IOT BASED SMART AGRICULTURE WITH AUTOMATIC IRRIGATION SYSTEM

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ABSTRACT

This review paper advocates the effective use of Internet of Things in conventional agriculture. It is bases on developing a smart irrigation system using Arduino UNO and ESP8266 WiFi module. Farmers benefit from the convenience of using an automatic irrigation system to irrigate their field. The pH sensor, water flow sensor, temperature sensor, and soil moisture sensor are employed for monitoring soil parameters. Using this data, the arduino microcontroller runs the servo motor and water pump. That data is also relayed wirelessly to the website via the internet using the ESP8266 WiFi module. It allows the user to control the device remotely via a secure internet web connection. Thingspeak.io platform is used to display the instantaneous values and reference values of several crop-related parameters. The aim of the project was to aid farmers to increase their yields.

Keyword : - *Smart Agriculture, Arduino UNO, ESP8266, Automation, Water, Irrigation, sensors, Embedded Systems, Internet of Things.*

1. INTRODUCTION

Water scarcity is one of the world's most pressing issues. The agriculture sector is a major consumer of water. As a result, a system that efficiently manages the consumption and supply of water is need of the hour. Almost all irrigation systems are currently subject to physical regulation. Because of the long-term viability of irrigated agriculture, pressure on the water distribution system is increasing, and the importance of water management is growing. According to World Bank, irrigated agriculture is responsible for an average withdrawal of around 70% of the global freshwater reserves. Moreover, in the developing world, factors like increasing population, along with income growth will require agriculture sector to increase its yield by 70% by the next thirty years. Hence, the world is moving towards the concept of Smart irrigation practices.

Smart irrigation is a unique scenario in which many scholars are interested, and it has been developing and emerging for decades. The major goal of smart irrigation is to save manpower, water, and electricity. To regulate soil moisture based irrigation, tensiometric and volumetric approaches are utilized, which are nearly simple yet similar to the characteristic curve of soil water, which differs depending on the kind of soil. All sensors must be maintained on a regular basis in order to function properly.

This kind of irrigation system is usually designed to operate automatically and use the moisture sensor to water the plants in a systematic manner without the need for human intervention. As a result, the major goal of the project was

to build an irrigation system that combines all of the aforementioned qualities with typical irrigation system features such measuring moisture analysis of the region to prevent crop damage. Temperature is measured in order to analyze the surrounding temperature, as the crop temperature is also sensitive.
It has the ability to control the irrigation system from anywhere in the world where the Internet is available. Another advantage of this planned irrigation system is that it will provide crop updates and inform farmers before any adverse conditions occur on the farms. It will quickly expand in order to control and monitor smart irrigation.
This technology can save human work while also increasing water conservation by effectively irrigating plants.

For transforming the conventional irrigation systems into a smart system, which can observe the soil parameters instantaneously and then actuate the peripherals, say water pumps, we need following components,
1: A microcontroller for analyzing the data and controlling the system. The most commonly used microcontroller is Arduino UNO as used in [1].
2: Sensors to observe the physical parameters of the soil and surrounding air. [2, 3].
3: Actuators like water pumps, and/or devices to control the flow of water through the piping system.

1.1 Related Work

An automated irrigation system using Arduino UNO is can be used to efficiently use actuators for different application. One such use of it can be seen for water for irrigation. It is an automated irrigation system. The design incorporates superior resource management as well as minimal power usage. A programmable microcontroller from the 8051 family to receive input signals that are then transformed into moisture values in the soil using soil moisture sensors can also be used. In [4] the makes use of information and communication technology to enable the user to assess and examine data collected by various sensors. We're employing a variety of sensors here, including humidity, temperature, wetness, light, and so on. The microcontroller receives signals from these sensors. The data is sent to the isolated server via serial communication from the microcontroller.

The degree of productivity has greatly grown as a result of new technology advancements in controlled-environment agriculture systems. Agriculture systems have improved in terms of capability, reliability, and production. A single plant in a home, a backyard garden, a small farm, or a major farming operation is all examples of agriculture environments. These agricultural automation systems will aid in the management and preservation of a safe environment, particularly in agricultural settings. The system addresses issues including temperature, humidity, pH, and nutritional support in general agriculture. The system also has to deal with desert-specific issues like dust, infertile sandy soil, frequent wind, very low humidity, and significant diurnal and seasonal temperature fluctuations. The system interventions are primarily meant to maintain the agricultural environment's adequacy. The use of fuzzy control is being studied as a way to reduce controller complexity.

Many irrigation system designers rely on the control system to make the transition to a reliable irrigation system easier. A novel system is being developed in this study to monitor and operate the irrigation system. The system employs an Arduino mega 2560 that has been modified with GSM technology, allowing the Arduino platform to receive/send SMS to/from the mobile phones of farmers/homeowners based on the soil's demand for water or the user's instructions. The system includes moisture sensors that are implanted in the soil to automatically irrigate the plants if the earth becomes dry, or it may be operated remotely by SMS message. There are several possibilities to consider. After receiving an SMS message from the microcontroller showing that the soil has been saturated with water, an SMS message to the controller to start irrigation is sent, followed by an SMS message to the controller to stop irrigation. One of which is if the water tank is empty, in which case the moisture sensor inserted in the tank will alert the homeowner that there is no water if the tank is empty, and the homeowner will then send an SMS message to the microcontroller, instructing it to turn on the water pump and fill the tank with water. Rainfall is another possibility; in this case. This proposed technology will save water while also keeping track of the watering operation. One advantage of the proposed system is that it saves time and labor because the homeowner does not have to monitor and irrigate the plant himself; instead, the system does it for him, and the homeowner can control the watering process from anywhere, whether outside or inside the house, and whenever the plant requires water. One of the system's benefits is that it reduces the cost of vehicles needed for irrigation. The system's downside is its high cost; there are fees associated with purchasing, installing, and maintaining the system.

In [5] offer a smart plant irrigation IoT system that adjusts to a defined irrigation habit automatically. In most cases, automated plant irrigation systems save time and effort. Based on static models built from the features of the plant ,in our proposed method, however, irrigation decisions are made by the user are dynamically altered in response to shifting environmental conditions. The model's learning mechanism reveals the mathematical relationships between the environmental factors utilized in determining irrigation habits and improves its learning technique as more irrigation data is accumulated in the model. We used four different supervised machine learning methods to evaluate the success of our irrigation model, and we applied the Gradient Boosting Regression Trees (GBRT) approach in our IoT solution. To evaluate the entire system performance, we set up a test bed in the cloud for the sensor edge, mobile client, and decision service. The preliminary results from our prototype system, which is being tested with two indoor plants, Sardinia and Peace-lily, are quite promising. The results show that the suggested system can successfully learn the watering habits of various plants.

1.2 Internet of Things

The rise in use of hand-held technologies like cell phones, tablets make The Internet of Things the most preferable technological solution to make conventional system smart. It enables precise interrelationships between a variety of appliances, equipment, and services based on the Internet, and this technology also aids in providing comfort to individuals so that they can accomplish their jobs more simply. The combination of irrigation with IoT allows for the most effective irrigation utilizing cutting-edge methodologies as discussed in [6]. It has the ability to calculate the strong contents of smart irrigation, such as monitoring water levels in reservoirs; it delivers a wonderful management system with wireless sensors. The Humidity along with Temperature Sensor detects air moisture and temperature. The Soil Moisture Sensor detects the moisture content of a plant's soil; if the content is below the minimal need, water is supplied from a reservoir via a relay, and an ultrasonic sensor measures the reservoir's water level before sending the data to the ESP8266 NodeMCU. It is a microcontroller that receives analog data from wireless sensors, coverts it into digital, and sends it using the MQTT protocol giving water when needed. This helps in analyzing the amount of water consumed every day.

2. METHODS AND MATERIALS

Our goal is to automate the farm activities which can transform agricultural domain from being manual and static to intelligent and dynamic, leading to higher production with lesser human supervision. We aim to establish a wireless network in the farming field, attach to the watering pipeline and connect the system to the cloud server, so that the individuals can remotely control watering through smart facilities.

This can help the farmers to reduce manpower, save time, save water, improve the quality and quantity of agricultural products. We have used 2 diff sensors -
1: Capacitive Soil Moisture Sensor - to measure moisture content present in the soil.
2: DHT11 Humidity Temperature Sensor - to measure Air Temperature and Humidity.

As soon as you power on the device, the OLED will start displaying the Soil Humidity, Air Humidity, and also Air Temperature. It shows the real-Time Data. All the sensors are attached to, node MCU – esp8266. Whenever the sensor detects a low quantity of moisture in the soil, the motor turns on automatically. Hence, it will automatically irrigate the field. Once the soil becomes wet, the motor turns off.

To monitor all these happenings of temp, humidity and Moisture content of the soil remotely we are using things speak server. Things Speak server will help us to have access over all this data online, remotely from any part of the world and this how we have taken help of iota in this project.

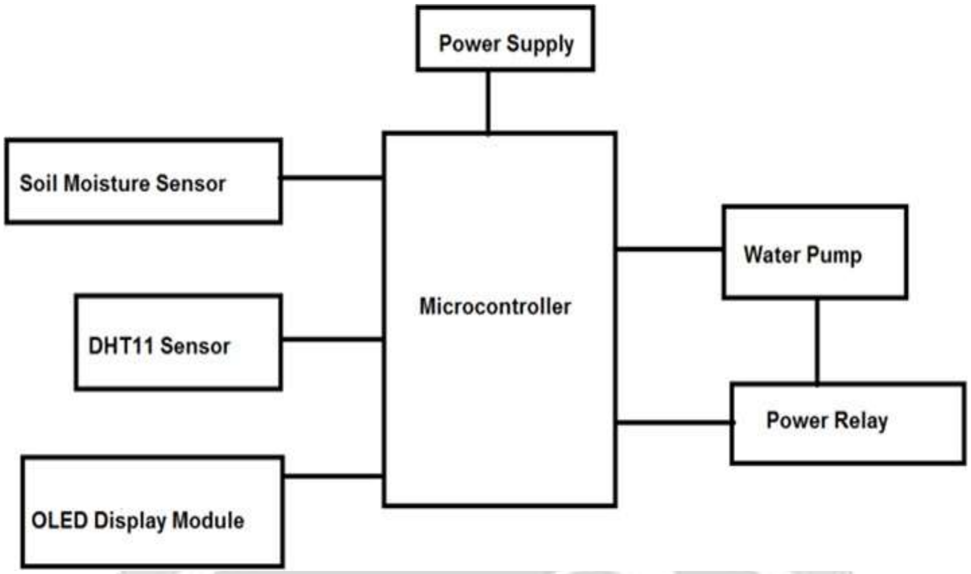

Fig -1: System Block Diagram

2.1 Components Description

Table -1 Components of the System

Serial No.	Components	Description
1.	Soil Moisture Sensor	The sensor is made up of two probes that measure the volumetric content of water. The two probes allow current to flow through the soil, and the resistance value is used to calculate the moisture content. Capacitive sensing, rather than resistive sensing as used by other types of moisture sensors, is used to assess soil moisture levels. Because it is built of a corrosion-resistant substance, it has the ability to prevent corrosion and has a long service life.
2.	OLED Display	The emissive electroluminescent layer of an organic light-emitting diode (OLED or organic LED), also known as organic electroluminescent (organic EL) diode, is a film of organic compound that emits light in response to an electric current. This organic layer is sandwiched between two electrodes, at least one of which is usually transparent. OLEDs are utilized in devices like television screens, computer monitors, and portable systems like smart phones and handheld game consoles to create digital displays. An important area of study is the development of white OLED devices for use in solid-state lighting applications.
3.	DHT11 Temperature Sensor	The DHT11 is a basic digital temperature and humidity sensor with a modest price tag. It measures the ambient air with a capacitive humidity sensor and a thermostat. On the data pin, it gives out a digital signal.
4.	Relay Module	An electromagnet operates a power relay module, which is an electrical switch. A separate low-power signal from a microcontroller activates the electromagnet. The electromagnet pulls to open or close an electrical circuit when energized. This is a 5V Relay Board Module with 1 Channel for Arduino PIC AVR DSP ARM. It can be controlled by a variety of microcontrollers, including Arduino, AVR, PIC, ARM, and others. Each one requires a driving current of 15 to 20 mA and is equipped with a high current relay: 5V / 10A DC, 250V / 10A AC .A standard interface that can be used with a microcontroller is available.

5.	DC Motor Pump	DC 3-6V Micro Submersible Pump DIY project: a miniature water pump for a fountain garden Water circulation system for small spaces This is a small, low-cost Submersible Pump Motor that runs on 3 to 6 volts. It can process up to 120 liters per hour while drawing only 220 milliamps. Simply attach the tube pipe to the motor outlet, immerse it in water, and turn it on. Make sure the water level is higher than the motor at all times. Dry running may cause damage to the motor owing to overheating, as well as noise.
6.	NodeMCU	NodeMCU is an open source platform based on the ESP8266 that allows things to be connected and data to be transferred using the Wi-Fi protocol. Furthermore, it may solve many of the project's demands on its own by providing some of the most important functionalities of microcontrollers such as GPIO, PWM, ADC, and so on. A circuit board that functions as a dual in-line package (DIP) that merges a USB controller with a smaller surface-mounted board housing the MCU and antenna is commonly used as prototype hardware.

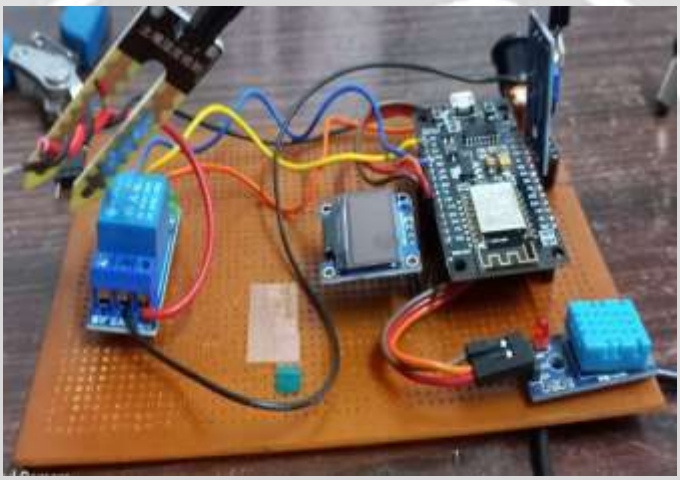

Fig -2: Prototype Setup

3. PROPOSED SYSTEM

The soil moisture sensor, the luminosity sensor, and the temperature sensor are all part of our system. The temperature sensor keeps track of the ambient temperature. The luminosity sensor measures the amount of light that falls on the plant. The sensors are connected to the Arduino Uno, a 60-pin ATmega328-based microcontroller with 14 I/O pins. The design is such that the plant gets watered if the moisture sensor detects moisture below the predetermined threshold value. To establish cellular contact between the system and the user, the GSM module is connected to the Arduino.

Live data is sent through the GSM module to the user via text message after insertion of the sum card into the GSM module, As well as the sensor conditions, this allows the farmer to maintain track of his field and detect any problems. We've also figured out how to operate the motor via Bluetooth. A general application is downloaded, and we can use it if there is a manual requirement to activate the motor. The Wi-Fi Module used here is to transmit all the data to the cloud. Spark fun provides a user with 50 MB of cloud storage; we use this site to upload our data at 45-second intervals.

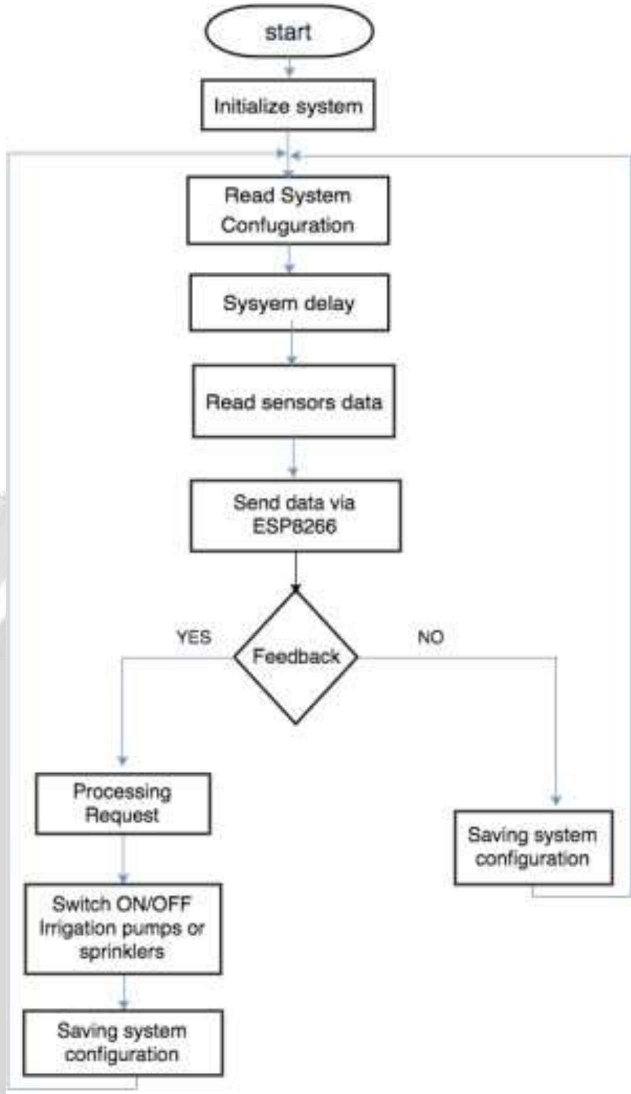

Fig -3: Flowchart for Proposed System

3.1 Implementation

The goals of this project are to investigate the parameters that need to be monitored in order to improve crop production, to select the appropriate sensor to measure the parameters, to integrate and test the sensor to measure on a selected microcontroller system, to investigate and integrate the Internet of things (IoT) platform using a selected microcontroller, and to demonstrate a working prototype of soil condition monitoring. The parameters that must be met in order to produce a better crop are explored. The major goal of this project is to keep track of soil moisture, temperature, and environmental conditions including temperature and humidity. To feed water to the crop, this project necessitated a human operation. In addition, this project will automatically monitor soil moisture, temperature, and environmental conditions such as temperature and humidity. By integrating the IOT function, this project may also be monitored via a website interface. [7]

As suggested in [8], a mobile integrated smart irrigation management, a Raspberry pi is employed. the communication element is based on smart phones crops or plants are examined along with their water requirements at various stages irrigation patterns are dynamic according to the growth cycles of the crop is monitored using sensors in the automated system and watering is done as needed using controlled irrigation cloud computing is an appealing answer to the vast amount of data generated because of its nearly endless storage and processing capabilities, as well as its quick elasticity.

4. CONCLUSIONS

Farmers currently use a manual irrigation method and irrigate their land on a regular basis. These mechanisms deplete a significant amount of water, resulting in water loss. In dry locations, rainfall is scarce and irrigation is difficult. As a result, the ESP8266 Wi-Fi based communication system was chosen due to its ease of use, maintenance, and low cost. The device is automated and will accurately monitor and control the water consumption. The user may interact with sensors from anywhere in the world in nanoseconds thanks to communication through websites, which is beneficial to the user. Farmers currently use a manual irrigation method and irrigate their land on a regular basis. These mechanisms deplete a significant amount of water, resulting in water loss. In dry locations, rainfall is scarce and irrigation is difficult. As a result, the ESP8266 Wi-Fi based communication system was chosen due to its ease of use, maintenance, and low cost. The device is automated and will accurately monitor and control the water consumption. The user may interact with connected systems remotely via websites. Depending on the size of the fruit tree or vegetable, this proposed project can be applied to all sorts of fruit crops and vegetables. Moreover, all the components that have been used are easily available off the shelf. This also makes the system easy to maintain.

6. REFERENCES

[1]. K. Taneja and S. Bhatia, "Automatic irrigation system using Arduino UNO," *2017 International Conference on Intelligent Computing and Control Systems (ICICCS)*, 2017, pp. 132-135, doi: 10.1109/ICCONS.2017.8250693

[2]. Monica, M., Yeshika, B., Abhishek, G. S., Sanjay, H. A., & Dasiga, S. (2017, October). IoT based control and automation of smart irrigation system: An automated irrigation system using sensors, GSM, Bluetooth and cloud technology. In *2017 International Conference on recent innovations in signal processing and embedded systems (RISE)* (pp. 601-607). IEEE.

[3]. Singh, P., & Saikia, S. (2016, December). Arduino-based smart irrigation using water flow sensor, soil moisture sensor, temperature sensor and ESP8266 WiFi module. In *2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)* (pp. 1-4). IEEE.

[4]. Yasin, H. M., Zeebaree, S. R., & Zebari, I. M. (2019, April). Arduino based automatic irrigation system: Monitoring and SMS controlling. In *2019 4th Scientific International Conference Najaf (SICN)* (pp. 109-114). IEEE.

[5]. Serdaroglu, K. C., Onel, C., & Baydere, S. (2020, December). IoT Based Smart Plant Irrigation System with Enhanced learning. In *2020 IEEE Computing, Communications and IoT Applications (ComComAp)* (pp. 1-6). IEEE.

[6]. Pernapati, K. (2018, April). IoT based low cost smart irrigation system. In *2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)* (pp. 1312-1315). IEEE.

[7]. Yusof, Z. M., Billah, M. M., Kadir, K., Ali, A. M. M., & Ahmad, I. (2019, August). Improvement of Crop Production: Design of a Smart Irrigation System. In *2019 IEEE International Conference on Smart Instrumentation, Measurement and Application (ICSIMA)* (pp. 1-4). IEEE.

[8]. Vaishali, S., Suraj, S., Vignesh, G., Dhivya, S., & Udhayakumar, S. (2017, April). Mobile integrated smart irrigation management and monitoring system using IOT. In *2017 international conference on communication and signal processing (ICCSP)* (pp. 2164-2167). IEEE.