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Autonomous Sprinkler System with Internet of Things

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Abstract
The objective of this work is to devise an intelligent and autonomous sprinkler system that operates based on the real-time moisture content in the soil to be watered. A moisture sensor that was submerged in the soil was interfaced to a sprinkler and programmed to control the water supply based on the moisture fraction present in the soil. Moreover, the IoT-enabled controller allows the control the sprinkler remotely in the extraordinary situations. The system is built as a low-cost model as compared to the earlier reported sprinkler systems using different wireless modules. The IoT feature in the present system can be an additional advantage as the user, from anywhere in the world, based on any forecast of thunderstorm can seize the watering process from a remote area, in the process saving a lot of water and preventing the death of plants through overwatering. This work proves the possibility of replacing conventional sprinklers with the smart sprinklers with IoT capability at relatively lower cost.

Keywords: humidity Sensor; internet of things; sprinkler; water wastage.

INTRODUCTION

A sprinkler is a watering device that is used to deliver the necessary water to the soil evenly, amply, easily as it is obvious that it would be impossible for a human being to water large area of field every day and multiple times throughout the day. Sprinklers need a lot of water to function properly but the shortage of raining and land reservoir water has become a major issue. In this paper, the idea is proposed of using moisture/humidity sensor for water distribution as per only the requirement. Internet of Things (IoT) is a concept of having everyday objects around us connected [1] through internet including smart phones, sensors etc. Once connected, they enable smart processes and services between them for the convenience of end user. So, if the sprinkler is connected through it then it can be controlled remotely by user for certain emergency scenarios i.e. if the user is away from the system and there is a forecast of heavy thunderstorm already then, he/she can stop the sprinkler from watering at all us using any internet connected device e.g. smartphone or computer etc. This way wastage of water is prevented and overwatering of plant, which may be harmful, is ceased. In modern era, the need of automated system is necessary because it is simple to use and easy to configure. Automated irrigation systems avoid watering wrong time of the day if the soil is moist. So, overwatering of plants or crops is prevented. It also eliminates any error caused by human. No extra labor is needed for just turning the valve on or off and saves a lot of time.

In the paper, "GSM Based Automated Irrigation Control using Raingun Irrigation System" by Suresh et al. [2] mentioned about using automatic irrigation system based on microcontroller in which the irrigation will be done only when there will be heavy requirement of water. The drawback of this system is that this only covered lower range of agriculture land and not affordable enough. The system is just limited to low level of automation of irrigation system. Also, the using GSM to send messages is certainly not cost efficient.

Microcontroller based automated irrigation system was reported by Shiraz P et al. [3]. Also, using this technique, they able to reduce over watering already saturated soils, avoid watering at the wrong time of day, which could have decrease crop performance or destroy it. This Microcontroller based system can easily be improved by using other modern controllers like Arduino etc. which are much less costly but far more functional and eliminates the need of having a ADC. And this is basic but functional system with no controlled application from the user itself.

In, A wireless application of drip irrigation automation supported by soil moisture sensors" by Mahir et al. [4] mentioned a wireless controlled irrigation system that monitors water content of soil continuously and powered through solar energy. The irrigation method removes the need for human labor. But solar energy is not reliable as of now because in a cloudy weather the system will not get enough power from the Sun. This system uses and RF module for controlling the sensor by a remote but the range of is very less. The basic elements of the unit are cheap but for the entire system, the cost is high.

The concept of IoT is based upon the fact that the information should be available to everyone all the time. Hence, that kind of data must be stored to a certain place through internet. Cloud servers act as virtual storage space which can be interpreted as a front end to access for internet enabled devices. This system is far more effective than the RF control or GSM control is that it has higher range than those as user can be anywhere in the world yet still can control the sprinkler system. Internet cost is decreasing as speed and consumption rate is increasing, so it is only a wise move to use such resource. Also, the basic parts for using IoT is far less expensive and easy to use. If a smartphone

application is used then more features like monitoring, security can be added in future.

METHODS

First, the system consists of following parts i.e. a microcontroller, wireless module, solenoid valve, relay, soil moisture sensor(LM393) figure-2, LCD display(16x2), water resource. A pipe is connected to the water resource which is then connected to the solenoid valve. The solenoid valve, figure-4, only opens when it gets signal from the microcontroller otherwise it's always in closed state. The moisture is dipped under the ground near the plants. The sensor is always on and senses the moisture content and sends the data to the controller which in exploits it to the LCD for displaying the data as shown in figure-7. The wireless module connects the controller with a cloud server. The controller can send or receive data from the server at any given moment as shown in figure-1.

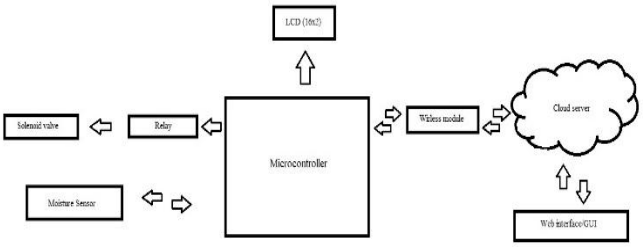

Figure 1: Block diagram of proposed hardware system components

The controller used here is Arduino, figure-3. Arduino is chosen as it is widely used for research purposes and different sensors and hardware are easy to interface. The soil moisture/humidity sensor uses 0.4 mA of current so chance of loading effect is very less. The solenoid valve requires 24V of power while the controller can only output 5V. So, the valve is given external power. The LCD is connected to the controller via usual connections with 15th and 16th pins are given +5V and ground connection for backlighting which is useful for viewing in low light. The display shows moisture content is percentage as programmed. The wireless module is connected to Arduino which takes 3.3V-5V as input. The code is written so that it can collect data from a certain server address and send data to it.

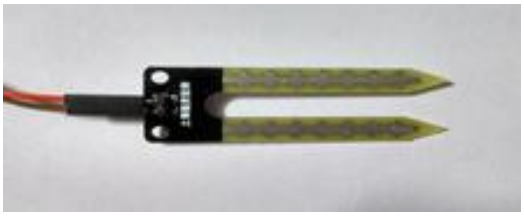

Figure 2: Moisture sensor

Figure 3: Arduino Uno R3

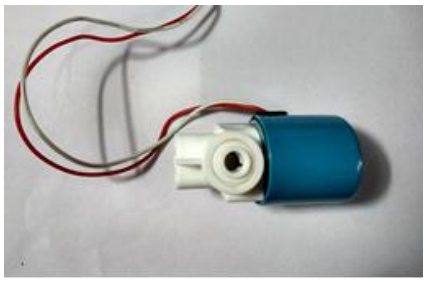

Figure 4: Solenoid valve

Figure 5: Moisture sensor in dry soil

Figure 6: Moisture sensor in 100% moist condition

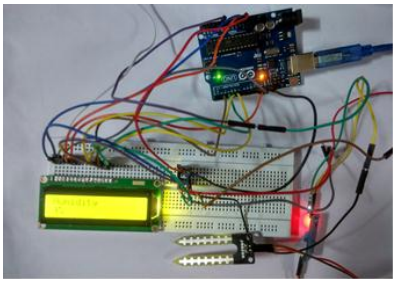

Figure 7: Primary circuit for the system

The solenoid valve is connected to the controller with external power supply. The valve opens only the controller sends high signal to it. The controller follows the simple algorithm as shown in fig-8.

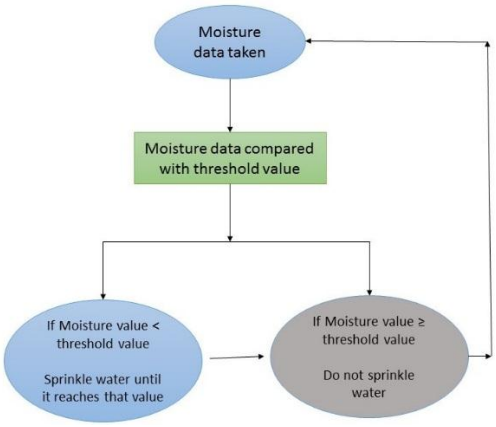

Figure 8: Basic algorithm for moisture control

RESULTS

First, the moisture/humidity sensor doesn't tell the moisture content of soil but it takes the di-electric constant of soil and measure the change in resistance as the water quantity increases its resistivity. So, proper calibration is required for the controller to detect the content. For this, a simple experiment is done. Bowls filled dry soil and water is taken and the sensor is dipped in both and input voltage is observed as shown in figure-5. For dry soil and total water content are set as 0 and 100 percent, figure-6, respectively. The rest of values are mapped by the controller itself although it is still advised to check them properly.

Next part, the solenoid valve is connected to the controller with external power supply. The valve opens only the controller sends high signal to it. The controller follows a simple algorithm written in the code as shown in figure-8.

For the software part, Arduino IDE is used for writing the and uploading the code to the microcontroller which is done in C language. The interfacing with wireless module is done using pins. The module must be connected to the internet all the time. For small scale demonstration, free cloud services are chosen but for complex systems these services aren't recommended. Currently this service only sends ON/OFF signal to the sprinkler. The server can be opened from simple web browser from any device having an active internet connection. A mobile application for smartphones running Android operating system is made for making a simple graphical user interface. The application is made using Android studio based on specialized JAVA language. The SDK has wide range of support including older versions of the Android platform in case developers like to support old devices.

CONCLUSION

This paper proposed a sprinkler which is independent of any human intervention while watering the plants when needed. It abandons the need of user monitoring and maintain the moisture level. The system is built as a low-cost model as compared to the earlier reported sprinkler systems using different wireless modules. The IoT feature in the present system can be an additional advantage as the user, from anywhere in the world, based on any forecast of thunderstorm can seize the watering process from a remote area, in the process saving a lot of water and preventing the death of plants through overwatering.

For future work, this method can be successfully implemented in agriculture while the farmer can easily monitor or improve crop performance without the help of any other labor. Also, zonal marking using IoT is possible for certain area of field to be watered. Security accompanied with more sensors can make a modern agriculture much simpler and with lesser efforts.

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