International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161
Available at http://inpressco.com/category/ijcet

Research Article

Smart Agriculture Monitoring system using Internet of Things

Prathmesh Bajare and Prof. B. B. Gite

Dept. of Computer Engineering, Sinhgad Academy of Engineering, Kondhwa Pune, India,

Received 10 Nov 2020, Accepted 10 Dec 2020, Available online 01 Feb 2021, **Special Issue-8 (Feb 2021)**

Abstract

The population of India mostly depends on agriculture. Agriculture contributes most of the part of the Indian economy. There is a hindrance to agriculture due to the migration of the people from the ruler area to an urban area. To stop this migration, there is a need for advancement in the agriculture field. The traditional irrigation system required lots of manual intervention, manpower and time. This can be minimized by an automatic smart agriculture system. An automatic smart agriculture system can be saving the time, money and power of the farmer. Smart agriculture is an emerging idea because sensors are capable of providing real-time information about the agriculture field. In this paper, smart agriculture based on the internet of Things has been proposed. This system uses the advantages of new technology such as NodeMCU, IoT and Wireless sensor networks. The main aim of this approach is the making use of a new era of technology i.e. IoT for smart farming automation. This system monitors the temperature, humidity, moisture using the respective sensor and upload to the cloud using NodeMCU.

Keywords: *Agriculture; cloud; IoT; NodeMCU; Smart Farming, environment parameters.*

Introduction

Indian people have agriculture is as their primary occupation. As per the survey, 58% of the rural areas people in India are dependent on agriculture for daily expenses. According to the second advised estimate of Central Statistics Office (CSO), the agriculture field contributes about 8% Gross Value Addition which is significant and important for the national economy. Under such a scenario, the usage of water particularly the freshwater resource by agriculture will be huge and according to the current market surveys it is estimated that 85% of available freshwater resources worldwide used by agriculture. These statistics will continue to be leading because of population expansion and increased food demand.

This calls for arrangements and strategies to use water sensibly by utilizing the improvement in technology. There are a lot of systems to achieve water savings in different crops, from basic ones to more technologically advanced ones. One of the states of art systems uses thermal imaging to monitor the plant water status. Automation of irrigation systems is also possible by measuring the water level in the soil and control actuators to irrigate as and when needed instead of predefining the irrigation schedule, thus saving and hence utilizing the water in a more sensible manner.

The paper is organized as Section II reviews the different approaches for IoT based smart agriculture. The proposed system with a block diagram and explanation of each component is explained in section III. The circuit diagram and working of the system are discussed in section IV. The result is discussed in section V and Finally, the system is concluded in section VI.

Literature Survey

Various approaches to smart farming have been introduced by different researchers. In this section, some of the paper and approaches related to this research has been reviewed.

K. A. Patel et al. [1] proposed an irrigation model based on the concept of Information Communication Technology. The main objective of this research is to gather real-time data from the agriculture field and on the basis of that data analysis system provides some outputs. The alert facilities were provided through SMS services.

J. Jayaprahas et al. [2] proposed an embedded soil analyzer that measures the pH value of the soil in the agriculture field. Further, based on the pH value of the soil, the nutrient value is calculated. This system consists of a microcontroller unit, sensors, signal conditioning, power supply, and thermal printer. This approach helps to predict the soil sequence on the basis of nutrient availability. Based on the concentration of the nutrient, the system will paper point at soil fertility.

Anand Nayyar et al [3] present an IoT based smart stick that enables live monitoring of the different agricultural parameters. This stick helps farmers acquire live data of temperature, soil moisture. The agricultural IoT stick gives the idea of plug and measures in which farmers can instantly enact smart monitoring system by positioning the stick in the field and obtaining live data feeds on different smart gadgets like smart tablets, phones, etc. and the information which is produced through sensors could be simply analyzed and processed by agricultural experts even in remote areas via cloud computing technologies.

Chandan Kumar Sahu et al. [4] present a model where the flow and direction of water are supervised and controlled. This is done with the help of DHTT11 and soil moisture sensor. This method also proposes a way to select the direction of water and this information is also sent to the 9 phones and Gmail account of the farmer. This model also enables the farmer to switch on and off the motor with a single click. This paper proposes a prototype where the number of sensors is deployed at different positions in the field. This paper also shows how the proposed model makes the traditional irrigation system more effective and sustainable. This paper also suggests an efficient energy and network model. This paper presents a model that is energy-efficient, sustainable, automated and costeffective.

Apurva C. Pusatkar et al. [5] proposed a WSN based system that helps in real-time monitoring of the agricultural field. This paper focused on the fact that the yield rate in agriculture has become stagnant and hence they have included additional agricultural parameters that have to be monitored. In addition to the conventional parameters like humidity, temperature and soil moisture, this paper focuses on the water level, flood, wind direction, wind speed, weather, etc. Agricultural projects usually use wired communication which has various problems and hence this paper points on the use of the wireless network. The writer also proposes an alarm system that sends an alert to the farmer. The proposed model also includes the use of a Global System for Mobile (GSM), ZigBee, General Packet Radio Service (GPRS), Global Positioning System (GPS) for the secure transmission of data. It also suggests the use of an automated irrigation system that constitutes the embedded system leading to lesser use of farmer energy and money. This paper also helps in increasing the yield of the farm by optimizing water usage. The proposed irrigation system enhances water management and sustainability.

Laxmi C. Gavade et al. [6] suggest a model detect humidity of the soil, temperature, sunlight, N, P and K contents using sensors in the agricultural field. By measuring these parameters farmer can increase the productivity of the soil as it detects the nutrients deficient in the soil. The average productivity in India is less than the world average and this paper presents a way to attain 10 'evergreen revolution' in agriculture. Fertilizers play a vital role in good yield but imbalanced use of P, K, N causes a decrease in crop production. In the conventional method, soil sampling is done manually but this paper presents a chemical analysis that consists of three techniques: optical method, conductivity measurement, and electrochemical methods. These methods help in measuring the primary nutrients.

Mrs. T. Vineela et al. [7] devised that information must be collected from different sensors and live monitoring should be done but in this research paper, the stress is laid on getting things automated. In this paper, the writers aim at increasing the crop yield by using different technologies. It also presents a cost-efficient WSN for getting information from the humidity sensor, soil moisture sensor, and temperature sensors. This paper suggests an automated system for better crop production. The authors suggest a methodology that does sensing data smartly and also proposes a smart irrigation system. In the proposed model various sensors are interfaced with raspberry pi hence making an efficient wireless sensor network.

A. Khattab et al. [8] proposed an IoT architecture for precision agriculture applications. This architecture includes three-layered structure, the first layer collect the information from agriculture field and process agriculture actions; the second layer is a gateway layer the connect frontend to the internet and backend where the data storage and processing took place.

G. Suciu et al. [9] discusses the necessity of the latest technology in smart farming using Message Queuing Telemetry Transport (MQTT) protocol. Farmers gather data in various formats using mobile sensors together with mobile devices such as Smartphones regarding mainly the crops, soil, and weather allowing them to effortlessly access their data and monitor their crops. The collected data are sent to the core cloud platform where they are processed and analyzed using a specific algorithm. The results are sent back to the farmers to improve the agricultural process also allowing remote actuating of the irrigation system.

Proposed System

The development of a smart agriculture system using sensors, microcontroller within an IoT system is presented. The aim of the implementation is to demonstrate the smart and intelligent capabilities of the microcontroller to allow the decisions to be taken on watering the plants based on the continuous monitoring of the environmental conditions in the field. The block diagram of the proposed system is as shown in Figure . 1.

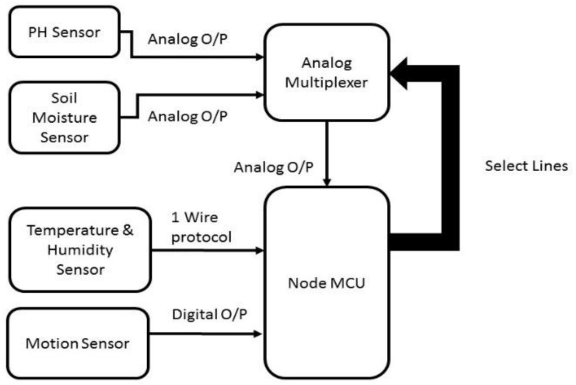


Figure 1. Block Diagram of the proposed system

The system implements key features of an ideal IoT based system which are data visualization and data logging. Received data from Node MCU is visualized in the form of text values and graphs. Text values are used to monitor the live data meanwhile graphs are used to understand deviation and patterns of changes in measures parameters that are refreshed every second. For further analysis, a large data set of measured parameters is required which is made available using data logging function on the cloud platform. It allows us to record reading at every minute which can be stored on the cloud for one year and it also provides excels sheets of logged data to keep a copy on local PC.

Each block of the proposed block diagram explains as below.

A. NodeMCU

NodeMCU is an open-source hardware and IoT platform including the ESP8266 Wi-Fi system-on-chip. The term 'NodeMCU' is called as firmware instead of DevKits. It uses the Lua scripting language. The programming code in the ESP8266 Wi-Fi model used the Arduino IDE by installing the library of ESP8266.

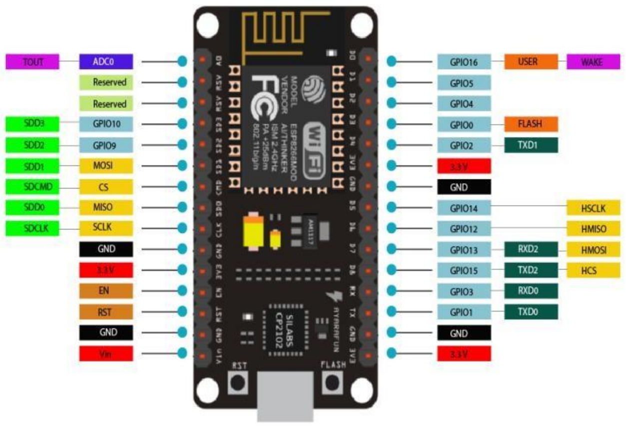


Figure 2. NodeMCU Model and its Pinout

B. pH sensor

Analog pH meter is specifically designed for the measurement of the pH value of the solution and conclude the alkalinity or acidity. The onboard voltage regulator facility provides a wide range of voltage operability of 3.3 to 5.5 V which is applicable to the board working on 3.3 V and 5V.

pH value measures the alkalinity or acidity of the solution. pH is also called the index of hydrogen ion concentration. It measures the scale of hydrogen ion activity in the solution. It is used in numerous applications in the field of medicine, agriculture. The value of pH is varied between 0 to 14 under thermodynamic conditions. The value of pH is equal to 7, it means the solution is neither alkaline nor acidic means neutral. The value pH less than 7, it means the solution is acidic and pH greater than means solution in alkaline or basic.

Figure 3. Gravity Analog pH Sensor

C. Soil Moisture sensor

Soil moisture sensor measures the water content present in the soil by using the basic property of the soil i.e. electrical resistance, dielectric constant as a proxy of the moisture content. The measured value and soil moisture calibrated based on the different environmental factors such as type of soil, temperature, electric conductivity.

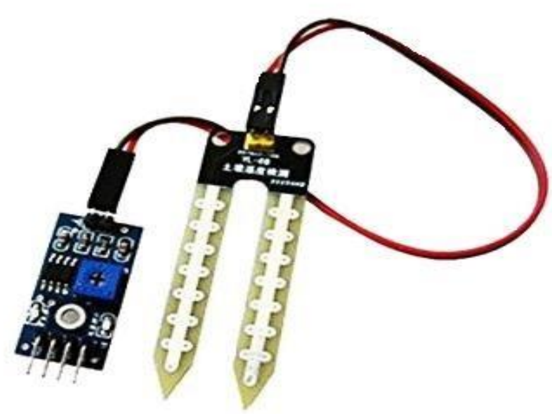


Figure 4. Soil Moisture Sensor

D. Temperature and Humidity Sensor

The temperature and humidity sensor is one of the most popular sensors among the embedded developers. It is widely used in the field of agriculture,

biomedical, environmental and consumer for measuring the real-time value of temperature and humidity. In this approach, the DHT11 sensor is used to measure the temperature and humidity of the soil.
DHT11 measures the humidity by measuring the electric resistance between the electrodes. The electrodes of the sensor are made of the moisture-holding substrate. when vapor has come in contact with the electrode, the substrate absorbed the vapor and start releasing the ions. These ions increase the conductivity between the electrodes. This sensor working on the principle of Negative Temperature Coefficient (NTC). Higher the humidity, more ions will be released and more conductivity is produced.

Figure 5. DHT11 Temperature and humidity sensor

E. Motion Sensor

The activity of the animal can be measure by the IR sensor. IR sensor is simply used as an obstacle detector sensor. This sensor has a pair of infrared transmitting and receiving tubes. The transmitter tube emits the infrared waves when the object come across the waves, the waves reflect back and received by the receiver tube. The onboard comparator circuit does the further processing and indicates the obstacle by glowing green light. This module has a three-wire interface with VCC, Ground, and Output. It is working on the voltage range of 3.3 to 5 V. The potentiometer is provided on the board to preset the range of operation. The effective range of this module is 2cm to 80 cm.

Figure 6. IR sensor

Circuit Diagram and Working Of The System

The circuit diagram of the proposed system is as shown in Figure. 2.

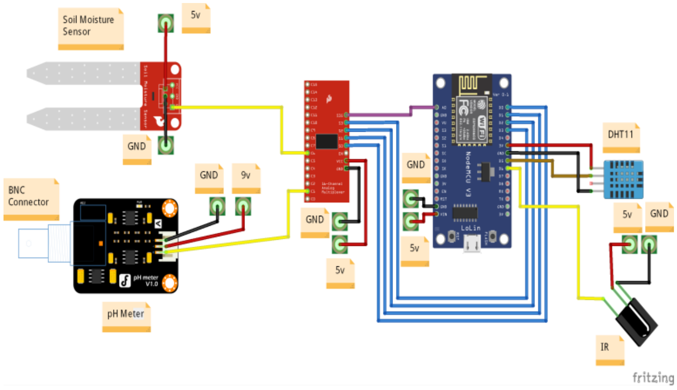


Figure 7. Circuit diagram of the proposed system

The system uses Node MCU as a controller as well gateway to cloud platforms using the internet. pH Sensor and Soil Moisture Sensor are used to measure pH level and moisture levels of the soil in the agricultural field respectively. PH Sensor as well soil moisture is analog but Node MCU has only on the analog pin. To resolve the issue a 16:1 analog multiplexer is used. The input sensor is chosen using select lines. The DHT11 sensor is used to measure the humidity and temperature of the surrounding environment. Node MCU communicates with Node MCU using 1 wire protocol. For motion detection digital IR sensor used. To communicate with cloud Node MCU requires the internet, which is accessed using the inbuilt Wi-Fi module ESP8266. The assumption in the system is that Node MCU is always connected to the internet. At the initial point of execution, all pins are configured as per their respective functions. Node MCU connects to the internet and attempts to connect to the cloud platform. After successful connection Node MCU starts taking readings from sensors. Using select lines Node MCU converts reading into digital values then afterward digitals values are mapped into appropriate pH values. Calculated pH values are posted to the cloud platform using a clouds communication library. Then using select lines analog signals from soil moisture sensors are read and then mapped into a percentage range of 0% to 100% and posted to the cloud platform. Node MCU reads temperature and humidity values from DHT11 and transfers them to the cloud platform. The motion sensor gives logic 0 output when motion is detected and vice versa which is posted to the cloud platform and displayed on the dashboard using the status indicator.

Result and Discussion

The stepwise analysis of the system is explained in this section. Figure 8 shows the setup of the system, consist of a hardware model and dashboard of the system shows on the monitor.

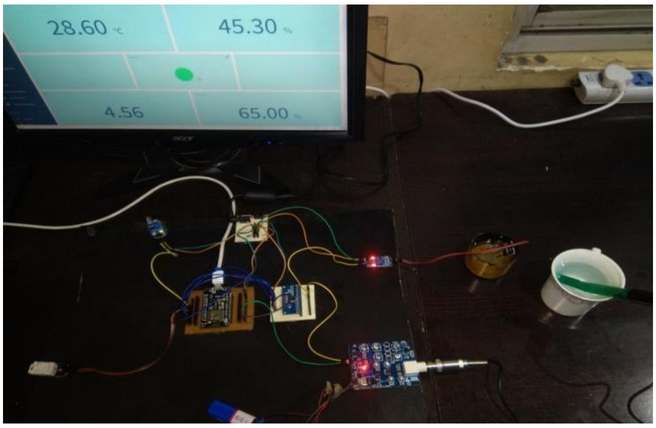
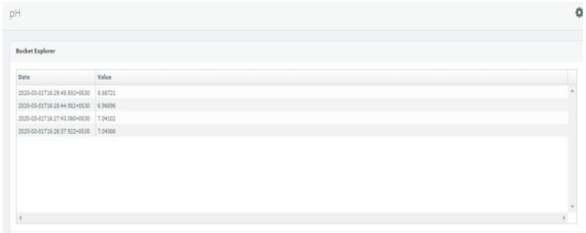


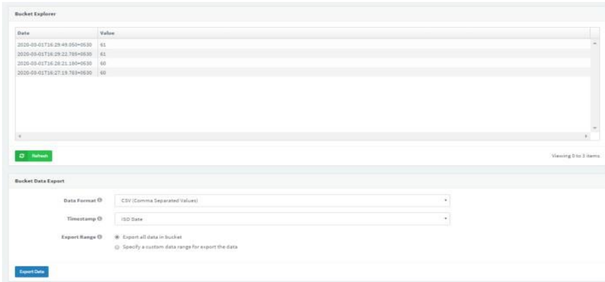
Figure 8. Setup of the IoT based smart agriculture system

The Dashboard of the system is as shown in Figure 9. The IoT based system uses a thinger.io cloud platform for live monitoring the real-time data. Figure 9 (a) shows a text value dashboard where live readings are displayed. Temperature, humidity, motion, pH, and Soil Moisture are displayed respectively. Figure 9 (b) is a dashboard where reading is plotted in graph format for a better understanding of deviations in parameters and patterns of changes in measures parameters. Figure 10 (a), (b), (c), and (d) shows data logging of Temperature Humidity, moisture, and pH. Meanwhile, Figure10 (e) shows exporting of logged data to email in excel format. For the quantitative analysis of parameters, a much larger dataset of measured parameters is needed. Data logging is a feature that allows users to log readings every minute, store on the cloud for over a year, and to export stored data on email in an excel sheet format to make the copy on the local machine.

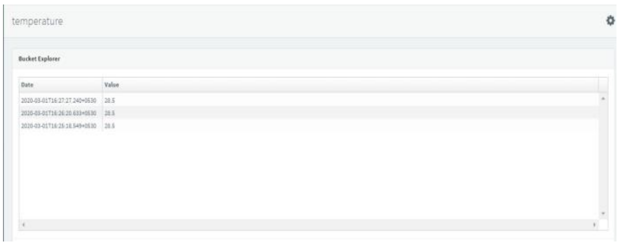
Figure 9. The dashboard of the system



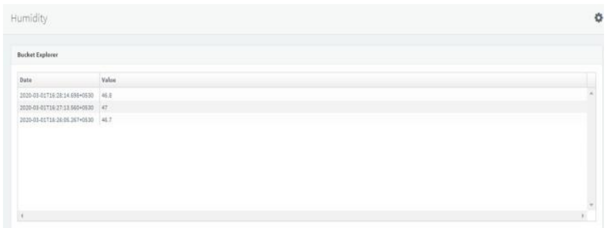
a



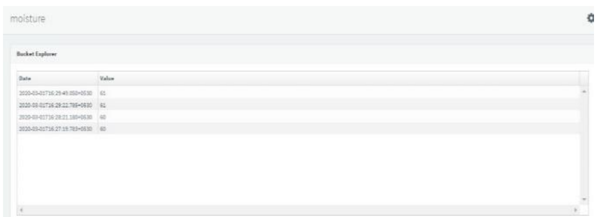
b



c



d



e

Figure 10. Data Logger Output for (a) Temperature (b) Humidity (c) moisture and (d) pH (e) Data export to excel

Conclusion

In this paper, the IoT based agriculture parameter monitoring system for a smart agriculture system is presented. The system measures temperature, humidity, moisture, and pH using the respective sensors. These values are uploaded on the thinger.io IoT platform using nodeMCU. These values can be monitor from anywhere. Another facility includes in this approach is animal detection using the IR sensor.

This system can prove to be very helpful for farmers to monitor the soil parameters and environmental parameters from the IoT platform. By selecting the predefined threshold for humidity, temperature, moisture, and pH, an alert can be produced for anomaly detection. The system also senses the attack of animals which is a prime reason for the reduction in the production of crops.

References

[1] K. A. Patil and N. R. Kale, "A model for smart agriculture using IoT," 2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC), Jalgaon, 2016, pp. 543-545.

[2] J.Jayaprahas, S.Sivachandran, K.Navin, K.Balakrishnan, "Real Time Embedded Based Soil Analyzer", International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 3, March 2014, pp.5700-5703.

[3] Anand Nayyar, Er. Vikram Puri, "IoT Based Smart Sensors Agriculture Stick for Live Temperature and Moisture Monitoring using Arduino, Cloud Computing & Solar Technology" May 2015.

[4] Chandan Kumar Sahu, Pramitee Behera, "A Low Cost Smart Irrigation Control System", IEEE sponsored 2nd International Conference on Electronics and Communication System (ICECS2015)

[5] Apurva C. Pusatkar, Vijay S. Gulhane, "Implementation of Wireless Sensor Network for Real Time Monitoring of Agriculture", International Research Journal of Engineering and Technology (IRJET). Volume: 03 issue: 05 | May-2016

[6] Laxmi C. Gavade, A.D Bhoi, "N, P, K Detection and Control for Agriculture Applications using PIC Controller", International Research Journal of Engineering and Technology (IRJET). Volume: 6 Issue: 4 | April 2017

[7] Mrs.T.Vineela, J. NagaHarini, Ch.Kiranma, G.Harshitha, B.AdiLaksh, "IoT Based Agriculture Monitoring and Smart Irrigation System Using Raspberry Pi", International Research Journal of Engineering and Technology (IRJET). Volume: 5 Issue: 1 | Jan 2018

[8] A. Khattab, A. Abdelgawad and K. Yelmarthi, "Design and implementation of a cloud-based IoT scheme for precision agriculture," 2016 28th International Conference on Microelectronics (ICM), Giza, 2016, pp. 201-204.

[9] G. Suciu, C. Istrate and M. Dițu, "Secure smart agriculture monitoring technique through isolation," 2019 Global IoT Summit (GIoTS), Aarhus, Denmark, 2019, pp. 1-5.