Journal of Applied Information Science
10 (2) 2022, 01-05
http://www.publishingindia.com/jais

# Design and Implementation of Low Cost Automatic Irrigation System using Microcontroller

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**Abstract: We are living in an era where we are facing a shortage in our water supply and other resources, primarily due to the ever-increasing population. The ever-increasing need to feed all this population is daunting. So there is a need to achieve maximum efficiency in utilizing these resources. Water is an important natural resource. The availability of freshwater is decreasing rapidly, that it is often said that if there is a third world war, it'd be for water. Usually, when we do agriculture, the most commonly faced challenge is water scarcity. Also, much of the water is not utilized by plants if we do the usual form of irrigation. Advanced irrigation techniques like automatic irrigation are starting to gain popularity these days. But they all need human intervention to monitor the process, which is tedious for large systems. We introduce our automatic irrigation system as a solution to this. We introduce a microcontroller-based automatic system, which actively senses the soil's moisture level, opens a valve when water moisture is below a threshold and stops when the cutoff level has reached. Thus water wastage is minimized. This sensor can monitor a single plant or an entire area. A farmer can easily monitor this system. Most of the fields of agriculture will benefit from the proposed system of automatic irrigation.**

**Keywords: Arduino UNO, Irrigation system, Low cost, Microcontroller, Soil moiture.**

## I. Introduction

Bangladesh is a village-based country, and agriculture plays an essential part in the country's growth. Agriculture in our nation is reliant on the monsoons, which provide an insufficient supply of water. As a result, irrigation is utilized in agriculture heavily. Water is supplied to the plant via the irrigation system, which is dependent on the soil type. In agriculture, two things are critical: first, obtaining information on the fertility of the soil, and second, measuring the moisture content of the soil. There are several irrigation systems available today that are utilized to decrease reliance on rain. And, for the most part, this approach is controlled by electrical power and an on/off schedule [1].

Smart Agricultural Systems have made rapid progress in recent decades and display the importance of agriculture across the world. Indeed, almost 50 percent of the population in Bangladesh, for instance, relies on the crucial agriculture sector. Unfortunately, the irrigation systems used to depend on the mills to water the land in conventional ways without knowing the adequate harvests in the past. These outdated systems are a major source of the waste of great amounts of water. The lack of appropriate water leads to the destruction of some crops. Nevertheless, novel irrigation systems have been developed with new technical advances without the farmer meddling [2].

From the mechanical ways of the 20$^{th}$ to computerized agriculture in the 21$^{st}$ century, agriculture develops. In the agricultural area, there are changing field operations, requiring high accuracy in procedures for optimizing crop yield and quality, and also controlling production costs. In an area that has year-round rainfall and groundwater shortages, Bangladesh will alleviate the problem of water shortage using sophisticated irrigation techniques. Automation systems should be developed to meet these preconditions. In fact, intelligent systems have proved themselves capable of regulating crop watering. Perhaps it serves to prevent irrigation of water waste. Moreover, the number of workers leading to savings will be reduced [3].

As the world's population grows, so does the demand for agricultural produce. Furthermore, in the case of many firms that hire individuals from the agricultural zone, the potential and abilities of farmers in the agriculture sector are being diminished. In order to meet the world's population projections, agricultural profitability must increase from 6.8 billion in 2013 to more than 10 billion by 2050. With farmers' abilities dwindling, economies have become a critical need. It is essential for manufacturers to look at mechanical early frameworks and update them so that a high embedded system may be achieved [4].

This paper is intended to facilitate and improve the system of irrigation by establishing and constructing a full automated watering system, and by eliminating overwatering from saturated soil, to boost farm productivity. In the proposed automatic irrigation system, the water level indicator is mounted in the storage tank and the component and root area of the plant is mounted by soil moisture sensors, which process sensor data and transfer them to the control unit, which controls water flow via the valves. Efficient efforts and contributions are needed to achieve the desired aims of this system. The commitment also shouldn't thus be restricted to personal sacrifice. Furthermore, the high effectiveness of contemporary irrigation systems must be of great importance to farmers.

The article is structured as follows: The introduction to this study is included in Section I, Section II includes a description of required components. A brief description of the proposed methodology given in Section III. The essential description of the design and implementation is given in Section IV, Section V describes the advantage and limitations about this work and finally, in Section VI, the conclusion of this research work has been drawn.

## II. Required Components

To accomplish the whole system, some components are needed. They are listed in Table I.

Table I: Required Components

| Sr. No. | Components | Quantity |
|---|---|---|
| 1 | Arduino UNO | 1 |
| 2 | Soil Moisture | 1 |
| 3 | 5V Power Relay | 1 |
| 4 | Mini Water Pump | 1 |
| 5 | Power Source (Adapter/Battery) | 1 |
| 6 | Jumper Wire | Not Specific |
| 7 | Breadboard | 1 |

A short definitions for components that using in system prototype is given below:

### A. Arduino UNO

If we want to operate a device or system automatically or actively, one thing we must keep in mind is that we have to place a device or system in a brain so that the device or system is given as many instructions from that brain can run on the system. Arduino is a brain that allows us to easily operate a system or device according to your instructions. Arduino type Uno R3 is a microcontroller that using in this work for motor position control. Arduino has 14 input/output digital ports that provide signals of PWM to servo motor by 6 of them and 6 input ports as analogue, also contains oscillator crystal of 16 MHz and cable USB for push through program. The Arduino advantages are independent platform, construction robust and low price. Table I shows the components description of the system prototype depending on their functions [5]. A typical image of Arduino UNO is shown in Fig. 1.

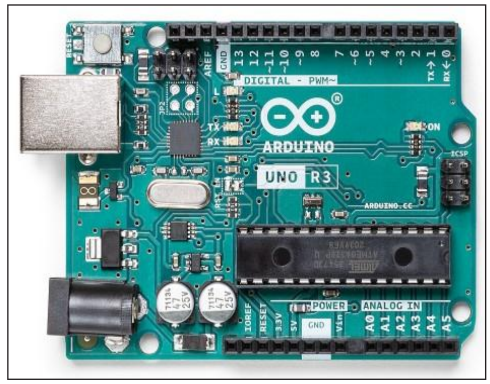


Fig. 1: Arduino UNO

### B. Soil Moiture

A special device called a soil moisture sensor is used to measure soil moisture. It measures the presence of water on the ground and sends a signal to the microcontroller. It has the ability to analyze so it is also called a sensor. These sensors are used to determine the flow of electricity in the ground which is measured between the two electrodes of the sensor. It will send a signal to the microcontroller if it exceeds the predefined ratio of current is indicated on the device [6]. A typical image of soil moisture sensor is shown in Fig. 2.

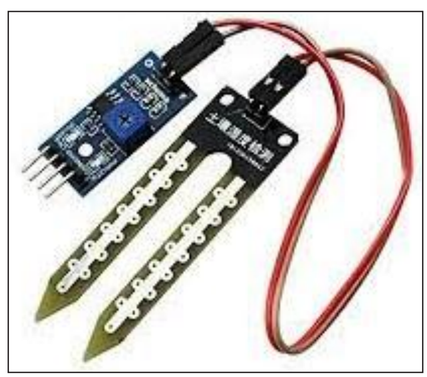

Fig. 2: Soil Moisture Sensor

### C. Power Relay

A power relay is a device used to ensure the flow of electricity on and off. Although its functionality may seem like that of a switch, it is also capable of operating at low voltages such as 5V power. It is very easy and safe to control the flow of electricity in the motor [7]. A typical image of 5V power relay is shown in Fig. 3.


Fig. 3: 5V Power Relay

### D. Mini Water Pump

A water pump or motor is essential for irrigation work. For automatic control of a motor, we will use a low voltage DC motor in this system. It can be operated at 5-12V volts. The motor has a power connector, water inlet, and outlet. These motors are called submersible motors because they operate under or near water [7]. A typical image of mini water pump is shown in Fig. 4.

Fig. 4: Water Pump

### E. Breadboard

A breadboard is a rectangular and perforated board. It is also called trainer board or projector board. It has two rows of holes at the top and bottom. Separately the holes in each row are connected horizontally. Again the holes in the middle are divided into several vertical rows. The holes in a vertical row are connected vertically. One row of holes does not connect to the other row of holes. Again, there is no connection between the hole on one side of the empty space in the middle and the hole on the other side [8]. A typical image of a breadboard is shown in Fig. 5.

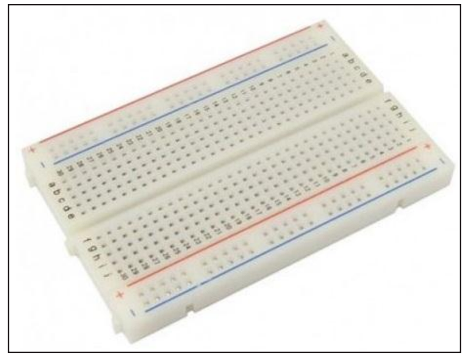

Fig. 5: Breadboard

### F. Power Source

Power is required to operate each electric or electronic device. Nowadays Electronics devices cannot be imagined without power. So in simple language, the power source is the medium from which the power is supplied according to the need of the device to operate the device. In our proposed device, we can supply power from two types of power supply. One is a power adapter and the other is a battery. So you have to ensure a 5V power supply from either of the two mediums. We will supply 5~9V DC power to the device using a power adapter [7]. A typical image of power source is shown in Fig. 6.

Fig. 6: Power Source

## III. Methodology

The circuit operation is quite simple: once the soil begins to induce dry, the detector can output to the Arduino board that switches ON the pump. Once the soil is satisfactorily patterned, Arduino switches OFF the pump. The soil wet detector is of variable resistance. This suggests its resistance varies per the physical phenomenon changes between its 2 detector rods. Once these rods area unit inserted into the soil, their physical phenomenon changes as per the soil's wet content. If the soil is dry, the physical phenomenon is a smaller amount (and the resistance is high). On the other hand, if the soil is kind of dampish, the physical phenomenon is high (and the resistance is low). So, the resistance of sensors switches from max to min, as per the soil's wet (an inverse proportionality). This variation in resistance is regenerate into associate in nursing analog voltage output and because the soil's wet will increase, the analog output voltage decreases, and contrariwise. The sensor's output voltage is given to Arduino as associate in nursing analog input. The Arduino board can then convert it into a digital price and live the soil's wet level (from zero to 100%). If the wet level is a smaller amount than the set intensity (say, 10 or 20%), it'll be put on the relay through the junction transistor, turning ON the pump. As soon as the pump is turned on the soil starts to get wet. Arduino can unceasingly scan the soil's wet level from each sensor. When a group wet level is reached (say, 90 or 95%) in each of the detector rods, Arduino can throw the relay, that turns OFF the pump. This cycle is continuous therefore the plant is patterned once its soil becomes dry.

## IV. Design and Implementation

The block diagram of the system is shown in Fig. 7.

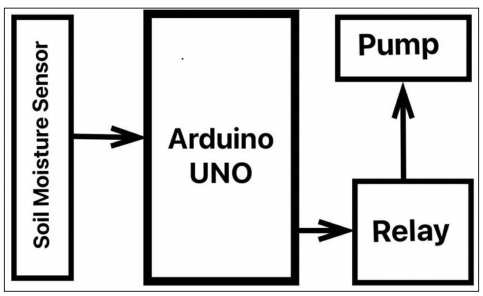


Fig. 7: Block Diagram

Fig. 8 displays the flowchart of the system.

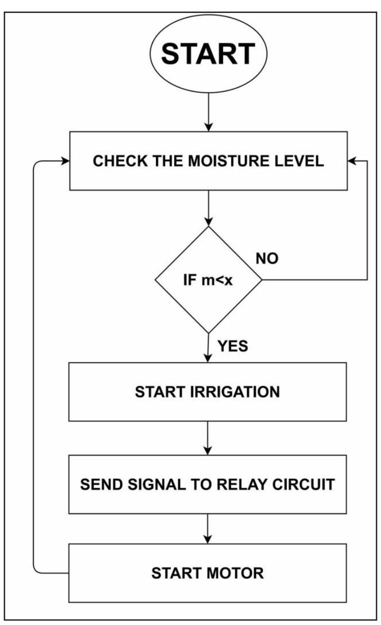


Fig. 8: Flowchart

Fig. 9 depicts the circuit diagram of the system.

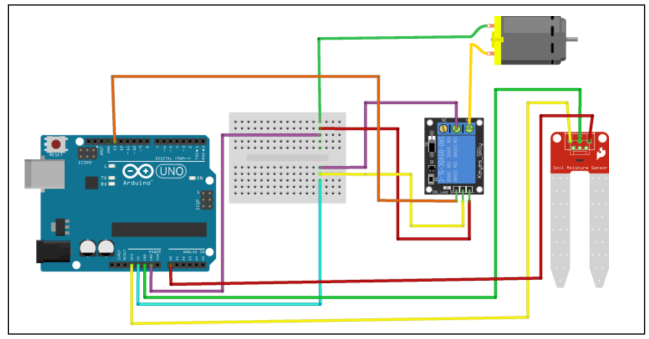

Fig. 9: Circuit Diagram

The software part comprises a programming language that is developed utilizing C++ programming. The codes are focused on Arduino UNO to be gathered and transferred. The equipment and programming are actualized and incorporated to structure and build up the automatic irrigation system.

Fig. 10 illustrates the hardware layout and interconnections.

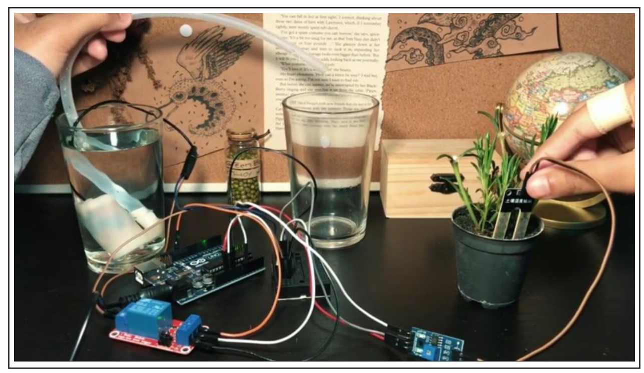

Fig. 10: Final Module of the System

In the proposed system, the wetness sensing element provides analog voltage output therefore it should be connected with Arduino UNO's analog input pins. That is given power from the board. Arduino UNO drives the relay and the motor is connected with the relay. The relay is employed to modify ON/OFF The motor or pump. It's connected between the "NO" (Normal Open) terminal and therefore the circuit ground. A power source or a battery is also needed to operate the whole system. The microcontroller, sensors and the motor will perform by the flow of energy from the source. When the sensors will detect low wetness or dryness it will send data to the microcontroller (Arduino UNO) then the microcontroller will turn on the motor with the help of a relay. When it seems that the water level is sufficient then sensors will send data again and by the same process, the motor will be turned off.

## V. Advantages and Limitations

Some advantages of the automatic irrigation system are mentioned below:

- *Saves Time:* A programmed water system framework can spare you a great deal of your time that you simply within the past would have spent watering your yards, gardens, and blooms. You'd currently be ready to set your device and this will identify when the plants need water and it will turn on and off the pump automatically. So you don't need to invest extra time to check the water level of the soil. The atmosphere wherever you reside, you'll proceed that occasion realizing that your gardens and blossoms are going to be well-kept and successful once you come.
- *Weed Reduction:* We will notice a discount within the variety of weeds showing, this is often thanks to the fact that area units that require water are the sole areas taking water, with the depiction of a specifically planned irrigation system.
- *Improves Growth:* Whenever plants, yields, yards, or blossoms area unit patterned with littler measures of water over a lot of drawn-out timeframes, they become faster, it's the proper condition for development. You may appreciate greener and a lot of delicious greenhouses and gardens.
- *Saves Money, Water, and Energy:* By using an automatic irrigation system we can greatly reduce the cost of agriculture or irrigation work. Using this method can reduce unnecessary electricity or fuel consumption, reduce irrigation costs and prevent water wastage.

The proposed device has advantages as well as some disadvantages. Although this system is easy to install in a small area and low cost, it may require a large number of sensors in a large area. This will increase the cost of building the whole system. Its installation and maintenance cost will be slightly higher than that of the irrigation system. In addition, the user must have some technical knowledge to use and maintain such equipment. Although the whole system will be operated automatically, its users need to pay attention to the functionality of the device, make sure that the sensors are transmitting the microcontroller's correct data and the motor is performing effectively. Since it is based on sensors, it is best not to rely solely on sensors. We hope that in the future it will be possible to solve all these problems through further testing [9].

## VI. Conclusion

The goal of this paper is to create a simulated framework of an automatic irrigation system that have been watering in different types of area of agricultural land or gardening. The primary goals of this inquiry are as follows: When compared to previous automatic irrigation frameworks utilized for the same application, the suggested simulated framework is simple and minimal in cost. Because it is Arduino-based and requires no external components, programming. The simulated architecture is simple to use and provides increased effectiveness. The system has the potential to be used on a much greater scale.

In the future, one may explore using more efficient sensors that are both cost-effective and require less electricity. This would increase efficiency while decreasing expenses. It would be really beneficial if there was a way to further reduce the cost of this system.

## Acknowledgment

The authors would like to express our heartfelt gratitude to every one of the Computer Science and Engineering Department teachers in Islamic University, Bangladesh and most importantly our beloved parents for their continuous support.

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