IFERP

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 10, Issue 7, July 2023

# Smart Irrigation System using Soil Moisture Sensor

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***Abstract***— ***IoT is an emerging technology with tremendous applications in fields such as: healthcare, automotive, and agriculture. Countries are attempting to improve the sustainability of agriculture by combining various technologies. Improving irrigation systems is critical for reducing water waste and contributing to the achievement of the Sustainable Development Goals. In this application, sensor technology is used to create a smart IoT irrigation system that can be used in agriculture.***

***Keywords— IoT, Smart irrigation, Moisture sensor, Temperature sensor, Relay system, Agriculture support, Wireless technology.***

## I. INTRODUCTION

Farming is a major occupation. Farmers make use of larger land portions to perform farming activities. This leads to difficulty when trying to reach every corner of the land and keep track of the resource availability. The reduced availability of clean water resources is a driving factor for their optimal utilization solution. IoT, based application makes use of sensors for data acquisition and processing and is reducing the distance between the virtual and the physical worlds. An irrigation system that is smart and based on IoT can help in achieving the optimized usage of water resources for a precision farming landscape. [1]

The goal of this system is to carefully preserve water resources, manage the entire system through manual and automatic means, and detect soil moisture levels.

The primary goal of this system is to provide irrigation to different areas of farming land based on environmental conditions such as humidity, soil moisture content and temperature. [15, 16]

Intelligent irrigation systems are based on dynamically predicting the soil moisture pattern and information regarding precipitation of the field for the coming days. These are required for the optimal usage and effectively utilizing fresh water for the purpose of agriculture.[2]

## II. LITERATURE REVIEW

Agriculture accounts for 60% to 70% of the Indian subcontinent's economy. Traditional agricultural practises must be modernised in order to increase productivity. Ground water levels are rapidly depleting as a result of unplanned use, a lack of rain, and a scarcity of land water [1].

Water scarcity is a major issue in this day and age. Water is an essential component in all fields. Agriculture is one of the industries that requires a lot of water. Water waste is a major problem in agriculture [2]. Water waste occurs when excess water is supplied to fields that do not require it. There are numerous techniques for reducing or controlling water waste in agriculture. Because of major climatic changes and a lack when it comes to precision in agriculture, the agricultural yield has reduced as population has increased. The major sources of irrigation are through canal systems. In canal systems fields are pumped with water at regular intervals with no prior idea about the field's current water level. The crops are negatively impacted from this form of irrigation. The crop health and returns are reduced because some of the crops are extremely sensitized to the water content in the soil. [20][6].

Moisture also regulates the soil fertility and aids in the survival of all plants. Moisture in the soil is the amount of water present. The growth of crops depends on the amount of water in the soil. The crop's root respiration will be impacted if the soil moisture content is noticeably high. In contrast, when moisture levels are exceptionally low, nutrients and fertilizers that escape into the water can cause groundwater pollution, which will limit how well the crop can absorb the fertilizers and increase soil salinization. [10][20].

In India, farmers utilize large portions of land for farming. It is a hard task to find and reach each and every corner of such massive lands. At times there can arise the problem of uneven distribution of water. This would lead to bad quality of crops which leads to monetary loss. The solution to such issues is to make use of smart irrigation systems using the latest IoT technology. [6][10].

## III. OVERVIEW OF THE SYSTEM

### A. Research conceptual idea.

[4] The idea behind a smart irrigation system is to measure vital soil factors like moisture content, temperature and humidity and use these values to irrigate the farming land.

Different crops have different requirements when it comes to growing conditions. Some crops thrive only when irrigation is performed at regular intervals while some others do not need regular irrigation. These growing conditions are hard to map out and meet in real time. Hence, an effective approach is required to reduce the manual labour load and migrate the managing of requirements aspect of crop growth to smart systems.

[8] This system aims to achieve the goal of smart irrigation. A soil moisture sensor is utilized to collect data on the moisture content of the soil. A DHT11 sensor is utilized to obtain information of the humidity and temperature conditions of the soil. This information is collected and stored on cloud. Processing of this information is done through cloud too. Based on the readings and conditions control actions are performed. If the soil moisture reading and temperature and humidity readings drop below a certain benchmark and the water motor is off, the motor is turned on using a relay module to irrigate the soil. If the soil moisture reading and temperature and humidity readings rise beyond a certain limit and the water motor is on, the motor is turned off using a relay module to stop the process of soil irrigation. Over a period of time the data on moisture content, temperature and humidity can be collected and analysed to understand the moisture requirements for a particular type of crop. This information helps in providing an optimal growing environment for the crops.

### B. Steps or process followed.

Fig. 1. Data acquisition: The sensors employed collect the data from the environment.

Fig. 2. Data processing: Data collected from the sensor is processed to check for the soil reducing beyond a particular benchmark value.

Fig. 3. Data analysis: Data is analyzed through the cloud.

Fig. 4. Wireless communication: Wireless communication is utilized to send the analyzed data from the sensors to perform a particular control action.

Fig. 5. Irrigation control: Based on the communication, control action is employed. [7][11]

### C. Components required.

- ***NodeMCU ESP8266:***

➢ Integrated circuit unit.
➢ ESP8266 is a system on a chip that is of low-cost.
➢ The ESP8266 consists of all necessary computer components like CPU, RAM, operating systems, wireless networks and SDK.
➢ Allows transfer of data by utilizing Wi-Fi protocol.

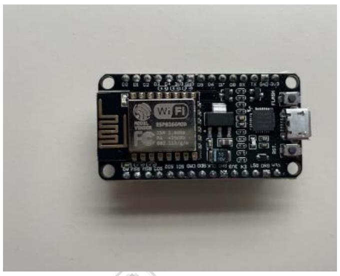

**Figure 1:** NodeMCU ESP8266

- ***Soil moisture sensor:***

➢ Employed to detect the quantity of water in the soil.
➢ The moisture level is calculated based on the volumetric content of water within the soil. Both digital and analog outputs are a part of this module.
➢ The module also has a potentiometer to adjust the threshold level.

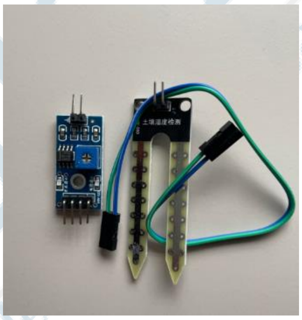

**Figure 2:** Soil Moisture Sensor

- ***DHT11 Sensor:***

➢ DHT11 is a simple and inexpensive sensor that measures the humidity and the digital temperature.
➢ Employs a capacitive humidity sensor and a thermistor to measure the surrounding air and delivers a digital signal on the data pin.
➢ The operation is simple, but the collection of data requires proper timing.
➢ Disadvantage: New data can only be accumulated for 1 time every 2 seconds. [13]

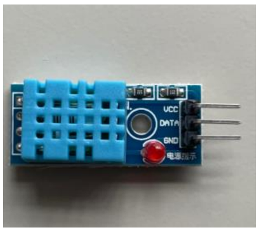


**Figure 3:** DHT11 sensor

- ***Relay Module:***

➢ Electrical power switch.
➢ Operated by using an electromagnet.
➢ Used to open or close an electric circuit.
➢ In this system the relay is used to turn the motor on or off based on the control conditions.

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International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 10, Issue 7, July 2023


**Figure 4:** Relay module

- ***Water Pump:***

➢ Submersible 5V water pump.
➢ Uses DC power supply.
➢ In this system used to irrigate the soil.

**Figure 5:** Water pump

- ***Connecting wires:***

➢ Male to Male wires.
➢ Female to Female wires.
➢ Male to Female wires.

**Figure 6:** Water pump

- ***Breadboard:***

➢ Used to build circuits.
➢ Used to connect the various components in the circuit.

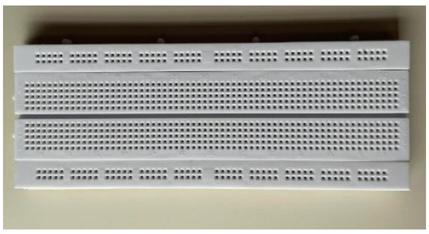

**Figure 7:** Breadboard

- ***ThingSpeak:***

➢ Analytics platform.
➢ Open-sourced.
➢ Used to visualize and analyse data.

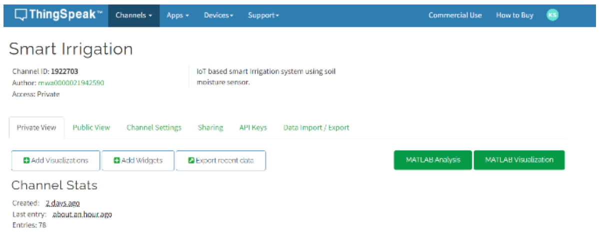


**Figure 8:** Cloud platform

## IV. WORKFLOW

### A. Workflow breakdown.

The workflow of the system is as follows:

- The soil moisture sensor is placed within the soil and the moisture level of the soil is measured. Soil moisture sensor gives an analog output.
- The DHT11 sensor is employed to measure temperature and humidity values of the environment that the plant/crops are placed in.
- Humidity as well as temperature plays a vital role in plant growth.
- The data from these sensors are collected and the microcontroller – NodeMCU ESP8266 is used to send this data to cloud.
- ThingSpeak is the analytics platform used. The data from the sensors are sent to cloud for analysis purposes. Graphs are generated in real time for the sensor data.
- If the soil moisture drops below 55% the motor is turned on using the relay and thus, irrigate the soil. If this soil moisture content is greater than 56% and the motor is on, the motor is turned off using relay module. This is the control action performed.

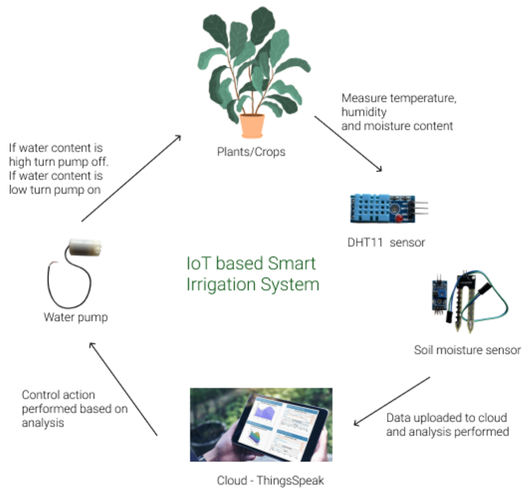


**Figure 9:** Workflow diagram

ISSN (Online) 2394-2320

**International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)**

**Vol 10, Issue 7, July 2023**

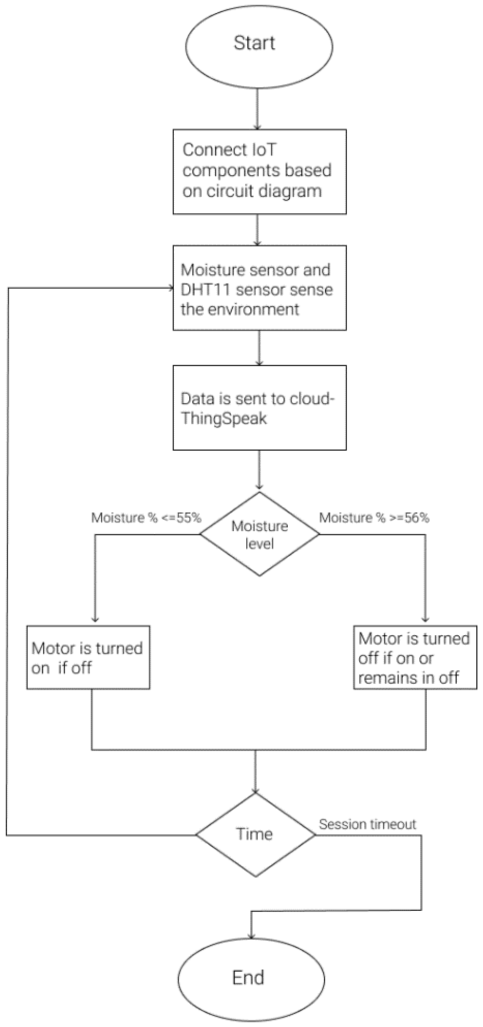


**Figure 10:** Flowchart

### B. Circuit breakdown.

The circuit for the given system is built using a breadboard. The connections can be seen as follows:

- The NodeMCU ESP8266 board is connected to the DHT11 sensor, the moisture sensor and the relay module.
- The relay module is further connected to the water pump. Power supply to the water pump is given directly through the AC supply in buildings by using a 5V adapter.
- The NodeMCU's ground pin is linked to the negative of the breadboard. The VCC pin of the NodeMCU is connected to the positive of the breadboard.
- The DHT11 sensor is connected to the D3 pin of the NodeMCU board.
- The soil moisture sensor is connected to the A0 pin of the NodeMCU board.
- The relay module's IN is connected to the D4 pin of the NodeMCU board. The VCC of relay module is connected to the 3V3 pin on the NodeMCU board and the ground of the relay module is connected to the ground of the NodeMCU board.

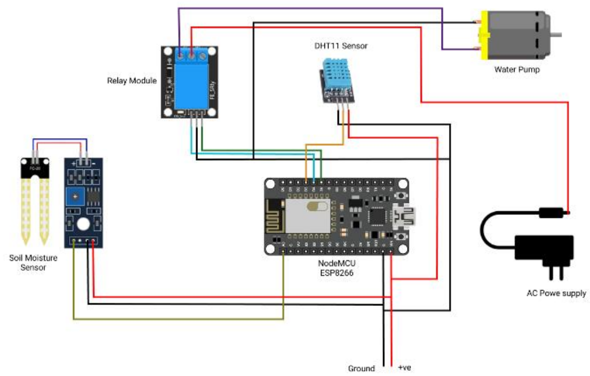


**Figure 11:** Circuit diagram

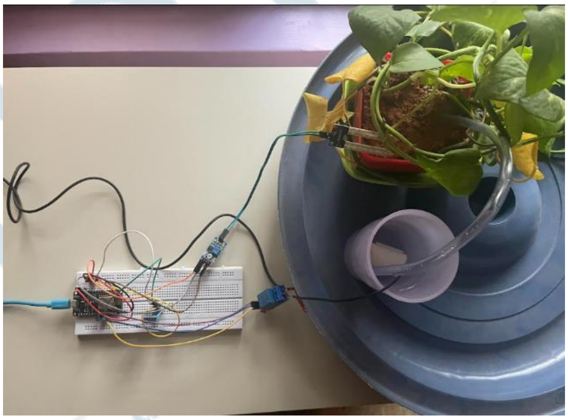

**Figure 12:** Circuit connections

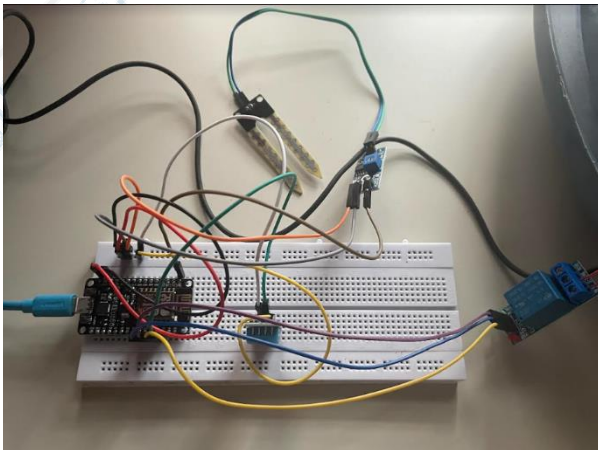

**Figure 13:** Circuit connections

### C. Result breakdown.

Outcomes of the above application are as follows:

- The NodeMCU ESP8266 collects the analog input from the soil moisture sensor. This analog value is then converted into percentage. The percentage value of moisture content is uploaded onto ThingSpeak [cloud] in real time.
- The NodeMCU ESP8266 also collects data on temperature and humidity from the DHT11 sensor. This

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ISSN (Online) 2394-2320
International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 10, Issue 7, July 2023

information is also uploaded onto ThingSpeak in real time.

- Graphs are generated for the data on ThingSpeak. These graphs can be used for analysis.
- The soil moisture percentage is used to control the motor. If the soil moisture percentage is less than 55% and the relay module status is set to LOW then the relay module status is changed to HIGH. This leads to the motor being turned on and water is pumped into the soil. If the soil moisture percentage is greater than 56% and the module is set to HIGH then it is changed to LOW and the motor turns off. If the relay module is already set in LOW then it remains in the same state. This is the control action performed.

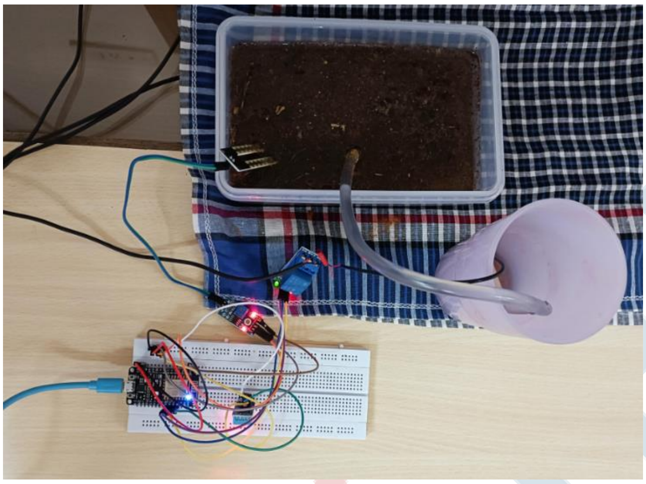

**Figure 15:** Motor turned on to irrigate the soil

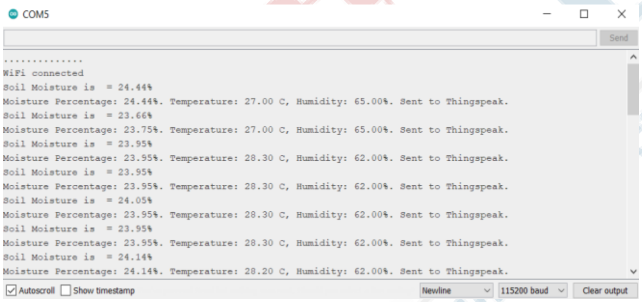


**Figure 16:** Connection established, values measured

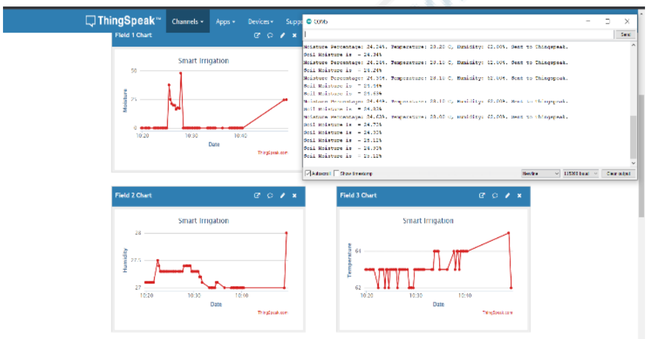


**Figure 17:** Connection established and values being measured in real time

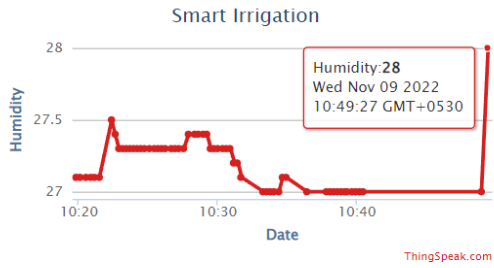


**Figure 18:** Humidity graph

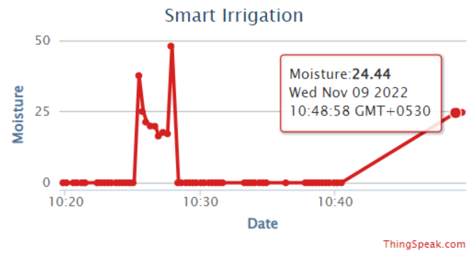


**Figure 19:** Moisture content graph

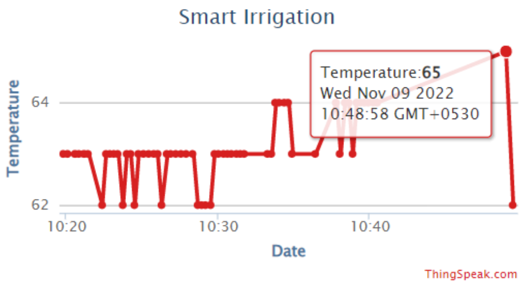


**Figure 20:** Temperature graph

### D. Benefits of Application.

[7][6] Some of the benefits of implementing a smart irrigation system can be listed as follows:

- Better crop management: The crops can be monitored and managed in a better manner using this system.
- Optimum growth rate of crops: The crops obtain the required amount of moisture and hence have a better growth rate.
- Monitor the product conditions in real time: The conditions in which the crops are growing are regularly monitored using the sensors.
- Prediction and making informed decisions: Based on the growth rate and information obtained from the sensors analytics can be run to automate the sprinkler system based on crop requirements.
- Reduce overall water consumption: Water is not wasted and is used in a sensible and optimised manner.
- Prevent diseases: The crops are not subjected to waterlogging or water deficit conditions. This prevents

the crops from getting infected with some diseases.

- Preserve the soil structure and nutrients: Since each crop gets the proper amount of water required for optimal growth the soil structure and nutrients in the soil are effectively preserved.
- Cleaner and efficient processes: The process of smart irrigation is a clean and effective way to handle irrigation for crops.
- Reduce resources: The overall consumption of resources can be effectively reduced by using smart irrigation techniques.

## V. FUTURE RESEARCH

[10] The future prospects of this application include:

- The moisture sensors can be installed at regular intervals in farming lands so that data about the moisture content can be collected for analysis simultaneously.
- Water pumps having varying degrees of output pressure can be installed in fields. By using this and the readings of moisture percentage the amount of water required by the crops can be determined and accordingly provided.
- By making use of the data collected over a stretch of time for moisture, humidity and temperature artificial intelligence algorithms can be built to identify the water requirements of various types of crops over different periods of time.
- Machine learning models can be implemented to optimise, analyse and predefine the amount of water required by crops over their growth cycle.
- The entire process of irrigation can be automated. This would reduce the amount of manual labour required in the process of irrigation.

## VI. CONCLUSION AND RECOMMENDATIONS

[9][8] Water management is very important in countries with limited water resources. Agriculture uses a lot of water, so this industry will also be affected. With growing concerns about global warming, we can develop a water management strategy to ensure that we have enough water for both food production and consumption. Result, water conservation research for irrigation has become more popular with time.

Implementing IoT-based smart farming systems will improve crop quality and reduce the need for human labour in the agricultural process. As agriculture is a key resource for obtaining food resources, process optimization and improvement are required. Also, intelligent irrigation technology saves water effectively; ensuring plants are no longer exposed to waterlogging and lack of water. One of the proposals involves extensive research and development to find out the existing drawbacks in processes and methods and propose better approaches to obtain better results. The benefits of R&D are significant and enable companies to ensure long-term effectiveness. Therefore, it can provide companies with an opportunity to identify ways to improve their IoT and WSN technologies. [7]

Higher attention has to be provided to management and safety concerns when introducing intelligent irrigation systems. A strong communication infrastructure is absolutely necessary for the nodes to perform the required tasks. Various sensors are typically used to connect systems, and maintaining communication between points is critical. Better communication and fewer mistakes and difficulties yield better results. [7]

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