Water flow controller for precision agriculture

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Abstract. In recent years, water crisis in Asia is reaching an alarming proportion that might very soon attain the worldwide global crisis and there is an utmost need to save water. The water crisis occurs due to the increase of population, poor water harvesting, and water wastage in the manufacturing industries, process industries and agriculture sector. Therefore, each sector requires a mechanism to reduce the water wastage and save it for future needs. In this paper, an efficient irrigation system is designed to reduce the water wastage in agriculture fields. Due to the farmer’s irregularity and negligence, they leave the motor turned ON for several hours which will lead to wastage of water and more power consumption. Similarly, they forget to switch ON the motor, which also leads to the damage of crops due to insufficient water supply. The proposed system controls the flow of water in the fields in accordance with the intensity of sunlight and moisture content present in the soil. This system uses the microcontroller (Arduino UNO) assisted with LDR (Light Dependent Resistor), capacitive type moisture sensor and DHT 11 (temperature and humidity sensor). Based on the sunlight intensity and moisture content present in the soil, the Arduino UNO is programmed to turn ON/OFF solenoid valve connected to the pipeline that controls the flow of water in the agricultural fields. Thus the proposed system can operate automatically and supply water to the fields whenever needed without any human intrusion. Further, a Wi-Fi module ESP8266 is connected such that the solenoid valve can be operated manually through mobile phones/laptops based on the measured parameters if required.

1. Introduction

The rapid growth of industries, residential areas and agriculture in vast scope leads to increase in water supply facility. In certain areas water supply is required continuously or at regular intervals. Water irrigation to crops is becoming quite difficult nowadays for the agriculturalists due to irregularity of water supply and their negligence as they leave the motor turned ON for hours together which will ultimately lead to water wastage. Similarly, they forget to switch ON the motor when required which again leads to the damage of the crops. To overcome the issue of water wastage in agricultural field, an alternate solution for irrigation has to be developed. In this paper, the water flow in the field is controlled using a solenoid valve that is operated based on the moisture content in the soil and light intensity of the environment measured using soil moisture sensor and LDR circuit respectively through the Arduino UNO microcontroller. The Wi-Fi module ESP8266 is installed with the microcontroller so that the entire system can be monitored as well as controlled using mobile phones/laptops from elsewhere. As a result, water wastage in the fields can be minimized without human intervention and it is done with more accuracy and precision. The proposed irrigation system is cost efficient and does not require any specific knowledge to operate it.

2. Literature survey
Zhao Liqiang et al. [1] introduced a cloud based irrigation system that controls the flow of water in the field by measuring the soil parameters like moisture and temperature. At present, water and electricity are in high demand. Pavithra D et al. [2] used an embedded controller to control the water flow and used solar energy to operate the motor in the field to conserve power and water.

Robert W et al. [3] worked on remote sensor systems with integrated control that has been led in scholarly research. To advance economically reachable remote detecting and control systems, valve control equipment and programming were created to be perfect with a business remote sensor hub. The effort was led as a team with a remote system seller to such an extent that the examination result and the item itself could eventually be accessible to producers. The valve control organize was assessed to have a restitution time of around 3.5 4.5 years, however some vineyard cultivators professed to see compensation in under 3 years.

Chandankumarsahu et al. [4] introduced wireless sensor network in irrigation. The primary work of wireless sensor network is to execute two sorts of hubs and building sensor. The equipment stage is comprised by information process unit, radio module, sensor control grid, information stockpiling streak, control supply unit, simple interfaces and broadened computerized interfaces. The objective of a scattering convention is to reliably convey a bit of control and synchronization directions to each hub in the system. The trial results demonstrates that wireless sensor network have wider applications in the agriculture.

Singh et al. [5] have proved that IoT can be used in irrigation to control the water flow in the field by measuring the required parameters in the field even though the farmer is away from the field. G. Eragamreddy et al. [6] developed an automated irrigation system. In this system, the water flow is controlled using the moisture content in the soil. Further the status of the water flow is also indicated via a website.

R. N. Rao et al. [7] introduced a low cost irrigation system, wherein the water flow is controlled automatically and indicated to the user via a text message to the mobile phone and also to the users Gmail account. E. Avar et al. [8] developed an automated irrigation system interfaced with a GSM module and an idea to implement the android application in the mobile phones to monitor and control the status of water flow in the field was developed.

3. Block diagram

The block diagram of the experiment setup is shown in figure 1. It consists of a capacitive type moisture sensor, a Light Dependent Resistor (LDR), temperature and humidity sensor (DHT11), solenoid valve, relay to operate the solenoid valve, Arduino, ESP8266 Wifi module and mobile/laptop to monitor the values.

![Block diagram of experimental setup.](image-url)
3.1. Solenoid valve
A solenoid valve is an electro-mechanical device which uses electric current to produce magnetic field. It differs in the mechanism of fluid they control and the characteristic of generated magnetic field strength, the electric current they use. The functions of solenoid valve are to open, close, distribute and to mix fluids. In fluid flows, the mostly used control element is solenoid valve. Solenoid valve is used in the industries, domestic washing machines and dishwashers to control the water from entering into the machines. It is used in automatic irrigation sprinkler systems. It is also used in paintball gun triggers to actuate Carbon dioxide hammer valve.

3.2. Arduino UNO
It is an open source microcontroller based on Atmega328P microcontroller. It consists of analog and digital input/output pins which can be used for interfacing various kinds of sensors and may be interfaced to other boards. It can be used to interface with huge variety of motors and other actuators for different applications. The board has 14 Digital pins, 6 Analog pins.

The Arduino is programmed using the software ARDUINO IDE via type B USB cable. It accepts voltages between 7 and 20 volts. It can be powered by a USB cable or by an external 9-volt battery. The general pins are LED, 5V, VIN, 3.3V, GND and IOREF. The special pins are Serial, PWM, SPI, TWI, AREF and External interrupts. To design an automatic irrigation system using solenoid valve the following components are used viz., Solenoid valve, Arduino UNO, ESP8266 Wi-Fi module, Light Dependent Resistor (LDR), capacitive type moisture sensor, DHT 11 sensor, 5V Relay, Regulated Power Supply (RPS), 10 K Ohm Resistor, Breadboard, Jumpers.

The circuit shown in figure 2 describes the connections which are to be done with the solenoid valve and relay. In this circuit, the output voltage from the Arduino is amplified by the amplifier circuit to operate the relay connected to the solenoid valve to perform ON/OFF operations.

![Figure 2. Relay and solenoid valve circuit.](image)

4. Results and Discussion
The proposed system is implemented using the Arduino UNO board. The relay and solenoid valve are controlled automatically and can be controlled manually using the Blynk Application on an android mobile phone. The android phone is connected to the board using the ESP8266 Wi-Fi module. The four parameters namely moisture, temperature, humidity and intensity is monitored and controlled using the ON/OFF switch button displayed on the Blynk Application. The sensor results viz., humidity, temperature, moisture, sunlight intensity and the status of the motor is linked with the Blynk app shown in figure 3 is the reading taken from the field model created in an area of about 30cm×30cm. When the moisture is above 250% the motor is turned OFF automatically or manually through the Blynk Application. Also the device is programmed such that if the light intensity is above 25% the motor will be still ON until the moisture reaches 300% to compensate the effect of sunlight.
5. Conclusion and future scopes
In this project, wireless control of irrigation system is done for precision agriculture. The major application of this project is for the farmers, who want to water their crops during their absence in the field. It was found that this system is cost effective and feasible. It can be used in the areas where there is water scarcity thereby improving the water sustainability. In future, this prototype can be extended to various purposes such as feeding the animals without any human intrusion from anywhere.

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