT-A Study.

[14] Muthukumaran, N., R. Ravi. Hardware implementation of architecture techniques for fast efficient lossless image compression system. Wireless Personal Communications, 2016. 90(3): 1291-1315.

[15] Krishna, K.L., et al. Internet of Things application for implementation of smart agriculture system. in 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC). IEEE, 2017.

  DOI: http://doi.org/10.30564/jrb.v2i2.1900