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Automated Watering and Irrigation System using Arduino UNO

Vighnesh B. Patil[1]
[1]Student, Department of Production Engineering
Dwarkadas J. Sanghvi College of Engineering,
Mumbai, Maharashtra, India

Ahmed B. Shah[2]
[2]Student, Department of Mechanical Engineering
Vishwakarma Institute of Technology,
Pune, Maharashtra, India

Abstract:- Agriculture is one of the most important sectors of India and contributes to 18 percent of India's GDP. The irrigation system used determines the quality of the yield and affects the sector. The conventional irrigation systems used in major parts of the country do not provide the optimum yield for crops. The main objective of the project is to develop an Automated Watering and Irrigation System that can be used to improve the conventional systems. The project is not only restricted to the agricultural field but can also be implemented at our homes or at commercial establishments having accommodation for lawns and plants.

Keywords:- *Automation, Irrigation, Arduino, Soil Moisture Sensor, IoT.*

I. INTRODUCTION

Water is one of the most important aspects for the growth of plants. The amount of water determines the rate of growth and life of the plant, and excess or scarcity of water can hinder their growth. Irrigation is an artificial watering technique which plays an important role in agriculture in India. Irrigation aids in the growth of crops, maintenance of landscapes and revegetation of soils in arid regions and through periods of less than average precipitation. The conventional way of irrigation involves irrigating the fields manually by using sprinkler systems, furrow irrigation, drip irrigation or manual labour. One of the major downsides of this conventional irrigation is that the amount of water supplied to the crop is incalculable. As a result of which, the crops do not receive optimum amount of water for growth, hindering their yield. In this paper we will be discussing the working of an automated irrigation system which will allow farmers to irrigate, and monitor the soil moisture content to optimise the yield of their crops. The system can be slightly modified to accommodate other watering applications.

A. Need of the System

The main need of the system for the agricultural sector arises because of the loss of yield due to improper irrigation which is quite significant. An automated system will deliver optimum amount of water depending upon the soil moisture content. The soil moisture content can be remotely monitored which eliminates the possibility of over irrigation or under irrigation. This also reduces the wastage of water, the manual labour cost and saves farmers from some of the tedious field work.

In the commercial and domestic sector like offices, workspaces and homes where there are indoor plants and lawns, the need of an automated system arises. The system would be cheaper and more effective in maintenance of plants and lawns as compared to its human counterpart.

II. SYSTEM DESIGN AND FUNCTIONING

A. System Overview

This paper discusses an automated watering and irrigation system which can supply water to the crops when needed as well as adjust the amount of water supplied depending on the soil moisture content. The sensors sense moisture content by sending an electrical current through the soil and measuring the output resistance. Since water conducts electricity, the output resistance determines the amount of water present in the soil. Whenever, the resistance increases, it means that the moisture content of the soil has dropped.

B. Construction

The system uses an Arduino Uno microcontroller as its core control system. A 4 module, 5V relay is connected to the Arduino. This relay is used to actuate the two solenoid valves and the pump. The two soil moisture sensors (EC-1258) are also connected to the Arduino. There is a water supply to the solenoids through a pump which draws water from a reservoir. The Wi-Fi module (ESP-8266) is also connected to the Arduino.

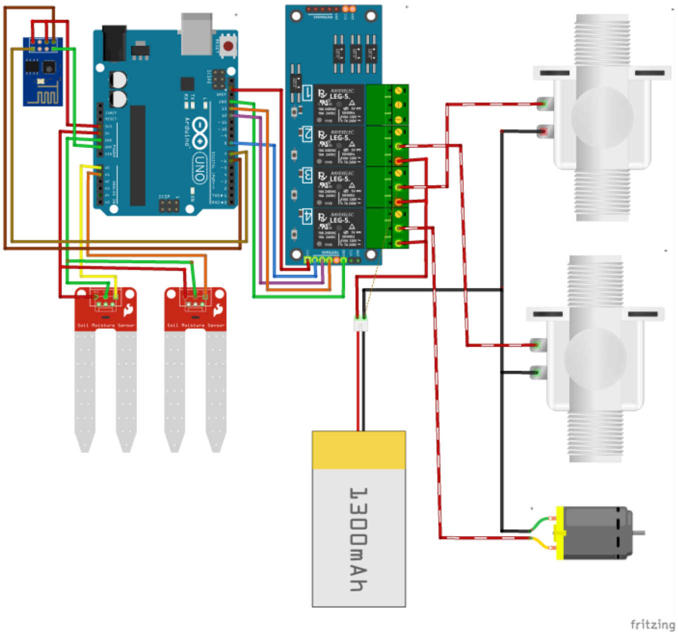

Fig 1:- Electric Circuit and Connections Diagram.

The Arduino is supplied power through a power bank operating at 5V DC. The relay and soil moisture sensor use the same pass through 5V DC from the Arduino board. The Wi-Fi module operates on 3.5V DC provided by the Arduino board's 3.5V pin. The pump and solenoid valves are provided with a separate supply by a single 12V, 4A DC connection.

C. Working

The system works on the principle of sensing and actuation. The soil moisture sensor is intended for the measurement of moisture in the soil which is connected to a microcontroller (in our case an Arduino UNO). After sensing, the sensor sends the moisture content of the soil in that section. If it is below 20%, the Arduino will send a signal to the relay which would actuate the pump. The pump is connected to the solenoid valve which would deliver the water to that particular section when it is required.

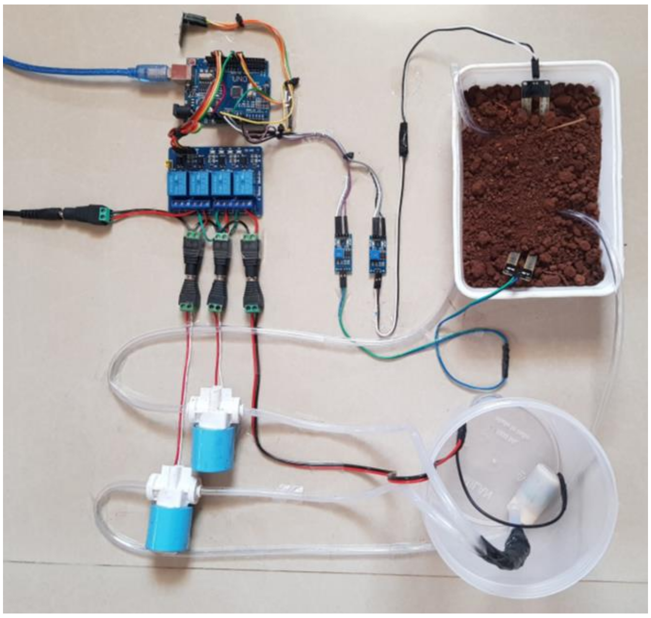

Fig 2:- System Setup

The main advantage of using this system is to reduce human interference and, ensure proper and timely irrigation. The logs and information of the watering schedule is uploaded to a cloud server called ThingSpeak. This data can be used for research in the field of agriculture.

D. Internet of Things (IoT) Integration

We have used a free service known as ThingSpeak to integrate IoT functionality in the project. "ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a

Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks."[1]

The data from the sensor is sent to the Arduino which is connected to the Wi-Fi Module (ESP-8266) which sends data to our ThingSpeak server. This collected data can be accessed by anyone who has access to the channel. This data can be used for monitoring the soil moisture at any given time or can be used in analysis and research of the water intake of plants or the water holding capacity of soil.

E. Dataflow Diagram and Sample Code

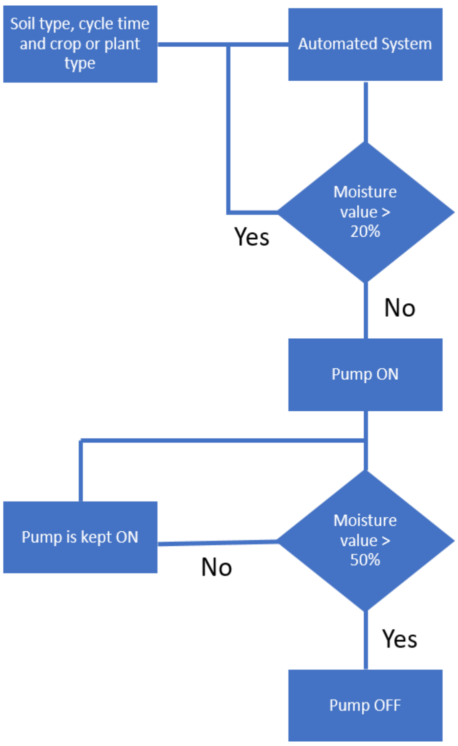

Fig 3:- Dataflow Diagram of Automated Watering and Irrigation System

Sample code for reading data from moisture sensors and supplying water is given below. The code which allows the Wi-Fi module to communicate with the server was taken from the ThingSpeak GitHub server.[2] The code mentioned in this paper only contains the original and integral part responsible for sensor control and actuation of valves.

```
int Sens1, Sens2;
void setup()
{
   pinMode(A0,INPUT); //Set pin A0 as Sensor 1
   pinMode(A1,INPUT); //Set pin A1 as Sensor 2
   pinMode(8,OUTPUT); //Set pin 8 as Relay 1 (Pump)
   pinMode(12,OUTPUT); //Set pin 12 as Relay 2 (Valve 1)
   pinMode(13,OUTPUT); //Set pin 13 as Relay 3 (Valve 2)
   //relays are in NO (normally open) condition
   Serial.begin(9600);
}

void loop()
{
   Sens1= analogRead(A0);
   Sens2= analogRead(A1);
   Sens1= map(Sens1,1017,0,0,100); //calibration of Sensor 1
   Sens2= map(Sens2,1017,0,0,100); //calibration of Sensor 2

   if(Sens1<20)
   {
      digitalWrite(12,LOW); //if soil moisture is less than 20% in section 1, open valve 1 and supply water to section 1
   }
   else if(Sens1>50 && Sens1<100)
   {
      digitalWrite(12,HIGH); //if soil moisture is greater than 50% in section 1, close valve 1 and stop water supply to section 1
   }

   if(Sens2<20)
   {
      digitalWrite(13,LOW); //if soil moisture is less than 20% in section 2, open valve 2 and supply water to section 2
   }
   else if(Sens2>50 && Sens2<100)
   {
      digitalWrite(13,HIGH);  //if soil moisture is greater than 50% in section 2, close valve 2 and stop water supply to section 2
   }

   if(Sens1<20 || Sens2<20)
   {
      digitalWrite(8,LOW); //pump on
   }
   if(Sens1>50 && Sens2>50)
   {
      digitalWrite(8,HIGH); //pump off
   }
}
```

[1] ThingSpeak. Wikipedia. https://en.wikipedia.org/wiki/ThingSpeak.
[2] Mathworks. mathworks/thingspeak-arduino. GitHub ThingSpeak Communication Library for Arduino, ESP8266 and ESP32. https://github.com/mathworks/thingspeak-arduino.

III. RESULT AND DISCUSSION

A. Sample Code Test Run Results

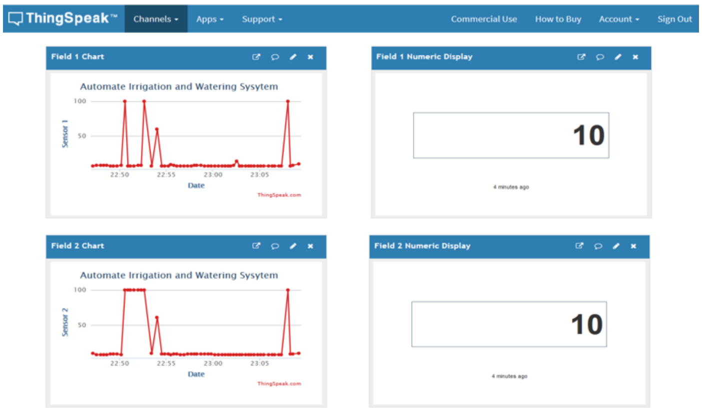

Fig 4:- Test Run Results

The above shown graphs represent the sensor data taken from a sample test run using the sample code. Field 1 chart represents the soil moisture measured by sensor 1 in test section 1 and field 2 chart represents the soil moisture measured by sensor 2 in test section 2. The sensor data interval is 15 seconds i.e. the sensor send moisture data every 15 seconds.

As shown by the graphs, when moisture in the soil drops below 20%, water is supplied to that section of soil till it reaches a moisture content of 50-100%.

B. Advantages

- The system eliminates the need of human interference.
- Operating cost includes only cost of electricity which is much less than the current labour cost for irrigation of crops on farms or watering of plants in office spaces.
- Initial cost for installation of system is low (≈3,500 INR).
- The crops or plants receive optimum amount of water. Thus, wastage of water or loss of yield due to improper irrigation is eliminated.
- The system provides live data and feedback which can be compiled and studied to build databases for the crops.

C. Limitations

- The absence of a graphical user interface (GUI) like a mobile or desktop app makes it difficult to monitor the system and its data.
- The operation of the system cannot be remotely controlled.
- The calibration of the sensor needs to be done through the programming software which might be difficult.
- Adjustments have to be done for the water supply since different plants require different amount of water.

IV. CONCLUSION

The automated watering and irrigation system is a solution to the improper irrigation and watering problem for crops and plants. It will not only increase the yield of crops but also prevent water wastage. It is also a very versatile system as it finds its application in agricultural, domestic and commercial sectors. This system can easily be self-sustaining by use of a solar panel.

A. Future scope

- Hydroponics: Hydroponics is the method of growing crops or plants without the presence of soil. It makes use of water which is enriched with nutrients that are important for plant growth so that the need of soil can be eliminated. Our system could be useful in the field of hydroponics as it could automate the whole process, provide crops or plants with optimum amount of water and nutrients at optimum time intervals and could give the consumers accurate data.
- Mobile application: We plan to develop an application for the consumers so that they can remotely monitor their plants or crops. Also, this app will allow the user to toggle the system or only specific sections of the system on and off.
- Database: We plan to develop an SQL database which will store all the incoming data from the soil moisture sensors. This database could be useful in research as it would contain the daily water consumption of crops. This could help determine the life cycle of plants and help in reduction of yield time, optimizing the yield and thus improve the productivity of crops. The data could also be used to create genetically modified organisms (GMOs) as the full life cycle details of a crop will be available to the researchers.

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