An IoT Instrumented Smart Agricultural Monitoring and Irrigation System

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Abstract—**These days, in the agriculture sector farmers are facing major problems regarding irrigation. Due to over- irrigation and under-irrigation, the crops can be damaged. This work development of an IoT instrumented smart agricultural monitoring and irrigation system. In this paper, an IoT platform based on ThingSpeak and NodeMCU is demonstrated, which will help the farmer to control the irrigation by using a PC or smartphone from anywhere and anytime, to monitoring the moisture and temperature parameter and reduce his efforts and also to optimize the use of water. Sensors value is sent to the IoT platform and if a value is below the threshold a notification will be sent to the user through E-mail to take suitable action.**

Index Terms—**IoT, ThingSpeak, NodeMCU, Sensor, E-mail, etc.**

I. INTRODUCTION

In agriculture, Irrigation is the most important part of it. There are two important parameters that are needed to be kept in mind while doing agriculture, collect information about soil productiveness and to measure the amount of moisture present in the soil. But the manual irrigation method used by the farmer for irrigation is not a perfect way to do irrigation. By this method, there is a wastage of water and so there is a need to conserve water. Also by this method, there should be over-irrigation and under-irrigation which is not good for crop growth. As there is a very little amount of fresh water available on earth and from this little amount maximum water is used for agriculture. So there is a need to develop a system that conserves water and provides a sufficient amount of water to the crops. The smart agricultural monitoring and irrigation system is consists of two parts. The first part consist of the hardware structure of the system and the second part consists of developing an IoT platform for monitoring and controlling the system. A smart agricultural monitoring and irrigation system is developed which offers a convenient irrigation process and water conservation. The main importance of the smart agricultural monitoring and irrigation system is to conserve water, provide the right amount of water to crops for optimum growth and reduce the workload on the farmers. By using this system, the crop productivity will increase and farmers can also do some other work.

As observed by the study in the old irrigation system, the plants are given water even though the soil moisture is very high this will affect the plants' growth. This water is not captivated by the plants and thus is misused. Most of the water is wasted due to evapotranspiration so the growth of the plant is not optimum . By this system, the user can monitor the moisture value and take a decision. In this way, the crop productivity increases and also reduce the workload of the farmers. Due to crop damage, there is a significant loss to the farmers but with the smart system, this loss can be controlled.

The problem related to the smart irrigation system is that you have to fully understand the variables affecting irrigation. These variables like temperature, humidity, soil moisture, etc. The most important parameter is soil moisture and user have to knowledge about how much a plant grow in particular moisture value. Also, need to take care of the cost of hardware and software. So we need to develop a very economical and reliable system which can be easily affordable by anyone.

The objective of this work is to develope a smart agricultural monitoring and irrigation system by which the farmer can monitor the various parameter related to the irrigation and take the decision. All these parameters data sent to the ThingSpeak. A ThingSpeak cloud platform is used to store the data and apply MATLAB analysis to take action.

An IoT based a smart agricultural monitoring and irrigation system is the topic on which many researchers have worked on different parameters with a different approach and some use analytics also. Also, worked on different hardware and software platforms. Let's have some ideas of related work done by the researcher to make an efficient and reliable system.

K K Namala, Krishna Kanth Prabhu A V, Anushree Math, Ashwini Kumari, Supraja Kulkarni, [1] mentioned about using Raspberry Pi, Arduino UNO, and Soil moisture sensor-based smart irrigation system. In the purpose system, they use the Zigbee module for wireless communication and also uses the HTML for creating webpages so the data will be shown on the webpage. This system is cost effective but there is a disadvantage that if the user doesn't know the IP address of Raspberry Pi then the user cannot access the data.

G. Shruthi, B. Selva Kumari, R. Pushpa Rani, R. Preyadharan [2] used a real-time smart sprinkler system for irrigation. In the purpose architecture, they use the soil moisture sensor, temperature and humidity sensor, GSM module, Web camera and uses ATMega328P microcontroller unit. In the system solenoid valve is used to control the pump. The algorithm design is simple whenever the soil moisture value below the threshold value the pump is on.

Monica M et al [3] purposed a system that contains ATMega328P microcontroller, GSM module, Bluetooth module, and different sensors. In the system, they use the Sparkfun cloud storage for collecting sensor data and analyze it. In this system, they apply some analytics also. The Bluetooth module is used to turn motor on/off through mobile phones. GSM module is used to send the text message.

Kiranmai Pernapati [4] mentioned about a low-cost IoT based smart irrigation system which NodeMCU ESP8266 microcontroller unit, soil moisture sensor, an ultrasonic sensor for measuring water level in the tank. The system uses a mobile application for data monitoring but does not use the cloud for storing the data. Also, the system uses the MQTT protocol for communication.

Hamza Benyezza Mounir Bouhedda, Khaola Djellout [5] proposed a system that uses a ThingSpeak IoT platform for the smart irrigation system. The system consists of the soil moisture sensor, water level sensor, and relay. Arduino is used with the ESP8266 Wifi module to communicate with the ThingSpeak platform. Also, they use the different functions of ThingSpeak for example plugin for automatic control of the relay, ThingTweet for sending a notification to your twitter account.

H. Nigam, A. K. Saini, S. Banerjee, and A. Kumar [6] designed a AQI monitoring system for the building occupants. This system monitors parameters such as temperature, humidity, heat-index, CO and CO2. For data transmission ESP8266-01 Wifi module is used and the sensor data is sent over MQTT protocol.

The approach for the solution after the study of various researchers is that the user must have information about different parameter values to set up the threshold values for the sensors. The hardware tools used is very cost effective and reliable. If the online platform provides the facility of sending notification then there is no need to use the extra hardware unit for notification. The systematic approach towards the solution to this problem is described as in this paper.

The rest of the paper is ordered as follows: Section II introduces the proposed system. Section III deals with hardware and software requirements. Implementation is presented in section IV. Flow chart of the system is discussed in section V followed by results in section VI and conclusion future scope in section VII.

II. PROPOSED SYSTEM

The system mainly consists of the three sensors i.e. temperature and humidity sensor, soil moisture sensor, and PIR sensor. The soil moisture sensor is used to measure the moisture value of the soil, temperature and humidity sensor used to measure the temperature and humidity of the surroundings and the PIR sensor is used to detect the motion in the field. All these sensors are interfaced with NodeMCU which has inbuilt wifi. With the help of wireless communication, the data is upload to the ThingSpeak cloud platform at a regular interval of 15 seconds. There is a threshold value assigned to each sensor as the sensor value crosses threshold value an E-mail notification is sent to the user. The architecture of the system is given below in the fig. 1.

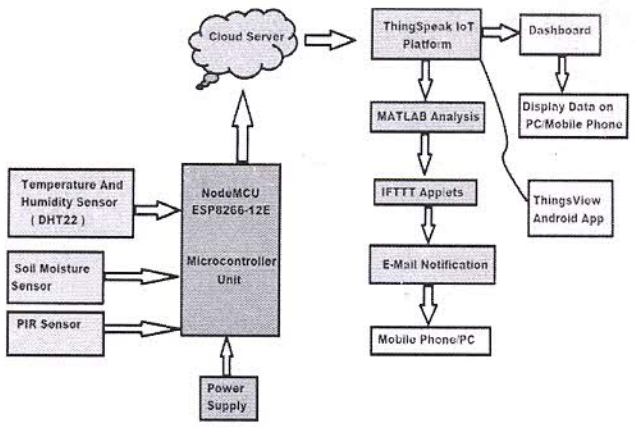

Fig. 1. The architecture of one node of the Smart Irrigation System

III. HARDWARE AND SOFTWARE REQUIREMENT

A. *Hardware Requirement*

1. *Soil Moisture Sensor*: Soil moisture sensor is used to calculate the moisture amount present in the soil which is a very important parameter of this system. The operating voltage of this sensor is 3.3V-5V. The analog value range is between 0-1023 because of 10 bit ADC used in the microcontroller. The value is shown in percentage form [7].

2. *DHT22:* This sensor is used to measure the temperature and humidity of the surroundings. The operating voltage is 3.3V-6V. The sensing period of this sensor is every two seconds and has an operating range -40°C to 80°C [8].

3. *HC-SR501:* PIR sensor is used to sense the motion of a body and also to detect whether a human/animal has crossses in or out of the sensors range. The operating voltage of the sensor is 3.3V-20V. The PIR sensor has an angle of greater than 110°. The range of the sensor is up to 6 meters [9].

4. *NodeMCU ESP8266-12E*:- NodeMCU is an easily available IoT hardware platform. The NodeMCU board supports direct uploading from the USB port. It combines features of the WIFI access point and station+ microcontroller. The operating voltage is 3.3V. It consists of 16 GPIO pin. It has a builtin ESP8266 wifi module in it. It is compatible with Arduino IDE. [10].

B. *Software Requirement*

1. *Arduino IDE*: The Arduino Software is used to write codes in C langauge and flash it on to the microcontroller board. This software is freely available on their website. All sensors are controlled by varying the code.

2. *ThingSpeak cloud platform:* ThingSpeak is an IoT analytics cloud platform and used to store data. It also supports MATLAB analysis. So one can write MATLAB code and perform different analyses on it. All the data is uploaded on the channel. The data is uploaded automatically at a regular interval of 15 seconds.

3. *ThingView App*: This app is used to monitor the data from anywhere through your mobile phone. This android app is available freely on the Google store. Also, the user can monitor different channel data in it.

IV. IMPLEMENTATION

In this section, the implementation of the different module which is used in the whole project is discussed. The three nodes system is implemented and each node has the same architecture. The implementation of the system is discussed below.