Grenze International Journal of Engineering and Technology, June Issue

Smart Agriculture System using IoT

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***Abstract*—Agriculture plays a vital role in the development of India, about 70% of the population is directly or indirectly dependent on agriculture, agriculture contributes 20% of India's GDP. Smart Agriculture is an application of IoT(Internet of Things) in agricultural practices. Use of the technology will be very helpful and beneficial for farmers and thereby for the country. This project will automate various aspects of the agricultural domain and thus help to reduce the burden of farmers. In the Smart Agriculture project, there has been a use of various sensors, NodeMCU, LCD and many other peripherals used in IoT. These devices help to detect various parameters involved in the agricultural field. IoT modernization helps in gathering information on circumstances like climate, dampness, temperature and fruitfulness of soil, by detecting these readings farmers can change their farming practices accordingly, to get maximum yield and a good crop. As the population is predicted to reach 10 billion people in 2060, and as a result of the population's rapid rise, there is a sudden surge in demand for food. Unfortunately, this increase in demand is only tangentially related to population growth. That is why there is a need for development of a system that will sustain this rising demand.**

***Index Terms*— Automation, Blynk application, IoT, NodeMCU, Smart Agriculture, Smart sensors.**

I. INTRODUCTION

Technology has become an integral part of human livelihood. This system aims to use the technology in agriculture as we are an agriculture dependent nation. While performing the agricultural practices farmers have to face many ups and downs due to bad environment conditions, sudden weather changes and many more. The traditional methods can lead to either unnecessarily excessive use of water or deficient use which can end up damaging the crop. It is necessary to develop an integrated ecosystem which will take care of all factors affecting productivity at every stage. To help farmers reduce the stress, a system was developed that brings automation in several steps involved in agriculture. The research proposes a system where various IoT devices are used in order to bring automation.
The proposed system makes use of components like NodeMCU, DHT11(humidity and temperature sensor), I2C module, Capacitive soil moisture sensor. Connections were made among these peripherals using jumper wires. It was decided to use the Blynk app for user convenience. The DHT11 sensor and soil moisture sensor were used to get readings from soil; DHT11 sensor detects the temperature and humidity of soil, and moisture sensors give moisture level of soil, these readings are then displayed on the Blynk app installed on the user's device.
After getting these attributes, a farmer can start the motor. A water pump is connected to the motor for releasing

Grenze ID: 01.GIJET.9.2.68

water into the farms. If required, the motor can be started by just one click on the Blynk app. This process becomes convenient as the farmer doesn't need to be there all the time in the farm to check for the moisture level and start the motor. Moisture, temperature and humidity values obtained from the sensors blended with the use of modern techniques will be helpful to farmers as it will not only monitor their crops' condition on a farm but also take necessary action in time. Thus, with minimal human effort, farmers can improve the quality of their produce and can implement the best-fit farming technique in order to increase the crop production.

II. LITERATURE REVIEW

To identify various approaches in developing a smart agriculture system, thorough literature survey was carried out on different research articles that were primarily based on IoT technologies. Moreover, the comparative study of these articles helped us in prototyping the proposed system.

These papers have used the microcontroller boards such as Arduino UNO and NodeMCU to achieve higher efficiency of embedded systems. The major reasons for utilizing these microcontrollers were the functionalities provided by them such as wide range of GPIO pins, enhanced processing capabilities with large memory, user-friendly environment setup to code, Wi-Fi support, cost-effectiveness. The readings are obtained from sensors. DHT11 and capacitive soil moisture sensors have been used for getting the values of humidity, temperature and soil moisture respectively. A motor is connected to pump water into farms. The data collected from sensors is transmitted through mobile technologies such as GSM, cloud platforms or via bluetooth. For applications requiring multiple sensors, a wireless sensor network can be created with data transmitting nodes. Along with the above-mentioned components, [12] has also used a raindrop sensor for measuring the rainfall intensity whereas [13] has used a pH sensor that provides critical feedback regarding soil nutrient deficiencies or the presence of unwanted chemicals. [4], [12], [13], [15], [16].

Extending the survey, it was found that some papers had some additional features. Some of them included tracking the level of water using an ultrasonic sensor or some of the papers were using Bluetooth technology for the transmission of data or the ZigBee protocol was implemented that guaranteed a longer coverage of data transmission. Along with this, one more distinctive feature was identified: Use of the advanced Raspberry Pi microcontroller board. Some papers were directly connecting Raspberry pi to the circuit whereas some included other microcontroller boards such as Arduino that was later connected to raspberry pi. An ARM7 processor was also implemented as it had a large number of pins available for connection, making it viable for larger applications such as implementation of a Wireless Sensor Network(WSN), so that multiple sensors of the same type can be connected to one single node before deploying it in actual farms. It was interesting to note that some of the papers suggested using a dedicated temperature sensor like LM35 whereas some spoke on the contrary to use DHT11 that solves the purpose of both humidity and temperature. These papers suggested that any of the available IoT interfaces such as , Blynk, Thingspeak, IoT Cloud or any other custom-made application can be utilized for developing the dashboards of the smart agriculture system. In [14], they used the Java programming language to build a similar custom application. [2], [3], [8], [10], [11], [14].

In [6], they developed the Internet Of Plants system. They specified general architecture and components of the IoT-based system by designing a PCB using the OrCAD software. They also implemented the concept of Artificial Neural Network(ANN) to help forecast the weather which can help farmers to adjust accordingly. DHT11 sensor and STM32L476RG microcontroller which supports USART protocol to communicate with the ESP-12E Wi-Fi module were integrated. Thingspeak was chosen for collecting and storing sensor data in the cloud.

A comparative study was presented in these papers. The challenges in developing such complex systems were also discussed. These included deficient production information, lack of awareness among farmers as to how to make full use of such devices, high cost of devices among many others. [17] suggested how innovations in the field of IoT can help overcome such barriers. These papers also shed light on the fact that IoT is not restricted to one particular area of interest and more diverse applications can be developed that solve problems faced in different areas with a single interface. [5] also suggests the impact of changing climatic conditions on small-scale farms and explains the role of IoT in regard for their protection. [1], [5], [7], [9], [17].

III. METHODOLOGY

The main motive of making this project is to integrate modern technologies with the sector of agriculture to pave the way for development. The Internet of things (IoT) is a revolutionary technology in this regard. Various complex real-life problems can be solved using IoT.

IoT has different components in itself. It is made of four distinct components: Sensors/Devices to capture data, Connectivity to transmit data using a network, Data analysis and processing and a user interface for better visualization. Let us try to understand the methodology of the proposed system by diving deep into all these four components.
Smart Agriculture System is a prototype which deploys different sensors that catch data and send it for processing making it apt for monitoring different parameters that affect a plant's growth. In this system, sensors have been deployed to measure three parameters. These parameters are moisture, temperature and humidity. The reading of moisture is captured by Capacitive soil moisture sensor while the readings of both temperature and humidity are sensed by the DHT11 sensor. Once this data is captured it is sent to a microcontroller for processing and performing the necessary operations. In the proposed system, the microcontroller used is NodeMCU which comes with a Wi-Fi module providing Internet connectivity. To execute the action of pumping water into the farmland which is discussed in the section of actual working, a water pump is utilized. And all these operations are commanded from an user interface created with the help of Blynk cloud.
Now, let us understand the actual working of the prototype. Firstly, capacitive soil moisture as well as DHT11 sensors are deployed which continuously sense the data from the environment. All these sensors are powered by a 3V power supply. All these sensors send this data to the NodeMCU microcontroller for processing. The microcontroller is in turn connected to a 16x2 LCD display. On this display, we generate the name of the system as well as the moisture levels. A DC Motor is also connected to the microcontroller with the help of a relay module. To make the user aware of the values, they are uploaded on the Blynk app. Blynk is an IoT interface which gives users the benefit of using different IoT functionalities through their cell phones. Three gauges have been created on the Blynk interface which display the value of moisture, temperature and humidity.
If the value of moisture displayed on the app is very less, then it will help the user to conclude that the water content in soil has drastically fallen and he needs to turn on the water supply. But this too can be achieved using the water pump integrated in the system. The motor can be controlled using a button created on Blynk which has two options on or off. The user can turn the water supply on or off with just one click. The whole system is connected with high-speed internet to work efficiently.
Setting up a dashboard on Blynk is also a very important step to complete the research. For this, any user needs to sign up on the portal. Once done, one can make a new template that acts as the skeleton for the interface. And then different buttons and gauges can be set up on this template. They take readings from the virtual pins and are connected using the code to the cloud. Wi-Fi name as well as password along with Blynk authentication token is required to be mentioned in the code.
Let us take a brief stroll in understanding the electronic components used in the proposed system.

Fig. 1. NodeMCU

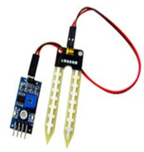

Fig. 2. Capacitive Soil Moisture Sensor

Fig. 3. DHT11 Sensor

A. NodeMCU

It is a microcontroller as well as an open-source platform based on ESP8266 making it Wi-Fi backed. It has got different pins to take power supply, establish connections among sensors.

B. Capacitive Soil Moisture sensor

This sensor measures the level of moisture based on the changes in capacitance rather than resistance. It is covered with corrosion-free material and thus can be placed in soil. The interface of this sensor is PH2.0-3P.

C. DHT11 sensor

This sensor stands for digital humidity and temperature. Temperature is measured using a thermistor while humidity using a capacitive humidity sensor. The humidity range lies between 20-90%RH while the temperature range is between 0-50℃. The error for the parameters is ±5% and ±2% respectively.

D. Relay module

It is a kind of electromagnetic switch which unlike other switches is turned on by an electric signal. When activated, the electromagnet results in the opening or closing of an electrical circuit. It requires a power voltage of 12V.

E. Water Pump

This is a DC motor meant for small-scale applications, operating on 9V power supply. It is used to pump water onto the farmlands.

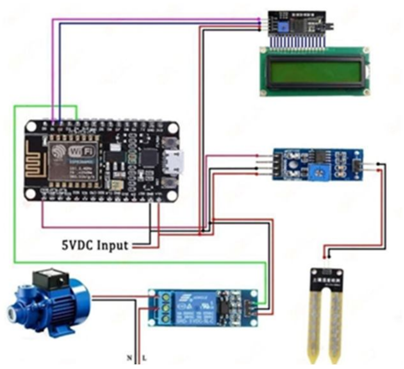

Fig. 4. Circuit Design of the proposed system

Figure 4 represents the circuit diagram of the proposed system. This makes it easy to understand how the connections are made for proper functioning of every individual component.

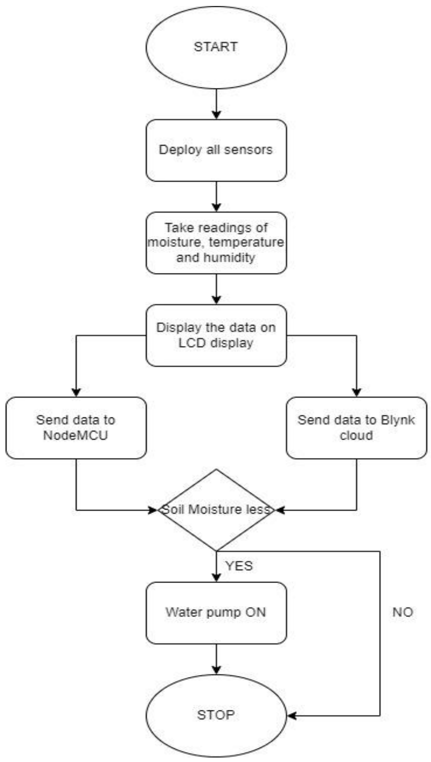

Fig. 5. Flowchart of the proposed system.

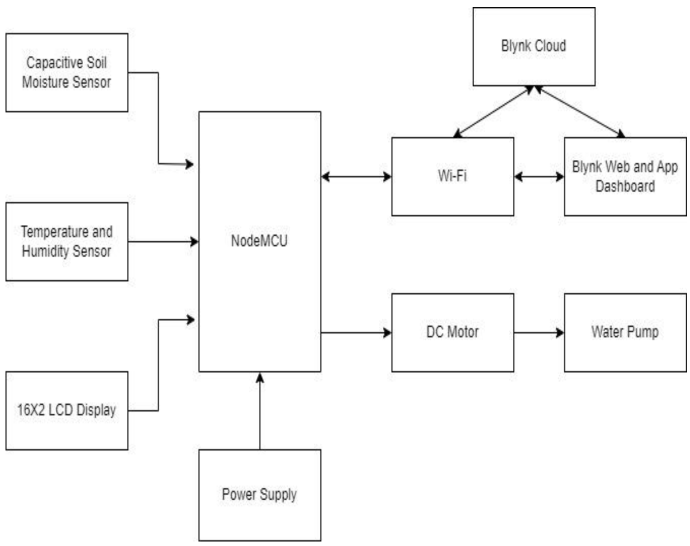

Fig. 6. Block Diagram of the proposed system

The flowchart of the system is shown in Figure 5. It gives us an idea about the mechanism of the system. The block diagram of the Smart Agriculture System is shown in Figure 6. It gives us a rough idea of how different components have been connected and how they perform in a synchronized manner.

IV. RESULTS

This section of the research paper involves evaluating the success of the proposed system. For this, testing has been carried multiple times with different parameters.Firstly, it was checked whether the sensors deployed are properly receiving the inputs from surroundings. These inputs were checked on the serial monitor. Once it was made sure that the values were correct, the next step was to update these values on the Blynk cloud server. These values were stored on clouds which form the base of continuous monitoring. These values were constantly checked.The next step was to run the motor at ease of use with the help of a button. To validate this, the motor is running perfectly fine once the user presses the button. The user will turn on the motor if he feels the moisture in soil is very low from the Blynk app. All the components of the system are working in a perfect synchronization which marks its capabilities to efficiently cater the sector of agriculture.

Fig 7. Humidity monitoring on Blynk console

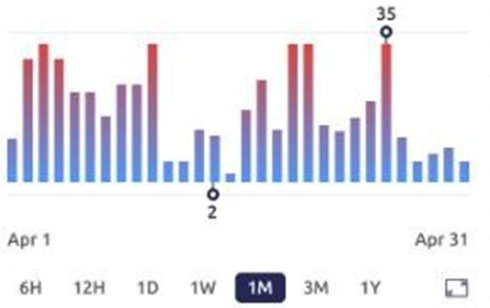

Fig 8. Temperature monitoring on Blynk console

Figure 7 and Figure 8 represent continuous monitoring of humidity and temperature available at the Blynk console respectively. This is very helpful in determining what all care needs to be taken for the crop with respect to environmental conditions.

Fig. 9. Moisture monitoring on Blynk console

Fig. 10. User-Interface on Blynk App

TABLE I. TABLE REPRESENTING DIFFERENT READINGS OBTAINED FROM THE SENSORS

Moisture	Temperature	Humidity
22	27	29
67	26	34
93	29	31
54	27	30
78	25	38
65	26	17
71	27	23

Figure 9 is showing the continuous monitoring that has been done for the parameter of moisture helpful for farmers. Figure 10 is the dashboard of the template designed on the Blynk console. It makes it easier for the farmers to navigate each and every parameter included for the monitoring purpose. Also, a button has been provided with which the farmer can switch the water pump on/off. Three different gauges have been added to show respective values. Table I has the values taken from the serial monitor of the Arduino IDE. These values have been validated with the ones displayed on the LCD display as well as the ones obtained on the Blynk dashboard.

V. CONCLUSION

The paper proposes modernizing the agrarian sector with the application of different sensors and integrating it with the Internet of Things. It makes it very easy for the farmers to monitor the growth of the crops because he is getting all the information regarding the factors affecting plant growth on his cell phone. Every component of the system is fully functional and working to its full capacity. Implementing such systems definitely come with some challenges which include constant internet accessibility for farmers even in the most remote locations. Also, awareness regarding the correct usage of electronic devices such as cell phones, sensors to farmers with little experience using technology is a major problem. But still, this system proves to be way more efficient than the existing methodology. Another interesting fact to be noted is that the proposed system is very cost-effective and thus can be afforded by farmers belonging to the poorest strata of society. The system saves a lot of water, sweat, time and energy for hard-working farmers.

REFERENCES

[1] Dr. V. Suma, “Internet of Things (IoT) based Smart Agriculture in India: An Overview”, Journal of ISMAC, Vol.03/ No.01, 2021.

[2] Nikesh Gondchawar, “IoT based Smart Agriculture”, International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 6, 2016.

[3] Muthunoori Naresh, P Munaswamy, “Smart Agriculture System using IoT Technology”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7 Issue-5, 2019.

[4] Ashwini B V, “A Study on Smart Irrigation System Using IoT for Surveillance of Crop-Field”, International Journal of Engineering & Technology, 2018.

[5] Tamás Mizik, “Climate-Smart Agriculture on Small-Scale Farms: A Systematic Literature Review”, 2021.

[6] Khurshid Aliev, Eros Pasero, “Internet of Plants Application for Smart Agriculture”, International Journal of Advanced Computer Science and Applications, Vol. 9, No. 4, 2018.

[7] Muhammad Ayaz, Mohammad Ammad-Uddin, “Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk”, IEEE, 2019.

[8] Miss. Bhagyashree A. Tapakire, Dr. Manasi M. Patil, “IoT based Smart Agriculture using Thingspeak”, International Journal of Engineering Research & Technology (IJERT)IJERTV8IS120185 Vol. 8 Issue 12, 2019.

[9] Agraj Aher, Janhavi Kasar, Palasha Ahuja, Varsha Jadhav, “Smart Agriculture using Clustering and IoT”, International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03, 2018.

[10] Hemlata Channe, Sukhesh Kothari, Dipali Kadam, “Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing & Big-Data Analysis”, Int. J. Computer Technology Applications,Vol 6 (3), 2015, pp.374-382.

[11] Abhiram MSD, Jyothsnavi Kuppili, N.Alivelu Manga, “Smart Farming System using IoT Efficient Crop Growth”, IEEE International Students' Conference on Electrical, Electronics and Computer Science, 2020.

[12] S. Darshna, T.Sangavi, Sheena Mohan, A.Soundharya, Sukanya Desikan, “Smart Irrigation System”, IOSR Journal of Electronics and Communication Engineering, 2015, pp. 32-36

[13] Prakhar Srivastava, Mohit Bajaj, “Overview of ESP8266 Wi-Fi module based Smart Irrigation System using IOT”,4th International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics (AEEICB-18)

[14] Karan Kansara, Vishal Zaveri, “Sensor based Automated Irrigation System with IOT: A Technical Review”, IJCSIT Vol. 6(6), 2015 5331-5333

[15] Srishti Rawal, “IOT based Smart Irrigation System”, International Journal of Computer Applications (0975 – 8887) Volume 159 – No 8, February 2017

[16] S. Abinaya, “INTELLIGENT IRRIGATION SYSTEM – AN IOT BASED APPROACH”, IEEE International Conference on Innovations in Green Energy and Healthcare Technologies(ICIGEHT’17)

[17] G. Umarani, K.Sharmila, “IoT: The Next Evolution of Internet”, International Journal Peer Reviewed Journal Refereed Journal Indexed Journal Impact Factor MJIF: 4.25 E-ISSN: 2454-6615.