INTELLIGENT IRRIGATION SYSTEM FOR OPTIMIZED AGRICULTURAL WATERING

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Abstract —
The Internet of Things (IoT) connects devices that can exchange information over the internet and control operations autonomously. Agriculture offers a wealth of data for analysis, aiding in improved crop yields. Utilizing IoT devices in agriculture modernizes information and communication in smart farming. Key factors for optimal crop growth include soil types, soil moisture, mineral nutrients, temperature, light, oxygen, and more. Various sensors monitor these parameters and transmit the data to the cloud. This paper examines some of these parameters for data analysis, enabling better agricultural decisions using IoT. The proposed system, implemented on the ThingSpeak IoT cloud platform, has shown superior performance.

Keywords— IoT, wireless sensor network, cloud computing, irrigation.

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DOI: 10.53555/ecb.2018.7.7.01

I. Introduction

Agriculture is the backbone of the Indian economy. However, agricultural water consumption often exceeds annual rainfall. Enhancing farm yield is crucial to meet the increasing global food demand. By analyzing and predicting ecological conditions, farm productivity can be improved. Crop quality relies on data collected from the field, such as soil moisture, ambient temperature, and humidity.

Advanced tools and technology can significantly boost farm yields. IoT technologies can gather extensive ecological and crop performance data. "IoT includes many new intelligent concepts for the near future, such as smart homes, smart cities, smart transportation, and smart farming" [1]. This technology can be used to apply precise amounts of fertilizer, water, and pesticides, enhancing productivity and quality. Sensors are promising devices for smart agriculture, as real-time environmental parameters like soil moisture, ambient temperature, and tank water levels continuously influence the crop lifecycle. A sensor network enables effective water regulation monitoring in agricultural fields.

To monitor crop conditions and improve productivity, it is essential to understand soil conditions. IoT facilitates field monitoring from any location. Parameters such as moisture, temperature, weather, and soil pH are considered for soil condition monitoring. GSM technology is used to transmit farm conditions to the user, as discussed in [1]. Automation in agriculture replaces traditional methods with advanced technology, reducing human interaction and increasing production rates. In [2], Arduino Uno and a moisture sensor measure soil moisture, with data updated to a webpage using GSM-GPRS SIM900A, allowing farmers to check sprinkler status.

This system focuses on maintaining soil moisture with an automated watering system, considering three parameters for better crop productivity. Global warming has reduced water levels, complicating soil moisture and fertility monitoring. Different sensors with Arduino Uno measure temperature, humidity, and moisture content, displaying the information on an LCD screen as explained in [3]. The work in [4] involves using Arduino Uno in irrigation, incorporating water flow, moisture, and temperature sensors. Data is sent to a website, enabling remote pump control and minimizing human error. As explained in [5], water is essential for irrigation and is distributed only when necessary, preventing water wastage.

II. Proposed System

- Input data are taken by the sens or from the external environment.
- Sensors are controlled by arduino microcontroller.
- Every data is sensed discretely by sensors and stores same to the cloud for further analysis.
- The threshold value of soil parameters is considered to predict suitability.
- Message is sent to the user to take further actions based on prediction.

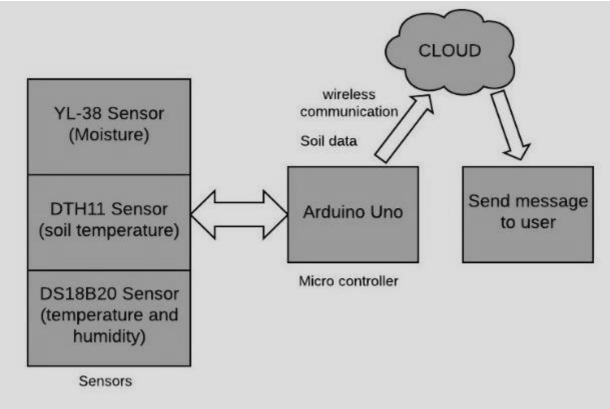

Fig.1 System Architecture

Table 1 : Threshold Values

Soil parameters	Threshold value
Moisture	30-80%
Temperature (atmosphere)	18-40°C
Humidity	45-70%
Soil temperature	20-40°C

The Soil parameters vary by location and over time. This work considers a few key parameters to predict soil status. Table 1 displays the various threshold values for different soil parameters.

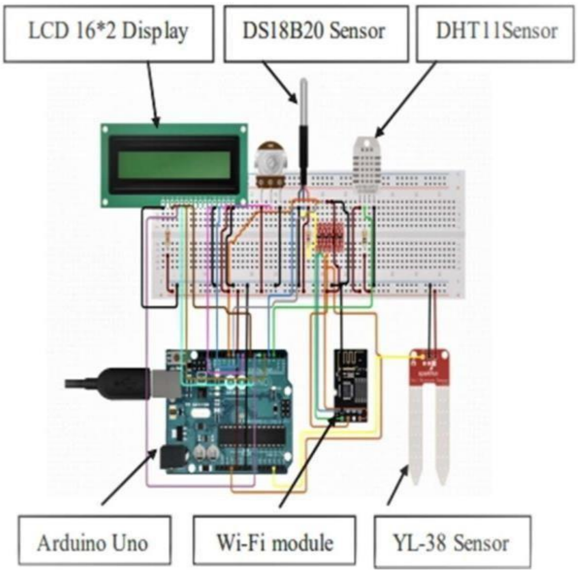

fig2 : Circuit Diagram

The circuit diagram illustrates the use of an Arduino Uno and various sensors to measure soil data. The tools used and their functionalities are as follows:

Arduino Uno: Microcontroller
YL-38 Sensor: Measures soil water content
DHT11 Sensor: Measures temperature and humidity
DS18B20 Sensor: Waterproof sensor that measures soil temperature
A Wi-Fi module is used to transmit the data to the cloud for further analysis

III. RELATED WORK

Significant research has been conducted to enhance agricultural performance. In [1], a system uses Arduino technology to control greenhouse watering and roofing, leveraging sensor data (temperature, humidity, moisture, and light intensity) and weather forecasts for decision-making. A Kalman filter removes sensor noise. The Agriculture System (AgriSys) [2] employs temperature, pH, and humidity sensors with fuzzy inference to process sensor data, displaying information on an LCD and PC. In [3], a Wireless Sensing Network with ZigBee technology manages air humidity, soil moisture, and temperature, utilizing components like soil moisture sensors, humidity sensors, temperature sensors, ZigBee, a 18F458 PIC Microcontroller, a water pump, fan, relay, and buzzer.

Paper [4] integrates a wireless sensor network with ZigBee to transmit soil moisture and temperature data to a web server via GPRS, enabling internet-based data monitoring through a graphical application. In [5], a wireless sensor network senses soil moisture, temperature, and humidity, extending node network lifetime with a sleep-wake plan and implementing node clustering. A GUI in MATLAB handles the data. Paper [6] details automation for remote agriculture using sensors and actuators connected to an IoT gateway with an OPC UA server, allowing cloud services to modify control rules without updating remote firmware.

In [7], the integration of WSNs with Cloud Computing is explored, offering performance comparison guidelines to improve performance and address storage and energy constraints. The systems mentioned share similarities in using wireless sensor nodes but differ in communication technologies and data storage methods. Typically, systems use one or more servers for data storage, which becomes costlier as the number of nodes increases. This paper proposes an irrigation system combining a wireless sensor network, IoT communication technology, and a cloud server to enhance system performance and data storage. The proposed system allows remote monitoring and control of irrigation, with real-time sensing of atmospheric and soil conditions such as air temperature, humidity, and soil moisture. IoT-based irrigation improves farm productivity with minimal human intervention.

IV.Methodology

IoT aids in determining soil suitability for agriculture. Plants rely on environmental factors that vary over time and location. Diverse IoT devices, such as sensors and Arduino Uno, help identify soil parameters. The proposed scheme operates as follows: 1) Each sensor measures relevant soil parameters and sends the data to the Arduino. 2) The collected data is transmitted to the ThingSpeak Cloud via Arduino. 3) Live data from the sensors is stored in the cloud. 4) Stored data is classified and analyzed using a classification algorithm on the ThingSpeak cloud. 5) Data that falls beyond threshold values is analyzed, and an email is sent to the user to prompt necessary actions.

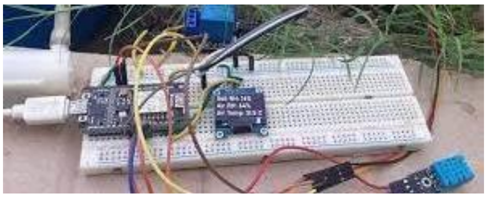

fig 3: experimental setup

A. Proposed Algorithm

Nomenclature:

n: Number of data, S_m: Soil Moisture,
S_{gt}: Soil ground Temperature, M_{th}: Soil Moisture threshold, GT_{th}: Ground Temperature threshold, DS: Data Store.

Algorithm for Smart Irrigation System in Agriculture

1: Begin
2: Sensors senses data S_m and S_{gt}
3: Node MCU sends the sensed data to ThingSpeak cloud 4: Data processing in ThingSpeak
5: for i=1 to n 6: {
7: if ($S_m >= M_{th}$) && ($S_{gt}>=GT_{th}$) 8: Classified as HIGH;
9: else
10: Classified as LOW; 11: end if
12 :}
13: if (Classification = HIGH)
14: Send e-mail to switch on motor 15: else
16: Store values in DS 17: End

Data sensed by the sensors is transmitted to the ThingSpeak IoT platform cloud. A classification algorithm is applied to the data, which is categorized based on a threshold value. Values above the threshold trigger actions, while values below the threshold are stored for further analysis, as explained in the algorithm above.

V. Advantages and Disadvantages of the proposed system

Smart irrigation systems offer numerous advantages over traditional irrigation methods. These systems can optimize water usage based on factors such as soil moisture and weather predictions. Wireless moisture sensors communicate with smart irrigation controls, indicating whether the landscape needs water. Additionally, the smart irrigation control receives local weather data to determine the appropriate times for watering. This prevents scenarios like sprinklers running during a storm, saving water and reducing costs by utilizing natural rainfall. The benefits of smart irrigation systems are extensive.

However, the proposed system has some disadvantages. The primary drawback is the cost, which can be significant depending on the property size. Installation requires digging up parts of the lawn to install pipework and connect it to the home's plumbing system, leading to potential yard downtime for days or weeks. Post-installation, the landscaping will need restoration. It is best to install an irrigation system before laying sod or extensive landscaping, as some of it will need to be removed during installation. Homeowners with well-maintained yards might find this aspect unappealing.

VI. Conclusion and Future Scope

The proposed work provides information on various soil parameters, including soil temperature, soil moisture, and atmospheric temperature, to predict irrigation suitability. This system helps analyze soil parameters, ensuring a better irrigation system for agriculture. Data collected from sensors are processed using machine learning techniques to create a fully automated system. Implementing an IoT-based smart agriculture system improves crop quality and reduces human involvement in agricultural activities. Results indicate that the Support Vector Machine (SVM) classification algorithm achieves 87.5 percent accuracy, outperforming KNN and Naive Bayes classifiers. The current work considers the correlation of soil temperature and moisture for classification. Future work may include classification based on the correlation of all four parameters and enhancing the system to predict soil fertility by considering additional soil fertility parameters.

In the future, this system could become more intelligent, predicting user actions, nutrient levels of plants, and optimal harvest times. Further advancements using machine learning algorithms can significantly aid farmers and reduce water consumption in agriculture.

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