A smart Agriculture Irrigation System using sensor array based IOT

Kola Murali, B. Sridhar

1PG student, Lendi Institute of Engineering and Technology, Vizianagaram-535005 India
Email: muralikola97@gmail.com
2Professor, Lendi Institute of Engineering and Technology, Vizianagaram-535005 India
Corresponding author’s e-mail: srib105@gmail.com

Abstract. The role of Agriculture is important to build a nation, since more than 58% of the population in our country is dependent on agriculture that means half of the population is investing in agriculture. However, many farmers are unfamiliar with intelligent irrigation systems designed to improve the water used for their crops. The proposed system is to precisely monitor the distribution of the water to crops. This IOT based system has a distributed wireless network of soil moisture sensors to monitor soil moisture. Other sensors such as temperature, humidity, rain, IR, LDR, foot. The gateway device also processes the detector’s information and transmits the data to the farmer. An algorithm was developed using threshold values for soil moisture and nutrients, and these values were programmed into a node com-based gateway to control water for irrigation. Complete sensor data is sent to the free cloud using NODEMCU and displayed on websites and apps. This proposed work presents extensive research on irrigation systems in smart agriculture.

1. Introduction

Modern world has required a huge amount of food for the improved population. They need to focus on Agriculture to make automation. We need smart systems to manage and monitor the farming remotely. This should provide water as needed and also provide some nutrients inside the soil. In addition, this intelligent system must control the entire farm. This type of intelligent system can be designed with minimal cost using microcontrollers, water level detectors, temperature, humidity and colour sensors, and an Internet or intranet connection with devices such as smartphones or computers. The designed system mainly comprises two modules; Embedded module and Ethernet Communication module. The first module contains Water level detector, Temperature and humidity, colour sensor and controller which are placed in smart farming to sense the parameters. The data is transmitted by Ethernet shield through Wi-Fi using node MCU(ESP8266).[1,2]

The embedded system module acquires the information of farming sensors and performs the respective function in real time. It has two modes of operation i.e. Automatic mode and manual mode. The system operates with continuous feedback automatic mode at given threshold values using GUI based IP mode. This kind of system is suitable for any kind of farming with some little modifications. Agriculture is India’s main source of income, with 70% of farmers and ordinary people dependent on Farming.[16]. Manual sidewalk irrigation systems choose most methods such as drip, cascade and trench irrigation [1-5]. In order to increase the productivity of agricultural crops, it is urgently necessary to shift manual irrigation.
methods to automation [6]. Water is one of the most valuable resources that need to be protected and stored for future water availability.

Built-in automated irrigation systems are suitable for farmers because they are cheap and easy to install [7]. The system will help farmers who irrigate their crops at the right time. The IoT irrigation system monitors the humidity and temperature sensors around the crop, ensuring the correct start and stop times of the engine. In this way, automated people avoid human error and manual check level of moisture of soil [8,9]. The IoT system allows you to control the Internet remotely. It can control sensors used in various blind spots of rail networks and water monitoring systems. The operation and human errors are avoided by the above mentioned way. [11]. The Internet of Things is a new area that is entering other areas to achieve performance. Currently, new sensors, sensor networks and radio frequency communications are being developed [17, 18]. It can detect intelligent, well-identified, accurate detection. The rise of cloud computing with this has replaced computer networking and mobile technologies. Other networks today include NFC, RFID, WIMAX, WPAN, GSM, LTE, 3G and Zigbee 3G, Bluetooth so that IoT can be developed as an intelligent system and this can be remotely controlled [12,13 ]

S. Muthunpandian et.al [1][14] stated that they have developed and implemented an automated system for continuous monitoring of arable land. The water level in the cultivable land which consumes electricity in the cultivable land has been maintained by the IoT model. Joaquin Gutierrez et al. shown that water use was kept to a minimum and that he activated solar energy to reduce energy consumption. It is developed by smartphones that work with sensor data on the website.

Mohan Raj et.al [3] focused on data monitoring in the agricultural cycle with a GSM sensor based on the ATMELE microcontroller, which is used to monitor changes in the windmill water level pH temperature. Since then, an IoT setup based on Arduino has been used, but in our opinion, it is more suitable for monitoring a large number of raspberry pi modules. Michael Williams [4] successfully demonstrates a Raspberry Pi based IOT model. The microcontroller also showed its potential to implement the systems on security setup, Home automation, entertainment power plants etc. [3,10].

The purpose of this work is to monitor highly accurate data and control agricultural automation using IoT technology. NodeMCU and IoT cloud configuration come from crops for real-time data monitoring. This model focuses primarily on humidity changes related to temperature change data obtained from smart sensors and controls the irrigation characteristics. In order to bring cloud computing into the model, the level of accuracy has been increased so that this can be made usable by farmers. The dissertation consists of an introduction, a description of the equipment, a proposed algorithm, results and discussion, and a conclusion.

2. Smart Agri System

Recent reports by the United Nations Food and Agriculture department estimated that in 2050 the world population will reach 9900 million. A major challenge will be to achieve the level of agricultural production necessary to meet the planned global demand for food and feed, fibre and fuel by 2050.

This has faced major challenges in the past, but it must specifically target productivity. By 2050 to address major barriers such as lack of resources, shortage of skilled labour, access to land and climate change. Precise Agriculture(PA) is presented as a solution to the serious problems facing agriculture and our world. For 30 years, the Palestinian Authority has adopted a simple method that exploits a variety of space, time and production, but it has proven to be an effective management method that applies accurate information at the right time. Write the correct amount of AP "R" concepts at the right time (Hosla, 2010).

Over the years, PAs have evolved globally and are slowly adopting new independent, unorganized, and resource-based technologies. The first decade of PA focuses on satellite terrestrial navigation services (GNSS) and the ability to detect and quantify local variations on Earth. For the past 20 years, we have focused on developing technology for precise resource management, such as tractor automation and crop fertilizer.
For more than 30 years, location-based agricultural data collection has evolved rapidly with sensors and sensor devices, providing new examples of fact-based management decisions for accurate control. Thus, future farming methods, production success, efficiency and sustainability will largely depend on "cultivation" as well as "crop data". Furthermore, it must be vigilant to overcome today's challenges with the IoT model as it is the right one to transform all areas and technologies related to smart technologies. Smart cultivation can be done by Advances in proximity detection and data processing techniques to overcome locally constrained data limits that can provide information on environmental characteristics, crops and soil. Recently, the number of proximity detection methods is increasing due to the fact that non-invasive methods are economical and economical [16-19]. These sensors must be interpreted to produce, collect, store, transmit, process, analyse, share and convert data into new information and behaviours (Figure 1). The sensor data generated by a single sensor does not provide relevant information that can be used to fully understand the situation. Therefore, sensor data collected from various sensors needs to be added, they generate data that do not provide the desired information about the current situation. However, need to understand the data sorted and correlated as per the requirement. Agricultural applications for mobile and cloud platforms can be integrated with wireless sensors to collect information related to environmental conditions.

![Diagram](image)

**Figure 1.** Agricultural internet of things model.

In order to avoid human interpretation to make accurate decisions and improve the quality, an App based crop monitoring management plays a prominent role. The App can easily operate by the former. The IoT based network shown in Figure 1 is developed to interface the Apps along with various types of sensor to observe the data from the crop. Here a decision is made accurately by using a dynamic model with time and thoroughly experimented. It allows the development of agricultural knowledge based on the collected experimental data to update the best practices [20].

### 3. Hardware components description:

#### 3.1. NodeMcu ESP8266:

NodeMCU denoted with ESP8266 which provides absolute and autonomous Wi-Fi network resolution and can host functions from a shared app processor or duplicate all Wi-Fi network functions. Once the ESP8266 fulfils this function, it becomes the device's only "application processor" and boots directly from external flash memory. It includes an integrated "cache" for significant development of module functions, including Wi-Fi adapters, wireless Internet access, and simple "UART" connectivity to complete any microcontroller platform design. Figure 2 above shows the NodeMcu ESP8266 module [21].

![NodeMcu Wifi-Module](image)
3.2. SENSORS:
The proposed work uses a variety of sensors to implement IoT operations to detect and monitor humidity, soil moisture, CO2, temperature, PH, and water levels.

3.2.1. Soil Moisture Sensor:
The below image shows the soil moisture sensor to monitor the moisture content in the soil.

![Soil Moisture Sensor](image1)

Figure:3A Soil Moisture Sensor

3.2.2. Temperature & Humidity Sensor:
Figure 3B shows the DHT-22 sensor, a digital temperature and humidity sensor used to measure temperature, humidity and temperature in real time at your current location.

![DHT-22 Sensor](image2)

Figure 3B. DHT-22 Sensor

3.2.3. Rain Sensor:
Figure 5 above shows a rain sensor used to determine the intensity of rain falling on a raindrop.

![Rain Sensor](image3)

Figure:4 A. Rain sensor

3.2.4. Ultrasonic Sensor:
Ultrasonic sensors shown in figure 6 are used to measure the distance of the objects using echo of sound at Ultrasonic frequencies. The sensor converts the sound wave into an electrical signal. Here it is used to check the pest on the crop.
3.2.5 **PIR Sensor:**
Figure 5A shows that the PIR sensor can be used to detect motion. It is almost always used to determine if a person has entered or left the sensor range.

3.2.6 **Light Dependent Resistor (LDR):**

The above Figure shows the LDR sensor used to find the light intensity in the cultivation field. All these are small, cheap, low power, easy to use, and do not run out.

**4. ThingSpeak Website:**
ThingSpeak is a web platform with an open API IoT source of information that extensively stores sensor data for various "IoT Applications" and displays the resulting data graphically on web tires. It communicates over an Internet connection that acts as a "packet bearer" between connected "objects" and ThingSpeak Cloud, retrieving, storing, analysing, observing and manipulating data from
connected sensors. Is. Arduino, NODEMcu module, Raspberry-pi, etc. This helps create "social networks" of things with sensor-based registration apps, location / location tracking apps and state updates as an alternative to managing "home automation" products connected to public networks. The biggest feature of this (on the Internet) when determining location is the term "channel", which includes the data field, the location field, and the status field for various sensing data. Data can be used in creating feeds on it, and MATLAB can be used to process and present information and respond to data with tweets and other alerts. With this we can create a public channel for community analysis and evaluation. To use "object / object" to detect everything and transfer it to the Internet, you need to connect the data to the PC, the object to be stored (sensor). To do this, the data must be uploaded to the network. What type of server (running applications) and what type of server counts as cloud? "Cloud" uses the graphical rendering task and is presented to users as a virtual server, and objects interact with the cloud via the available "WLAN connection". Internet connections available to consumers and most businesses use sensors / activators to convey analog information to the environment. The Internet of Things helps to integrate everything and allows us to interact with components, and more interestingly, objects / things allow us to interact with other "things". The image below shows the Ting Spec ID and API key [21].

5. Block Diagram and Explanation:

This section describes the project methodology applied to the project. Guidelines used to complete the project from start to finish. The methodology consists of several activities that have been implemented to allow the project to: Complete successfully [24].

5.1 System Design

This session discusses in detail the progress made in designing a real-time air quality reporting model. Therefore, this chapter covers the design and construction of a real module as shown in Figure 1. This can be divided into two categories:

i) Hardware development part. ii) Part of software development [23].

This low cost configuration consists of the Arduino and Node MCU sensor node network. To connect Wi-Fi and fast monitoring of the sensor data node MCU included in the work, which access the network easily and remote server. Arduino Uno interfacing with DHT 11 sensor for monitoring temperature and humidity of the given environment and 4

Process of the data based on threshold value with reference to the other sensors those are barometric pressure and Air quality sensor, which are interfacing with Node MCU. The gas sensor is detecting the carbon dioxide and carbon monoxide gases with reference to pressure and DHT11 sensors [14]. The threshold values are adjusted in the setup as per the quality standards of air. This can continuously be monitored with IoT cloud server-ThingSpeak. Users can access the data either by using Android mobile or by internet. When the gases have reached above the threshold value, the network has sent an immediate alarm to the users. So they immediately save their life’s and also the proposed model has connected exhaust fans to exhaust the gas from that environment. We can observe detailed hardware in the block diagram picture :6.
5.2 Software development part
The process of the software developed has given in flow chart fig:7. Block diagram of a programming model. Block diagram showing temperature, humidity and light intensity on an LCD screen. Scheme for measuring temperature, humidity and soil moisture on THINGSPEAK:

6. Sensing and Monitoring Operations Flow
The below programming flowchart are shown with temperature, humidity and soil humidity on the LCD, Table of soil temperature, and humidity on the THINGSPEAK website.

7. Results and Outputs:
As shown in the figure: 3 DHT11 voltage, ground connected to + 5V and 0V, the signal can be connected to any digital pin 8 of the MCUNode MCU, and other components such as voltage level
from MQ135, ground, etc. to +5V and analog output. This pin is connected to the analog A0 pin of the MCU [22]. As shown in the Figure. 4: LCD RS pin digital pin 12, digital pin 11 activation pin, D4 pin digital pin 5, D5 pin digital pin 4, D6 pin digital pin 3, D7 pin digital pin 2, R/W pin grounded VSS - Pin grounded, vcc pins are 5 V, the 10 k resistors are +5 V and ground and slider are on the LCD Vo pin. The DHT 11 data pin is connected to the digital pin of the MCU node, and the MQ135 pin is connected to the analog pin shown in figure. 8.

Thingspeak allows sensors, devices and websites to send data to the cloud, where the data is stored in private or public channels. Once the data hits the feed, we can analyse and visualize it, calculate new data, or interact with social media, web services, and other devices.

Figure: 8A. Functioning of Proposed work in laboratory, Figure 8B. Working of the Proposed in Real time crop Field.

7.1 Steps for Experimentation
Step 1: - This is the hardware of the project. First, start the kit with the toggle switch.
Step 2: - First we need to subscribe to the thingspeak web page using our email address and then we need to create a channel based on the project name.
Step 3: - This is the IoT webpage. We need to log into the website using our email address and we can communicate with NodeMCU on the device via the Wi-Fi module.
Step 4: - After successfully logging into this. Now you can see the name of the previously created project channel.
Step 5: - We can observe the temperature of the plot, soil moisture and moisture level, which can be beneficial for plant growth. This is observed when the data observed on the website is loaded into the Thing speak database using the Wi-Fi module connected to the NodeMCU [1].

Here, the sensor output is considered as a graphical representation. Benefits Electric shock, less risk of leaving poisonous animals in the field. Watering depends on the level of humidity in the area. All form parameters can be viewed in an online graphic document. Effective and inexpensive design. Effective and affordable design; quick response; ease of use.

Experiments are to review IoT networks with Soil Moisture, Temperature, Humidity, LDR, Ultrasound, Rain Sensor and integrate them with the cloud. Including two IoT sensors. All sensors were connected to an in crop field in picture 8. These sensors are interfaced to NODE MCU. Sensors are generating the real-time information for various field parameters to make up the motors on/off. IoT devices and setup are programmed to receive data. Send sensors (current and voltage information) connected to the platform.

More precisely, every 15 seconds, the IoT sensor device can provide 6 parameters such as moisture level, temperature, humidity values. This information has sent to the website server using the concept of channels in the publish / subscribe paradigm. Internet of Things for Research the PQ device
publishes the above 6 parameters related to provide precise irrigation to crop fields. Figure 9 shows the energy information connected to the IoT device throughout the kitchen Soil Moisture, Temperature sensor. On the farming field, this information can be accessed from any device and from anywhere with an Internet connection. The interval measured in Figure 9 humidity level and sunlight intensity level contains an average value. Figure 10 Depends on the pest monitoring by the value of ultraSonics sensor values, it will display different hands from 0 to high value according to the random movement of pests. Figure 11. It represents an average rain value in day/ week close depending on the motor for irrigation is on/off, Such that if no rain with respect to time and it remains closed to zero.

Construction of hardware and its functioning Fig:18 NodeMcu Interface with Sensors, Motor, Arduino IDE.

8. Conclusion:
An intelligent irrigation network monitors and controls the farm's irrigation system. It is based on IoT technology and monitors the condition of the agricultural soil through the integration of many sensors such as temperature sensor, moisture sensor, soil moisture sensor, LDR, rain sensor, etc. In addition, the sensor connects to the internet via a Wi-Fi module. Users can control the irrigation characteristics through reports displayed on the application on the mobile platform. The program displays sensor values and monitors the water pump in an emergency. This is to warn users and to make this setup easier to use. After all, microcontrollers are small and applicable to any environment, the Internet of Things is evolving all over the world, from all angles, and the ThingSpeak IoT web service is an interesting web technology with the ability to create as Expectations of designers.

References

[1]. J. JegatheshAmalraj, S. Banumathi, J. JereenaJohn, “A Study On Smart Irrigation Systems For Agriculture Using IoT”, International journal of Science & Technology Research, volume 8,issue 12,December 2019.

[2]. R. N. Rao and B. Sridhar, “IoT based smart crop-field monitoring and automation irrigation system.” 2nd International Conference on Inventive Systems and Control (ICIISC), 2018, pp. 478-483, 2018 doi: 10.1109/ICIISC.2018.8399118.

[3]. Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Ángel Porta-Gándara ," Automated Irrigation System Using a Wireless Sensor Network and GPRS module”, IEEE Transactions On Instrumentation And Measurement, Vol. 63, No. 1, January 2014

[4]. Roopaei, M., Rad, P., Choo, K.R., Choo, R.,’’Cloud of things in smart agriculture: intelligent irrigation monitoring by thermal imaging.’’ IEEE Cloud Comput. 4, 10–15. 2017

[5]. H. Saini, A. Thakur, S. Ahuja, N. Sabharwal, and N.Kumar, “Arduino based automatic wireless weather station with remote graphical application and alerts”, 3rd International Conference on Signal Processing and Integrated Networks (SPIN), Feb 2016, pp. 605–609.

[6]. S. R. Nandurkar, V. R. Thool and R. C. Thool, “Design and Development of Precision Agriculture System Using Wireless Sensor Network”, IEEE International Conference on Automation, Control, Energy and Systems (ACES), 2014.

[7]. JoaquinGutierrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Angel Porta-Gandara,” Automated Irrigation System Using a Wireless Sensor Network and GPRS Module”,IEEE Transactions on Instrumentation And Measurement, vol-21,pp.211,2013.

[8]. B. Sridhar, S. Sridhar and V. Nanchariah, “Design of Novel Wireless Sensor Network Enabled IoT based Smart Health Monitoring System for Thicket of Trees,” 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC), 2020, pp. 872-875, doi: 10.1109/ICCMC48092.2020.900161.

[9]. V. Vidya Devi, G and Meena Kumari, “Real- Time Automation and Monitoring System for Modernized Agriculture”, International Journal of Review and Research in Applied Sciences and Engineering (IJRRASE) Volume 3, Issue 1, Pages: 7-12, 2013.

[10]. Y. Kim, R. Evans and W. Iversen, “Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network”, IEEE Transactions on Instrumentation and Measurement, Pages: 1379–1387, 2018.

[11]. Q. Wang, A. Terzis and A. Szalay, “A Novel Soil Measuring Wireless Sensor Networkl, IEEE Transactions on Instrumentation and Measurement”, Pages: 412–415, 2018.

[12]. Indian Economic Survey, http://mofapp.nic.in:8080/economicsurvey, Govt. of India, 2018.

[13]. R. Venkatesan and A. Tamilvanan, “A sustainable agricultural system using IoT,” International Conference on Communication and Signal Processing (ICCSP), 2017.
[14]. G. Arvind and V. Athira and H. Haripriya and R. Rani and S. Aravind, "Automated irrigation with advanced seed germination and pest control", IEEE Technological Innovations in ICT for Agriculture and Rural Development (TIAR), 2017.

[15]. JP Vasseur, N. Agarwal, J. Hui, Z. Shelby, P. Bertrand and C. Chauvenet, “RPL: The IP Routing Protocol Designed for Low Power and Lossy Networksl, Internet Protocol for Smart Objects (IPSO) Alliance”, White Paper, 2011.

[16]. Vaishali, S, “Mobile Integrated Smart Irrigation Management and Monitoring System using IOT.” Communication and Signal Processing (ICCSP), International Conference on. IEEE, 2017.

[17]. Jagannathan, S, and R. Priyatharshini. "Smart Farming System using Sensors for Agricultural Task Automation." Technological Innovation in ICT for Agriculture and Rural Development (TIAR), IEEE, 2015.

[18]. Wenjiang Huang, Qingsong Guan and JuhuaLuo, “New Optimized Spectral Indices for Identifying and Monitoring Winter Wheat Diseases”, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Volume 7, Issue 6, Pages: 2516-2524, 2014.

[19]. S.G. Galande and ShalakaR.Londhe, “Leaf disease Detection and Climatic Parameter Monitoring of Plants Using IOT”, International Journal of Innovative Research in Science, Engineering and Technology, Volume 4, Issue 10, Pages: 9927-9932, 2015.

[20]. Roopaei, M., Rad, P., Choo, K.R., Choo, R., “Cloud of things in smart agriculture: intelligent irrigation monitoring by thermal imaging”. IEEE Cloud Comput. 4, 10–152017.

[21]. S. Gangopadhyay and M. K. Mondal, “A wireless framework for environmental monitoring and instant response alert,” 2016 International Conference on Microelectronics, Computing and Communications (MicroCom), Jan 2016, pp. 1–6.

[22]. T. Thaker, “Esp8266 based implementation of wireless sensor network with LINUX based web-server,” March 2016.

[23]. Viani, F., Bertolli, M., Salucci, M., Polo, A., “Low-cost wireless monitoring and decision support for water saving in agriculture”. IEEE Sens. J. 17, 4299–4309. 2017.https://doi.org/10.1109/JSEN.2017.2705043.

[24]. Y. Zhou, Q. Zhou, Q. Kong, and W. Cai, “Wireless temperature amp; humidity monitor and control system,” 2012 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet), April 2012, pp. 2246–2250.