

An Internet of Things and Cloud Based Smart Irrigation System

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ABSTRACT

Irrigation is the method of providing water to plants in order for them to expand and develop. Watering plants or irrigation is not a modern concept; it has been followed and applied from century to century or decade to decade. Technologies have evolved in lockstep with the passage of time. When we equate the 1980s and 2021, we see a dramatic difference in technologies as well as in the irrigation method. In the 1980s, irrigation was achieved using ploughs and furrows. Irrigation is the method of supplying water to the root zone at the right time. Plants draw water from wet soil, and by the mechanism of evapo-transpiration (ET), plants transpire water into the atmosphere while drawing nutrients available in soil with water for root zone development. When the supply of water in the root zone falls below a certain threshold, plants are unable to draw nutrients and water for nourishment. As a result, it is important to supply high-quality water to the root zone before the threshold limit is reached. This limit is determined by the species of plant, soil, and climate. Since the threshold cap varies depending on the type of plant. Scientific scheduling necessitates the application of the appropriate volume of water at the appropriate period and location within the facility. This necessitates constant monitoring of soil moisture content at the root zone and the initiation of irrigation according to a pre-programmed schedule based on the nature of the plant, its development, soil type, and climate. As a result, for scientific irrigation scheduling, sensors must be planted near the root zone in the soil to access the representative moisture status. The signals produced and detected by soil moisture sensors must be processed in a microcontroller for irrigation scheduling in accordance with predefined software. The microcontroller should also be designed to relay the signal to a distant location where the pumping and well system for irrigation control is located. Similarly, the feedback of these sensors should be analyzed by the microcontroller according to a predetermined program to terminate the irrigation depending on the plant, its level of development, soil, and climate. This paper presents a cloud based and internet of things based irrigation system. This system makes use of sensors to collect real time irrigation data, stores data into the cloud, owner of data gives command and appropriate action is taken on the based on the result generated.

Keywords

IoT, Arduino Uno, Soil Moisture, Humidity, Sensors, Mobile Applications, Cloud Storage

Introduction

Every living organism need fresh water [1.] As a result, saving water is our primary obligation. The majority of irrigation water is wasted due to free flow irrigation. Water should be utilised efficiently in irrigation by employing contemporary technology. It is important to be aware of new advances in order to combat the free flow of water in irrigation and regulate it via the use of smart irrigation techniques. As a result, a review of the existing literature was conducted in order to investigate current advancements in making irrigation automated and obtaining the needed nutritional content of the crop in production.

Every living thing need clean water [1.] As a result, conserving water is our major responsibility. Because of free flow irrigation, the bulk of irrigation water is squandered. Water should be used efficiently in irrigation by utilizing modern technologies. It is critical to stay up to date on new developments in order to prevent free flow of water in irrigation and manage it via the use of smart irrigation techniques. As a consequence, a survey of the available literature was carried out in order to explore current developments in automating irrigation and achieving the required nutritional content of the crop in production. The zig bee protocol, Global System for Mobile Communication (GSM), and other telemetry techniques are useful for communicating between the transmitter unit (i.e. farm unit) and reception unit (i.e. farmer sitting room) to make irrigation automated. [2] [3]

Irrigation optimization [4] in terms of time and space need sophisticated irrigation scheduling methods. Scientific irrigation scheduling is a method that provides an expected future water need over a reasonably short period of time in order to satisfy all crop requirements while avoiding water under or over application. There are numerous variations, but these scheduling techniques usually employ real historical short-term climatic data to estimate future short-term water usage in order to forecast the timing of the next irrigation event.

Irrigation scheduling [5] [6] [7] is often planned to meet full irrigation conditions, although the techniques are equally applicable to a shortage of irrigation. Plant responses to stress, such as stem water potentials, plant temperature, and growth rates, or fluctuations in stem diameters, measured soil water levels, internodes lengths, or monitored by energy balances, can also be scheduled, as can various combinations of these processes with climate-based approaches. Irrigation scheduling enhances the yield-to-consumptive-use ratio, owing to better timing of water applications.

However, it is usually not possible to separate the impacts of schedule from other improved farming techniques that a firm normally employs in an on-farm irrigation scheduling system. Improving irrigation systems, such as switching from gravity surface irrigation to pressurised drip or sprinkler irrigation, can help with irrigation scheduling, especially when the system is automated and composed of soil water sensors, but specific benefits of scheduling systems are difficult to allow or quantify. [8]

This article describes a cloud-based and IoT-based irrigation system. This system uses sensors to gather real-time irrigation data, saves it in the cloud, the data owner issues a command, and necessary action is done depending on the results.

Literature Survey

Temperature sensors, moisture sensors, analog to digital converters (ADCs), and solenoid valves comprise the automation system. To make the system automated, critical factors such as soil moisture and temperature are monitored. To do this, the entire field is divided into small pieces, each with one moisture sensor [9]. The unrestricted flow of water also leads irrigated land to have a variety of difficulties, such as soil salinity, the influence on fertility, and soil quality, to name a few. The nutritional content of the crop is increasing through a variety of techniques these days. Crop rotation and the cultivation of legumes enhance the nitrogen content of the soil, which is beneficial to crop development [10].

Wahba et al. say in [11] that drip irrigation is the optimum irrigation scheduling method for improving water usage efficiency and crop yield, and the study is based on green peas. In this study, green peas were grown in two seasons, one with increased irrigation to maintain a high moisture value and the other with medium irrigation, and the effects on growth criteria such as leaves area, plant height, fruit set percentage, and dry matter of stems, leaves, and total plant were studied. Dasare et al. suggested a method in which water is used in a scheduled manner when groundwater levels fall day by day. It employs a GSM system to maintain communication between the farmer and the farm unit, as well as an 89C51 microprocessor, optoisolator, 16X2 Liquid Crystal Display, and a relay. The GSM system displays SMS and maintains connection between the farm unit and the farmer [12].

The automated solar irrigation control system was utilized to conserve water and energy. Irrigation is done at night utilizing a photo-sensing control system for efficiency, and the Amplitude Shift Keying (ASK) modulation technology is utilized for transmitting and receiving information. [13] proposes a system for commercial usage and applications such as greenhouse systems. Bharathi and Prasunamba are employing PLCs and SCADAs for irrigation in smart cities, and the system is also leveraging the Internet of Things (IoT) to maintain communication between the irrigation land and the farmer. This also provides a reference model for smart irrigation through the use of water management and IoT [14, 15].

The study conducted by Banumathi and Sravanan in [16] employs the concept of automated irrigation through the use of conductive sensors, which function on the basis of soil conductivity; wet soils are more conductive than dry soil. To detect conductivity, a conductive sensor is put near the plant's root zone. The pump will turn on and off automatically based on the preset parameters. The automated irrigation method employed by Naik et al. in [17] is tested and compared on different types of soil (i.e. sandy soil, clay soil, loamy soil) at varying moisture levels. The clay and sandy soil results are more efficient than the loamy soil results, indicating that loamy soil requires longer time for irrigation under the same conditions. The technology utilized is solar power from renewable solar energy, which saves more than half of the water and electricity required. This system employs an Arduino-based automated watering system that makes use of GSM.

Temperature and moisture sensors are installed near the root zone of the plant, and the whole information related to the moisture value is supplied to the farmer's mobile phone through GSM, as well as the valve is controlled by Sindhuja et al. [18]. The system proposed in [19] used GSM-based control irrigation system, which also includes bluetooth for remote monitoring, which bypasses the range problem of signals with GSM network, and the use of smoke sensor is a good

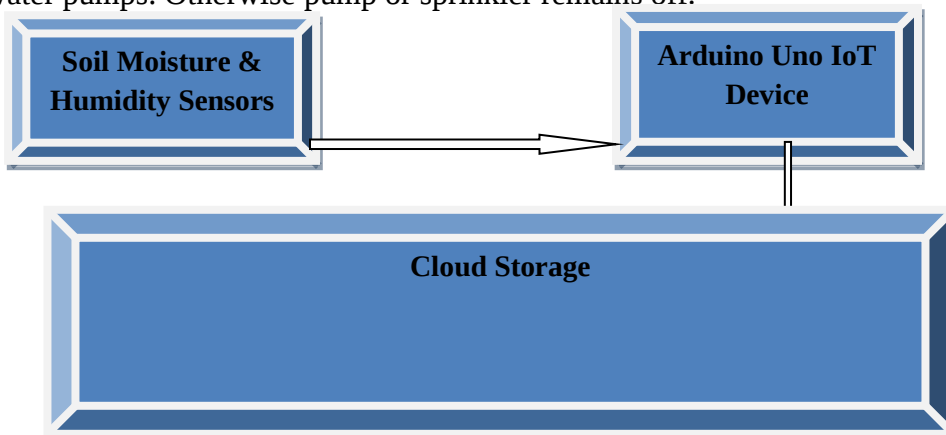
concept that is used to send emergency information in case of fire in farmland or sparking in motor pump. The author recommended utilizing a drip irrigation system to irrigate the land in [20]. The drip irrigation approach also employs the use of a fertility meter and a potential of hydrogen (pH) meter to calculate the crop's fertility requirements. This is an excellent approach since the necessary amount of fertilizer is applied to the plants, assisting in the resolution of problems such as soil salinity and other associated difficulties.

Sumalatha and Kumar's [21] system use solar energy to automate irrigation, while a GSM system is utilized to maintain contact between the agriculture and the farmer. Temperature sensors and soil moisture sensors are used to provide the precise value of moisture, based on which the valve in the system is turned on/off. In [22], Anusha and Gouthami utilize a distributed wireless network of temperature and moisture sensors implanted in the root zone of the plants, as well as a water level sensor inserted in the tank to verify the water level in the tank. Wireless sensors are an excellent watering concept.

The microcontroller is preprogrammed with the soil moisture sensor's threshold value and the tank's water level to limit water waste [22]. The irrigation is controlled by the ARMLPC2148 Microcontroller. The system employs dispersed nodes for signal transmission, and all nodes are linked to a centralised node, which employs an Advanced RISC Machine (ARM). The system also contains a widespread wireless network of moisture sensors positioned near the root zone of the plants that sense the state and communicate it to the nodes, and the microcontroller controls the entire process by receiving the signal [23]. The study [23] describes an automated irrigation system powered by solar energy, with the microcontroller serving simply as a power source. Various sensors are placed in a paddy field to precisely monitor the moisture content of the soil. These sensors provide the farmer with the value of the water level on a regular basis via a cellular phone. If the moisture level exceeds a certain level, the motor pump will shut off automatically.

IoT Based Irrigation

This section outlines a smart irrigation framework. The soil moisture and humidity sensor, Arduino Uno, Central Cloud Storage, and mobile apps are the framework's major components. Soil moisture and humidity data is continuously collected using soil and humidity sensors. These data is sent to Arduino Uno device. Arduino Uno kit sends the data to centralized cloud. This cloud is connected to mobile applications. Farmer can set humidity and moisture value by using mobile applications. Farmer is able to set values specific to a crop. If the actual humidity and soil moisture is within the range set by the farmer then smart irrigation system turns on sprinkler or water pumps. Otherwise pump or sprinkler remains off.



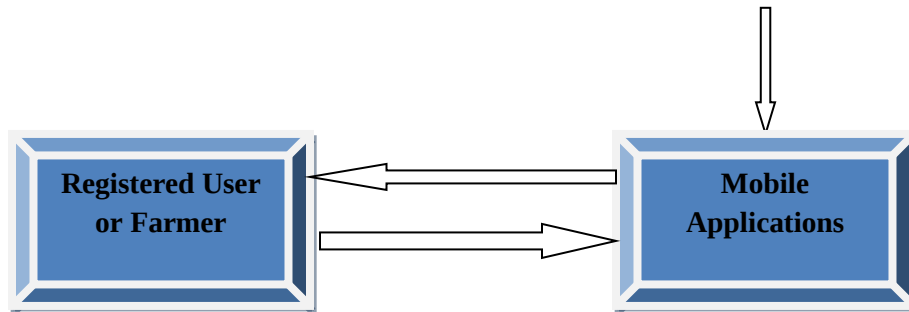


Figure 1: IoT and cloud Based Irrigation System

Conclusion

Plants collect water from moist soil and, via the evapo-transpiration (ET) process, they transpire water into the atmosphere while absorbing nutrients present in soil with water for root zone growth. Plants are unable to take nutrients and water for sustenance when the availability of water in the root zone falls below a specific level. As a result, it is critical to provide high-quality water to the root zone before the limit is reached. This limit is influenced by plant species, soil, and climate. Because the threshold cap changes according on the type of plant. The application of the proper volume of water at the right time and location inside the facility is required by scientific scheduling. This demands continuous monitoring of soil moisture content at the root zone, as well as the start of irrigation on a pre-programmed schedule based on the nature of the plant, its development, soil type, and environment. As a result, sensors must be put near the root zone in the soil to obtain the representative moisture status for scientific irrigation scheduling. This article describes a cloud-based and IoT-based irrigation system. This system uses sensors to gather real-time irrigation data, saves it in the cloud, the data owner issues a command, and necessary action is done depending on the results.

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