



Design and Implementation of an IoT System for Smart Irrigation

Wisam Hayder Mahdi^{ID}, Basit N. Khalaf^{ID}, Omar Abdulkareem Mahmood^{*ID}, Mustafa N. Ghazal^{ID}

Department of Communications Engineering, College of Engineering, University of Diyala, Diyala 32001, Iraq

Corresponding Author Email: omar_abdulkareem@uodiyala.edu.iq

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ABSTRACT

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The agricultural sector in Iraq is facing numerous challenges such as water scarcity, climate change, and low productivity due to outdated farming practices. Therefore, there is a dire need to introduce modern technology into the agricultural sector to enhance its productivity and efficiency. This work presents an Internet of Things (IoT)-based smart agriculture system aimed at increasing agricultural productivity by optimizing crop management. The system employs various sensors to monitor environmental conditions in real-time. The data collected is processed by a microcontroller and transmitted wirelessly to a web application that provides farmers with visual information about their crops. The system is designed to be affordable and easy to use, allowing farmers to monitor their crops remotely and take necessary actions to optimize their growth. This, in turn, can lead to increased crop yields, reduced costs, and improved profitability.

1. INTRODUCTION

The agricultural crisis in Iraq is getting worse every day. Previously, the sector was a thriving industry that provided Iraq with food, but now it is suffering even more from relying on traditional irrigation systems or agricultural drip systems and not utilizing cutting-edge technologies based on the fundamentals of smart irrigation and Internet of Things technology. It should be noted that this paper's unique contribution is the application of a fresh strategy for low-cost sensor fusion. Therefore, the ideal method for monitoring agriculture using many parameters is to use a smart agriculture monitoring system. We are able to increase agricultural yield and production quality thanks to this monitoring. We can get some very useful information about what our crops are doing in the fields thanks to the cool instrument known as smart agricultural monitoring. In the realm of plants, it's like having a number of tiny spies that keep us updated on their growth and other activities. We can quickly transfer this data to the IoT platform once we get it in order to monitor everything. Thing talk is the name of this platform [1]. ThingSpeak is a real-time platform that enables verification and analysis of data. The information collected or recorded in ThingSpeak is shown in a dynamic and visual manner. After reading the material on this platform, a qualified farmer or botanist might make the appropriate adjustments in the field to increase profits and achieve a high yield [2].

Ragab et al. [1] discussed how the Internet of Things (IoT), is transforming farming and other related practices. IoT is what happens when all of our devices communicate with one another and the internet to make things smarter. Currently, farming is also utilizing IoT technology with a practice known as "smart farming." Hence, farmers can make more informed

decisions about their fields by using real-time information rather than only speculating about when to water the crops. Mahmood et al. [3] studied an advanced irrigation system that makes use of an ESP8266 NODE MCU device and a DHT11 sensor. It functions similarly to an intelligent sprinkler that detects when the soil is dry and automatically provides water to the plants. Moreover, it updates a server known as ThingSpeak, enabling you to monitor the field from a laptop or phone. Nawandar and Satpute [4] provided an overview of the reasons behind the prominence of farming in developing nations. Essentially, it's because it provides food and a means of income for over half of the population. These nations are investigating improving the soil and irrigation techniques because they have an urgent need to produce stronger and better crops. One significant contribution has drawn attention to the fact that many farmers still rely on antiquated and frequently unreliable irrigation techniques. As a result, a system that uses sensors placed in the soil to track plant water requirements in real time has been created. This sensor-based method optimizes water use, enhances crop health, and lowers labor costs by allowing irrigation to happen only when needed rather than on a set timetable [5]. Precision agriculture, which incorporates cutting-edge technologies into conventional farming methods, is the main topic of this conversation. With the use of contemporary tools and data-driven methodologies, this strategy seeks to optimize crop yields while reducing resource waste. In essence, it is a scientific improvement on organic farming methods that encourages agro-industry sustainability and efficiency. Wireless sensor networks (WSNs) contribute significantly to this direction [6]. Another strategy is to monitor agricultural surroundings using IoT technologies and remote sensors. These small gadgets make it possible to track important variables like temperature,

humidity, and soil nutrient levels in real time, which promotes more knowledgeable and effective farm management techniques [7]. Kansara et al. [8] discussed how IoT may also help us make farming smarter. The intention is to delegate part of the job to the tech and make farming a little less hands-on. For example, we could use sensors to examine the crops for us instead of having to do it by hand every day. It like having several little farmers working in the field that are always updating you. Not to be overlooked is the broad overview provided by several people in the study [9]. They serve as a reminder that farming is the original food factory and source of raw materials. It's not only a matter of sowing seeds and crossing our fingers; it plays a significant role in maintaining our economy and providing work for people. The use of IoT and WSNs in the agriculture industry is further covered in the conversation. These technologies enable more accurate and automated agricultural practices by facilitating real-time data collecting and communication across multiple farming environment components. According to the majority of what they've read, these networks are the data collecting equivalent of Swiss Army knives—they allow us to gather information from anywhere without having to run wires everywhere. The goal is to make farming extremely intelligent and productive by utilizing all of this automation and IoTs stuff [10].

This paper's remaining sections are organized as follows: A survey of cutting-edge research pertaining to the planned topic is provided in Section 2. The system design, including the essential requirements, is described in Section 3. The system design and implementation specifics are covered in Section 4. While Section 6 discusses the software requirements, Section 5 concentrates on the hardware elements used in the suggested system. Section 7 discusses the experimental findings from the different sensors. The paper is finally concluded in Section 8 with a summary of the results and closing thoughts.

2. STATE-OF-THE-ART WORKS

This section will cover some of the exciting new developments in smart irrigation, such as intelligent watering systems that let plants sense and respond to their surroundings. The basic idea behind these IoT-enabled farm watchdogs is to employ some high-tech equipment to monitor anything that could affect crops, such as the temperature, humidity, and even the air quality. In essence, their goal is to provide farmers with real-time information on agricultural conditions, enabling them to optimize crop growth while minimizing water and financial waste and maintaining environmental sustainability [2].

2.1 Related work

The challenge of smart irrigation in farmers has drawn substantial interest, particularly in light of the emergence of IoT and subsequent technologies. We looked through research journals, and publications on smart agriculture. An inventive IoT-based system for vehicle environmental monitoring is presented in reference [11], with the goal of improving environmental management and delivering real-time data. In essence, their goal was to create an intelligent device that monitors the surroundings of crops. As a result, they installed sensors to measure humidity, gas, and temperature. These sensors send the information to a distant computer over Wi-Fi. This computer uses sophisticated input-output technology to monitor all of the sensor data. An

inventive fencing system that can identify the presence of animals close to farms is suggested by Jayaraman et al. [12]. When an animal touches an exposed wire, the system's sensing mechanism completes an electrical circuit and activates a microprocessor. This configuration acts as an intelligent intrusion detection monitoring device. The system has the ability to send notifications to the farmer and can automatically activate alert mechanisms like lights and buzzers based on the time of day. The system's versatility and sustainability are increased by the fact that it can be powered by either solar energy or a traditional power source. In order to assist farmers; Gubbi et al. [13] offered an Android and Internet of Things-based solution that sends real-time field and agricultural information straight to their mobile smartphones. In order to assess if irrigation is required, the system has a device that can monitor soil conditions, particularly moisture levels. By providing end users with timely and easily available data, this method improves decision-making. It also saves all those wonderful things on the cloud, so you can access it whenever you'd want. Through the creation of a Smart Sensor Agriculture gadget intended to track soil temperature and moisture levels in agricultural fields, Sahu and Behera [14] focused on smart farming. An Arduino microcontroller and other electrical components are used in the system to allow for real-time crop condition monitoring, giving farmers constant updates on the health of their plants. Furthermore, research [15] investigates the novel idea of smart precision agriculture, which uses sensor technology to improve farming accuracy and efficiency. In essence, they are developing devices and tools that can be used in agriculture through the use of wireless sensor networks. These sensors serve as the system's brains, monitoring conditions and even issuing alerts as necessary. Finally, Rau et al. [16] proposed systems for creating and distributing databases, which have gained a lot of attention in the computer community regarding privacy and security. An IoT-enabled pesticide spraying system with a security and feature is suggested by study. With the goal of improving agricultural techniques' efficiency and safety, the system is made to run on solar power. In order to relieve farmers of the tedious task of applying pesticides, Agribot was created. It functions similarly to having a robotic assistant in the fields, monitoring conditions and ensuring everything is in working order. All of the above works are similar in principle in employing the sending and receiving of signals for use in the irrigation process. The objective of our work different of other work by is to outperform static approaches and effectively manage the complexities inherent in IoT environments, thereby providing for users a more resilient and versatile solution.

While researches [12-15] examined a variety of additional advances and IoT applications in the agricultural sector, studies [11, 16] concentrated on the use of IoT technologies in agricultural irrigation systems, and discussed the use of sensors in a device and monitoring the required processes. There is no doubt that the use of the IoTs, sensors, and the simultaneous transmission and reception of information has led to an increasing demand for this technology.

2.2 Objective of the work

The goals of an IoT smart farming system are to monitor agricultural conditions using smart devices, such as soil moisture sensors, temperature sensors, and air quality monitors. It's like giving farmers superpowers to always know what's going on with their plants, allowing them to optimize

crop growth and save water and other resource consumption. This smarty-pants system seeks to accomplish the following:

- (1) Cut down on all that hard work folks have to do by hand.
- (2) Install a plethora of sensors and tiny assistants that can sense the air and soil and alert us to problems.
- (3) Communicate with farmers about the status of their crops wherever they may be, particularly in the event of unfavorable weather.
- (4) To help farmers plan more effectively, make sure they have an easy-to-use way to view all the data on their computer or phone.
- (5) Reduce costs by avoiding wastage of water or other resources as the system assists in determining the precise requirements of the crops.
- (6) Monitor the temperature of the crops, the amount of moisture in the air, and the temperature of the crops.

Therefore, it's like having a bunch of tiny spies in the field, but they're absolutely harmless and only tell the farmers secrets that make the plants grow big and strong. Since everything is completed automatically, everyone may relax more.

3. SYSTEM DESIGN

Smart agriculture monitoring systems are a collection of intelligent devices that assist farmers in determining the most efficient methods for crop growth. They use these little helpers to the fullest extent possible, making the most of their capabilities with a variety of sensors to address various problems on the farm. Smart farming, as it is now understood, is essentially a modern, technological update on traditional farming methods [17]. When it comes to crops, it all boils down to using the newest and best equipment to achieve the best value. In these systems, a multitude of sensors communicate with a microcontroller, which functions as a miniature computer head overseeing the efficient execution of each sensor's function. Consider sensors that measure soil moisture. They alert you to when the dirt is thirsty or not, much like the farm's water police. This is significant because it ensures that farmers are growing their crops in optimal conditions and helps them conserve water. It's like having a super-powered plant whisperer that doesn't need to actually whisper. Not to be overlooked are the gas sensors. These bad boys detect any harmful gases that can affect the health of the crops. They protect the crops from dangerous gases and other things, acting as their bodyguards. While they went into further detail about all the fancy technology in the previous study [18], the main idea is that smart agriculture makes use of a variety of sensors to monitor various aspects and ensure that everything is functioning as it should. It's similar to having a group of robots using IoT technology and avoiding obstacles to keep the crops healthy [19]. We utilized mobile applications because they were readily available, accurate, and simple to use, as mobile communication networks are among the most widely used communication systems [20].

4. SYSTEM ARCHITECTURE AND IMPLEMENTATION DETAILS

4.1 System architecture

Figure 1 shows the system architecture which used in our work.

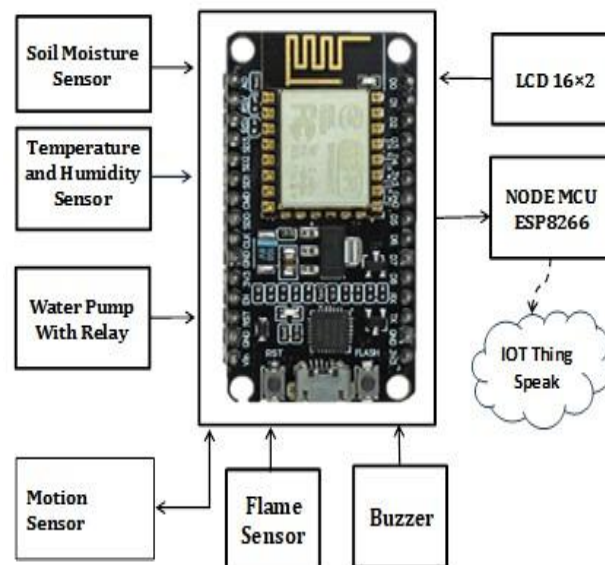


Figure 1. System architecture

4.2 Requirements analysis

The main tasks that this system must complete are:

- (1) Determine the actual soil moisture content, use a soil moisture sensor.
- (2) Use a tiny device known as a microcontroller, transform that moisture data into a digital format.
- (3) Verify that the data may pass from the sensor component to the controller, which is the main supervisor.
- (4) Cool the microcontroller sufficiently to allow it to receive all of the sensor data.
- (5) Ensure that all of the sensors work well together, adjust the voltage to each one.
- (6) Get the system to display the readings, upload all of the sensor data to ThingSpeak, a secure online platform, via an Application Programming Interface (API).

4.3 Implementation methodology and technical approach

Implementing the work is rather simple. Initially, we will create a basic system consisting of a single large network with two nodes. Every node has several sensors connected to it, resembling a little computer. These sensors gather information from the surroundings and transfer it to the node.

These days, a micro-controller that functions as a miniature translator is housed inside each node. It converts the jumbled, analog data from the sensors—which sounds like the sound of an outdated phone line—into clear, digital information that computers can comprehend. The node then transmits this digital data to an object known as a NODE MCU ESP8266 module, which is essentially the node's way of saying, "Hey, main control room, I've got something for you!"

In relation to the primary control room, also known as the IoT platform, this is where all of the sensor data resides. All of the sensor data is sent by the microcontroller to the NODE MCU ESP8266, which acts as a middleman to forward the data to the IoT Platform. Like a relay race, but instead of using a baton, we're using data. The IoT platform serves as the finish line, the node as the handoff location, and the sensors as the runners. Throughout the entire process, the micro-controller remains idle, ensuring that everything runs without a hitch.

5. HARDWARE COMPONENT DETAILS

5.1 NODE MCU ESP8266 module

The ESP8266 NODE MCU is an inexpensive, open-ended, little tech friend that everyone can play around with and it is characterized by low energy consumption and is suitable for the Iraqi environment. Because of its amazing ESP8266 Wi-Fi module, it's ideal for experimenting with Internet of Things applications. It works well with the Arduino software and has a ton of useful pins for performing both digital and analog tricks. Basically, this board is your jam if you want to make your devices smarter by connecting them to the internet. Because it functions like the Swiss Army knife of microcontroller boards, this bad boy is huge in the IoTs space. Many people adore it for their IoT projects because it's affordable and simple to utilize. It's similar to the handy gadget that transforms any ordinary object into a Wi-Fi-enabled smarty-pants device. This board is ideal for those interested in developing devices that interact with one another and communicate over the internet. This is the ESP8266 NODE MCU as shown in Figure 2.

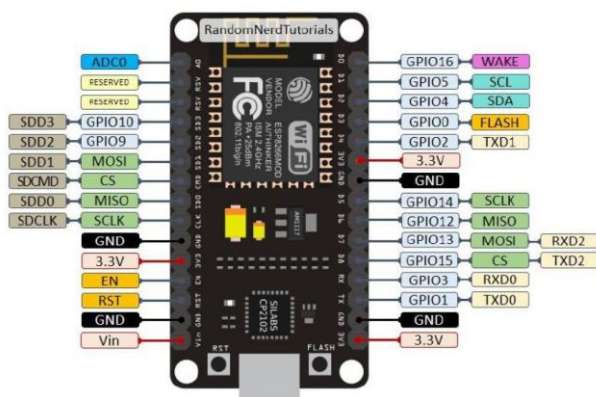


Figure 2. NODE MCU ESP8266 module

5.2 ESP module-12E

The ESP-12E is essentially a small, tidy device that uses an ESP8266 chip as its central component. Tensilica Xtensa® 32-bit LX106 RISC CPU powers this chip, which operates at 80–160 MHZ, making it akin to a little brain. It has this neat feature called RTOS, which functions as a little supervisor for real-time operations. It has a place for a 4 MB flash memory to hold some random data, and it has 128 KB of RAM to organize things in its mind. Oh, and it's really intelligent with Wi-Fi, getting along well with the outdated b/g/n standards. It's as though your device had a Wi-Fi companion of its own that it can connect to. The ESP module-12E is described in Figure 3.

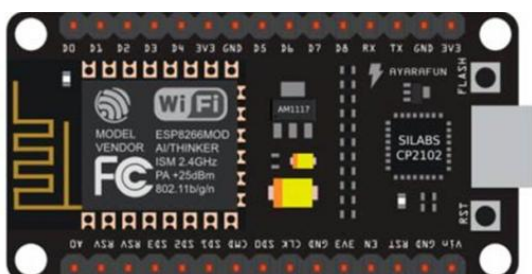


Figure 3. ESP module-12E

5.3 Soil moisture sensor

Soil moisture sensors are instruments that measure the amount of water present in the soil. An IoT-based smart agriculture monitoring system that uses a soil moisture sensor can provide farmers with critical information about the water requirements of their crops. The soil moisture sensor is displayed in Figure 4.

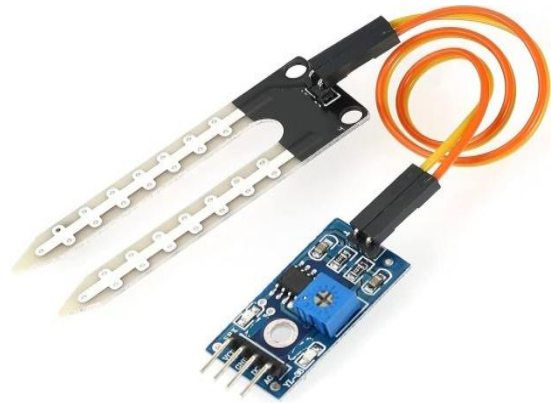


Figure 4. Soil moisture sensor

5.4 Temperature and humidity sensor DHT-22

This device is used to record temperature and humidity data. The Temperature and humidity sensor DHT-22 is displayed in Figure 5. When crops start to get ready, temperature plays a significant role. When temperature surpass the limit level, it will be detrimental for crops development, health and Quality. As a result, we measure the temperature and humidity using a DHT-22 sensor. These sensors get information from their environment. Every piece of information in its environment is in analog form, which is sent to a microcontroller and sequentially converted to digital form and this analog data send to micro-controller and change into digital form in sequence.

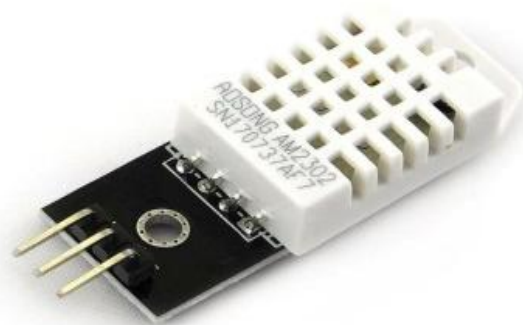


Figure 5. Temperature and humidity sensor DHT-22

5.5 Relay module

In Figure 6, the relay component is displayed. Relays are electrically driven switches that can be used to regulate high-voltage or high-current circuits by means of lower-voltage or lower-current signals. Relays can be used in an IoT-based smart agriculture monitoring system to operate different devices, like lighting, ventilation, and irrigation systems, based on the data gathered by the sensors.



Figure 6. Relay

5.6 Water pump

A water pump in an IoT-based smart agriculture monitoring system can be used to automatically irrigate crops in response to data gathered by the sensors. Here are a few justifications for employing a water pump: irrigation automation, remote control, affordability, effectiveness, adaptability, and watering in arid areas. Figure 7 illustrates the water pump.

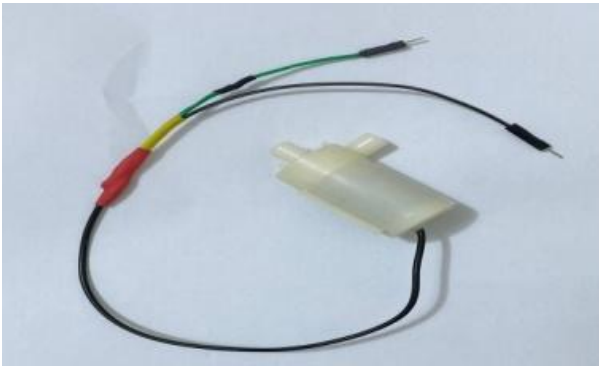


Figure 7. Water pump

5.7 Motion sensor passive infrared sensor (PIR)

The PIR is basically like a fancy motion detector. It works by picking up the heat that we and animals give off. So, when someone or something like a critter wanders through the warehouse, it notices. It's got two parts, and when a warm body crosses the path between them, it's like saying "hello!" to one side and "see ya!" to the other, which makes the sensor go all "whoa, something's moving!" Then it's like, "Hey, you need to know about this!" and it sets off an alarm and sends a notification to your phone through the Blynk APP. It's like having a super chill sidekick that keeps an eye out for you. Figure 8 shows the motion sensor.



Figure 8. PIR sensor

5.8 Lithium battery base and battery lithium (3.7 V)

In this work, many portable gadgets were powered by a lithium battery base. Rechargeable lithium batteries have a high energy density and are lightweight, which makes them perfect for use in portable applications like this one. An approximate total voltage of 11.1 V (3.7 V per cell) is provided by this battery. Using a voltage regulator, the battery is connected to different electronic parts in the operation. The battery powers the ESP 8266, an electronic device that connects to Internet networks and transfers data, with a voltage of 7.5 volts. The water pump's purpose was to elevate water and pump it into the irrigation system, even though it was powered by a 3.7 volts battery. Figure 9 displays the lithium battery base and the lithium (3.7 V) battery.



Figure 9. Lithium battery base and battery lithium (3.7 V)

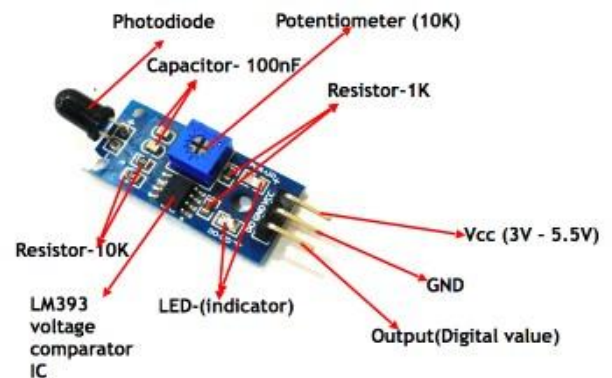


Figure 10. Flame sensor

5.9 Flame sensor

Fires can cause significant damage to both property and human life. Therefore, for the safety of individuals and the protection of assets, it is critical to detect and extinguish fires as early as possible. There are numerous methods for identifying a fire, such as observing if there is a significant temperature spike or if smoke is present. However, flames can occasionally be stealthy, fail to produce smoke, and catch them by their heat, as it's a surefire indication (pun intended) that something's wrong, just to be safe. The problem is that taking a temperature alone might be a bit tricky, particularly in the early stages of a fire. For this reason, the hottest (yet coolest) idea is to use a flame sensor. It's like the easiest and least expensive approach to detect that unwanted heat radiation before it becomes a full-fledged fire. These tiny devices are a

firefighter's worst nightmare since they are able to detect fires before heat waves even begin to dance. We therefore have a higher chance of keeping our spaces fire-free with these bad guys around. In Figure 10, a flame sensor is displayed.

6. SOFTWARE REQUIREMENTS

6.1 Arduino IDE

The Arduino IDE is the program that we experimented with for this work. It's similar to the popular free tool that's used by all Arduino tinkerers. It's incredibly user-friendly for programming those little computer boards we call Arduino Modules because it's the real deal, designed by the people who created Arduino themselves. These modules are now really intelligent little brains with microcontrollers within. They only need to be fed some code, and they will follow your instructions. The Arduino IDE functions similarly to their own computer, allowing you to program all the exciting features you desire. The editor and the compiler are its two chief allies. The compiler is similar to a grammar checker for code; it ensures that everything you write makes sense before sending it to the Arduino board. The editor is similar to your notepad,

where you jot down all your brilliant ideas. Once you have finished writing your masterpiece, you will receive a Hex File, which is simply a fancy term for a file that contains instructions for the microcontroller. The Arduino Module merely needs to be uploaded to the board in order for it to begin operating. Playing telephone is similar, but instead of whispering "I love you," the instructions are more along the lines of "turn on the light" or "move the robot arm." You can think of the code you write as a set of instructions that explain what occurs when an input and output are broken down. All you have to do is feed it the information you want it to know, process it using some logic, and then program it to perform an action in the actual world, such as turning on a light or rotating a wheel. It's similar like giving advice to a friend, but with a lot less argument and a lot more technical terminology. We will be writing code in the embedded C language within the Arduino IDE. The ESP8266 microprocessor that we have set up will receive the code that is entered into the Arduino IDE editor and uploaded to its memory. The DT22, flame sensor, PIR, and soil moisture sensor, among other sensors, will receive this code as instructions and be sent into them. These sensors will use the ESP8266 microcontroller to measure the necessary parameters and transmit the results to the Blynk Cloud. The Arduino IDE is displayed in Figure 11.

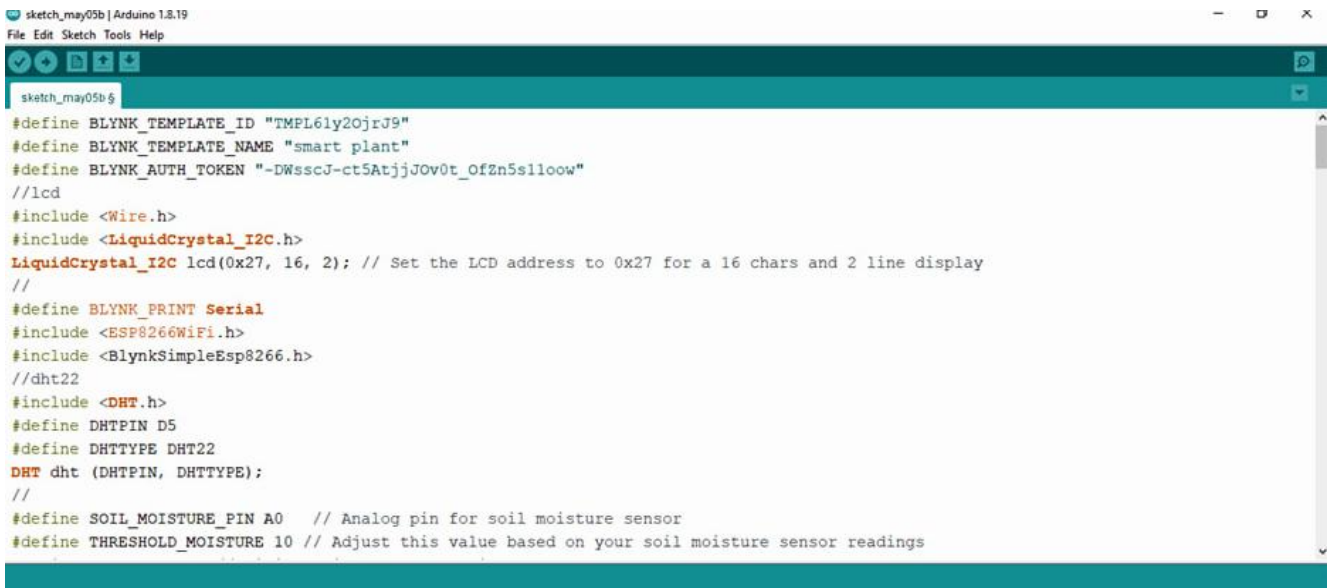


Figure 11. Arduino IDE

6.2 Blynk cloud

With Blynk, you can create screens to monitor and manage your gadget projects from your phone or tablet—whether it's an Android or an iPhone. You can quickly put together a tidy small workspace with buttons, sliders, graphs, and other gadgets once you download the Blynk app. It's like playing with Lego but for grown-ups who prefer to tinker with tech. These gadgets allow you to do things like flip pins on and off and see what your sensors are picking up. It is compatible with those fancy Arduino Ethernet and Wi-Fi devices, but it can also be used with devices that are connected to your computer via USB. In order to feed all of the data collected from the sensors into the cloud, we are linking the ESP32 microcontroller with the Blynk cloud. The cloud platform may be used to store this data. This data is safe and secure, and the Blynk cloud platform's privacy policy will guarantee data security. This is the Blynk setup in Figure 12.

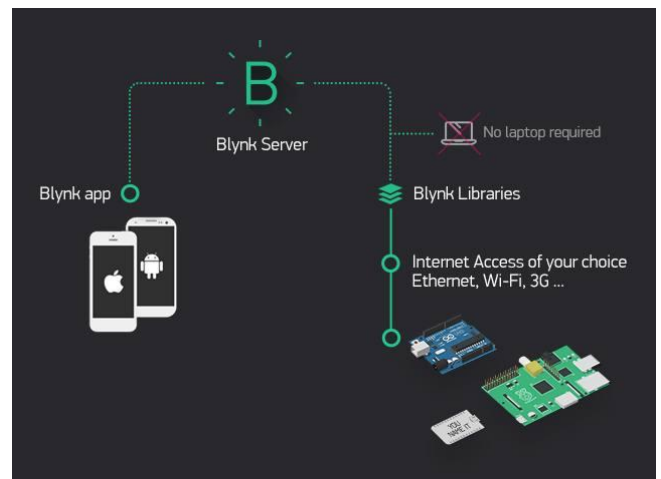


Figure 12. Blynk setup

6.3 System architecture

To measure the temperature, humidity, and fire motion in the warehouse, this system uses four different types of sensors: the DHT22, PIR, soil moisture sensor, and flame sensor. Its central component, the ESP8266 microcontroller, is what makes it all work. It is a combination of a Bluetooth and Wi-Fi module. The microcontroller and all of the sensors' voltage inputs are connected. In order to ensure a steady and even current supply throughout the setup, the power supply for all the sensors and the microcontroller can be obtained either by

connecting batteries in parallel or by using the DC data line that is used to charge mobile phones. The ESP8266 microcontroller can access all of the sensor values. The Arduino IDE is then used as the software to upload this to the Blynk cloud. The microcontroller, which is programmed in embedded C, transmits the commands to the sensor. After being processed in the cloud, the data will be available for viewing. Using the Blynk app, users can examine data stored in the Blynk cloud on their mobile device. To provide users with security, the data is transported via the encrypted Blynk server. Figure 13 displays the architecture of the system.

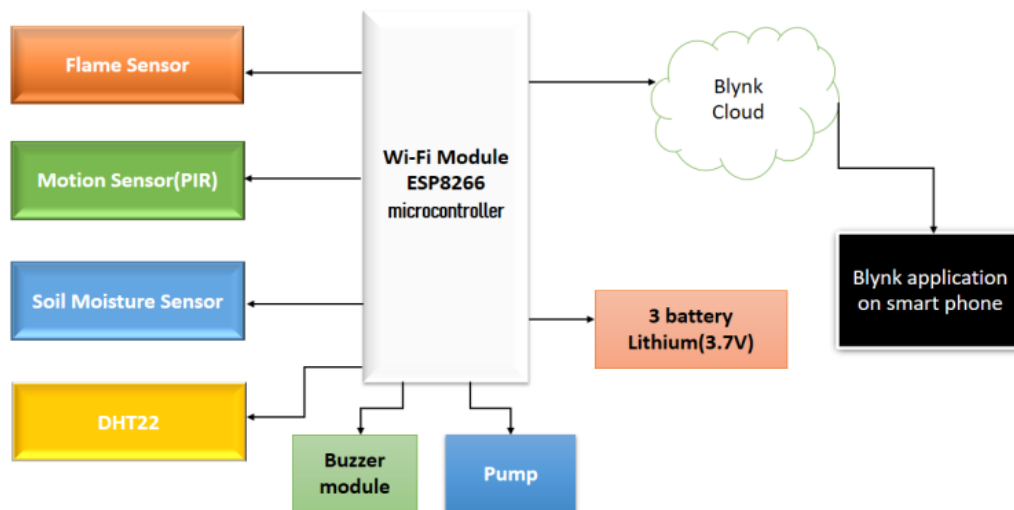


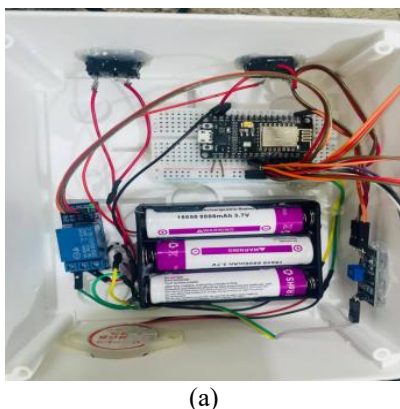
Figure 13. System architecture

7. RESULTS

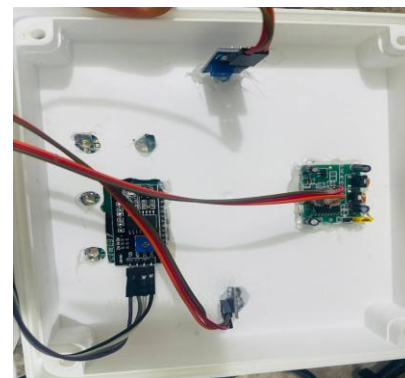
The "IoT Based Smart Agriculture" initiative makes use of data gathered from a variety of sensors. Although these values are shown on your laptop, a cell phone can be used to monitor them as well. These graphical readouts can be displayed in the language of objects on any mobile phone that supports Blynk. With the use of this technology, farmers can better manage their operations and boost overall output by monitoring and responding in real time to environmental conditions on the farm.

7.1 Connect and operate the circuit

As seen in Figure 14, the electronic circuit was successfully connected once we turned it on, connected to the Internet, and ran the Blynk program over the phone.



(a)



(b)



(c)

Figure 14. (a) Completely connect the circuit's components (the lowest portion); (b) Completely connect the circuit's components; (c) The device in its final form

7.2 Test

(1) Flame sensor

As illustrated in Figure 15, the fire sensor transmits information to the Blynk program, which notifies people about the existence of a fire in an area, when it is exposed to high temperatures and starts a fire in a nearby region.

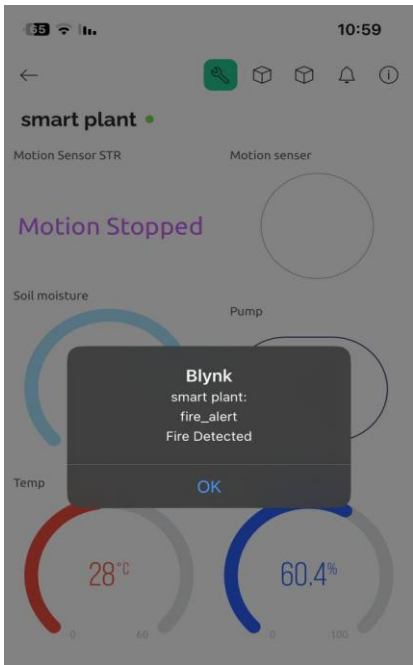


Figure 15. Test flame sensor

(2) Soil sensor

According to the soil sensor, as seen in Figure 16, the soil's moisture content is 79 percent. This suggests wet soil. When its level is low, it communicates with the ESP 8266 by sending parameters. The ESP 8266 then uses the Internet to communicate with the Blynk application, which uses the information to activate a water motor through a relay and send a notification to a phone.



Figure 16. Test soil sensor

(3) PIR sensor

As seen in Figure 17, the motion sensor recognizes movement on the farm when there are birds or animals, so it sounds a warning to let them leave. If there is movement, it also signals in the green light program.

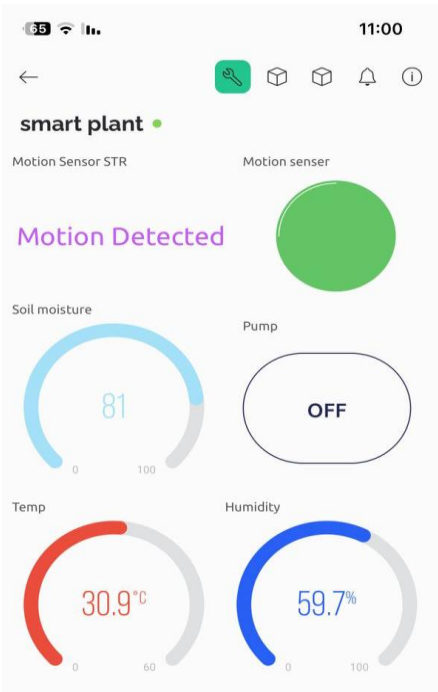


Figure 17. Test PIR sensor

(4) DHT22 sensor

Oxygen level and temperature sensor. To determine the percentage of temperature and oxygen, it transmits the data every two seconds. If the temperature % grows more than 40 degrees Celsius, the Blynk application sends a notification to the phone of the existence of excessive temperature, as illustrated in the Figure 18.

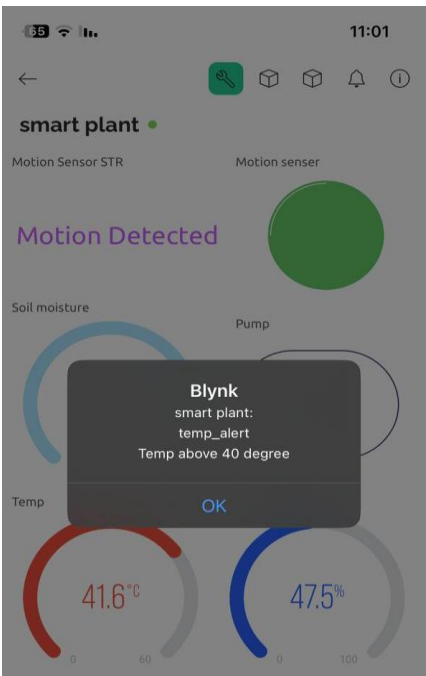


Figure 18. DHT22 sensor

8. CONCLUSION

In conclusion, farmers may monitor and maximize crop growth with the help of the IoT-based smart agriculture monitoring system, which provides a useful and efficient solution. It can be emphasized here that the novel contribution of this paper is the use of a new approach to low-cost sensors fusion. By collecting and analyzing data on numerous environmental elements such as temperature, humidity, soil moisture, and light intensity, the system offers farmers with vital insights about the health and growth of their crops. By utilizing sensors, the system may identify possible difficulties including pests, illnesses, and nutrient shortages, enabling farmers to promptly address or minimize these problems. In addition, the system helps farmers save time and money by automating operations like fertilization and irrigation, which increases agricultural yields. There is a lot of room for growth in terms of smart agriculture technologies in the future. For instance, combining machine learning and artificial intelligence could increase the precision of data analysis and crop growth and yield forecast; “by integrating algorithms that facilitate and improve the accuracy of data, analysis and process of dealing and forecasting through an intelligent comparison of agriculture and food production”, implement ML model for predictive irrigation using the collected dataset, Drone technology monitoring of crops from the air may also yield much more precise information about crop development and health.

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