Design of Arduino UNO based smart irrigation system for real time applications

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ABSTRACT

The fundamental principle of the paper is that the soil moisture sensor obtains the moisture content level of the soil sample. The water pump is automatically activated if the moisture content is insufficient, which causes water to flow into the soil. The water pump is immediately turned off when the moisture content is high enough. Smart home, smart city, smart transportation, and smart farming are just a few of the new intelligent ideas that internet of things (IoT) includes. The goal of this method is to increase productivity and decrease manual labour among farmers. In this paper, we present a system for monitoring and regulating water flow that employs a soil moisture sensor to keep track of soil moisture content as well as the land's water level to keep track of and regulate the amount of water supplied to the plant. The device also includes an automated led lighting system.

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1. INTRODUCTION

Numerous variables, including soil quality, water volume, pH level, and sunlight, are crucial to agriculture. For the plant to develop properly in the soil, each of these quantities needs to be supplied in a certain amount. Consequently, this initiative automates and controls the water flow and content [1]–[4]. The project utilizes various sensors to collect environmental data such as temperature, humidity, and soil moisture content, which are then processed by the Arduino UNO board to determine the optimal amount of water needed for the plants. The system then automatically controls the water supply to the plants based on the readings from the sensors, ensuring that the plants receive just the right amount of water.

In India, where agriculture is one of the top industries in the nation and is reliant on rainfall, irrigation is very important. This has an issue with uneven and erratic water distribution in the soils [5]. The fertility and moisture of the earth are key factors in the development of soil-based plants. To address these issues, we combine an Arduino UNO controller with a soil moisture monitor, a DC water pump, light dependent resisters (LDRs), and light emiting diodes (LEDs) [6]–[8]. The two leads that make up the soil moisture sensor are used to gauge the amount of water present in the earth. These leads enable the flow of current through the soil, which calculates the resistance value to determine the soil's wetness content [9]. More water in the soil will increase its ability to transmit electricity, resulting in lower resistance values and higher moisture levels. Similar to how soil will transmit less electricity if there is less water present, low moisture levels are accompanied by high resistance values [10]–[12].

A photo resistor is a type of light-controlled variable resistor, also known as an LDR. A photo resistor shows photoconductivity when the resistance decreases as the intensity of the incident light increases. In light-sensitive detection circuits as well as light- and dark-activated switching circuits, a photo resistor can be used [13]. High resistance semiconductors are used to create light resistors. A photo resistor can have a resistance as high as several mega ohms (M) in complete darkness, but only a few hundred ohms in complete illumination [14]–[16]. A pump is a mechanical device used to transport fluids (liquids, gases, or occasionally slurries). Depending on how they transport the fluid, pumps can be divided into three main categories [17]. The project's foundation is a microcontroller device called Arduino UNO. The C-based Arduino programming language is used to operate it. Students can use it more easily because the programme is open-source. The microprocessor used in the Arduino UNO is an ATmega328P [18]. It has numerous analogue and digital pins that are used for programming and controlling various types of electronic devices. It has 6 programmable analogue pins and 14 digital pins. It is linked to a computer via the Arduino IDE [19], [20]. The goal is to automate agriculture, increase field productivity overall, ensure proper plant maintenance and growth, save manpower and water, improve soil health through real-time sensing and control, assess soil quality, and make sure the right type of soil is being used for a particular type of plant. It is suggested that an automated irrigation system be used, where the right sensors are used to sense the soil conditions and a microcontroller can control the amount of water delivered to the soil based on those conditions. The farmer will keep an eye on the soil's nutrient level. The plant's root zone contains sensors that measure the moisture in the soil.

2. SENSORS

The volumetric water content of soil is determined using the soil moisture sensor. By measuring the soil's permittivity, which is a function of the amount of water present, this sensor employs capacitance to determine the water content that is present in the soil [21], [22]. The volumetric amount of water in the soil is calculated by placing this sensor into the sample soil, and the results are expressed as a percentage. Soil moisture sensors use an indirect method to measure the volumetric water content by substituting another soil property, like resistance or dielectric constant, for the labor-intensive task of directly measuring the water content in free soil [23]–[25]. It is necessary to calibrate the relationship between the recorded component and soil moisture because it can vary depending on the type of soil, soil temperature, or electric conductivity. In general, sensors that measure soil wetness by volume are referred to as soil moisture sensors. Another class of sensors, commonly known as soil water potential sensors, measure the water potential, a different aspect of soil moisture [26]. These sensors have tension and gypsum blocks.

LDR are light sensitive resistors, and as the amount of light they are exposed to increases, their resistance decreases. LDRs are light-sensitive electronics that are most frequently used to measure or indicate the presence or absence of light. When the LDR sensor is exposed to light, the resistance decreases drastically, sometimes even to a few ohms, depending on the light intensity. In the dark, their resistance is very high, sometimes reaching up to 1 M. LDRs are nonlinear sensors with variable sensitivity depending on the wavelength of applied light. They have a wide range of uses, but occasionally technology like photodiodes and phototransistors renders them obsolete. LDRs made of lead or cadmium have been outlawed in some nations due to environmental safety concerns.

3. CONTROL STRATEGY

The block layout of the suggested system is shown in Figure 1. The graph Figure 2 between the digital readings provided by the soil moisture sensor in Figure 2(a) and amount of moisture in the soil in Figure 2(b). The water pump is activated when the soil moisture digital number is below a certain threshold. The number is zero and the water pump is turned off when there is too much water in the soil. The system can help farmers save water and energy costs, increase crop yield, and improve the overall health of the plants. Additionally, the project can be modified and expanded to incorporate other features such as fertilization, pest control, and remote monitoring.

The measurements of light intensity have been plotted. The strength varies between around 1,000 cd during the day and 500 cd at night. In Figure 3 shows the moisture content of soil has been plotted against time. The moisture content was measured at an interval of 15 minutes. The ability of the soil to hold water has been mapped against time in Figure 4. Five hours apart, the absorbing ability was assessed. The system is designed to optimize water usage by providing just the right amount of water to the plants, thus reducing water and energy costs, improving crop yield, and promoting plant health. The project is cost-effective, easy to build and use, and can be implemented in small or large-scale irrigation systems. The project has the potential to revolutionize irrigation in agriculture and can be modified and expanded to incorporate additional features such as fertilization, pest control, and remote monitoring.

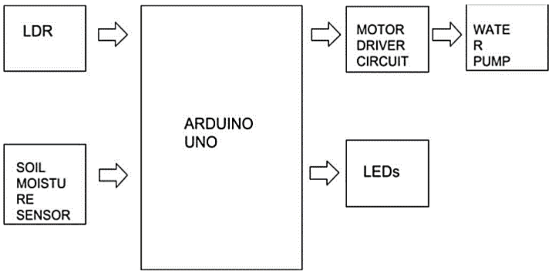


Figure 1. Block diagram of proposed system

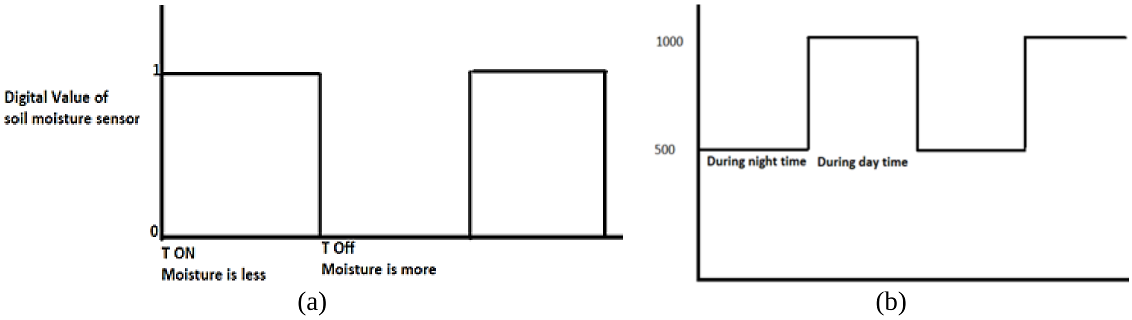


Figure 2. Proposed system (a) digital values given by the soil moisture sensor and (b) moisture in the soil

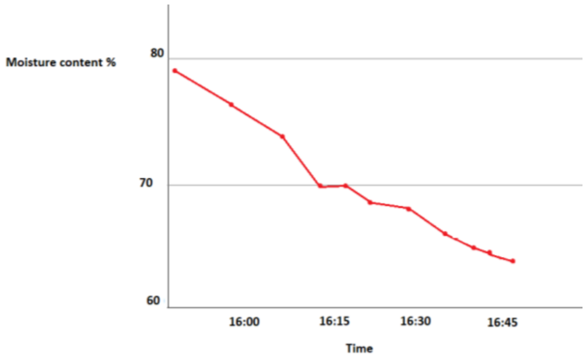


Figure 3. Comparison of moisture content with time

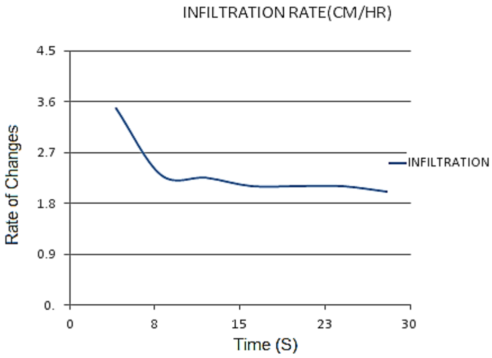


Figure 4. Water absorbing capacity with time

4. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 5 depicts the system's experimental setup and the source code that is operating on the Arduino IDE platform. The ATMEGA328 microcontroller on the Arduino UNO development board is linked to the soil moisture sensor, the LDR, and the LEDs. According to test results, the soil moisture sensor constantly monitors the soil's moisture content. If the moisture level is low, the water pump is automatically turned on, and if the moisture level is adequate, it is turned off. The LDR senses the light intensity throughout the day and when the intensity drops below 600 cd (around nighttime) the LEDs glow. Circuit connection of proposed system is shown in Figure 6.

A moisture sensing probe is inserted in the soil next to the sprinkler head in the irrigation system described above in order to generate an electrical signal indicating the amount of moisture present in the soil surrounding the probe. The irrigation system described above uses an immiscible DC pump that delivers water under pressure through a valve. Figure 7 shows experimental results, which the representation of moisture level and moisture content in the soil vs time is shown in Figures 7(a) and 7(b).

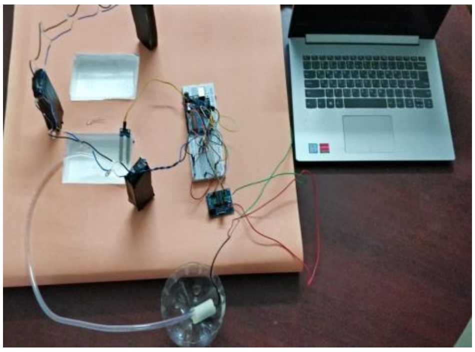


Figure 5. Experiment setup

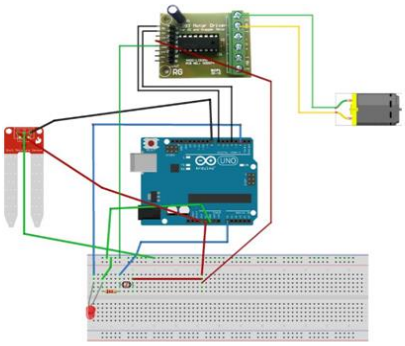
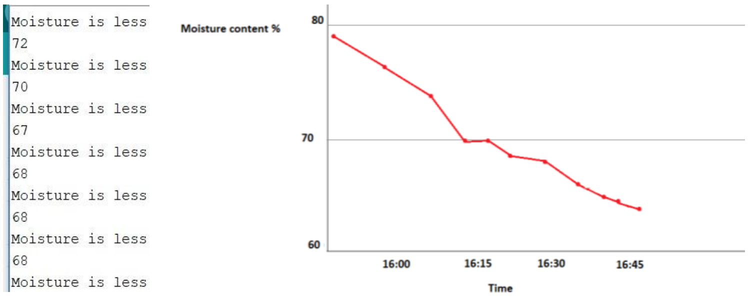


Figure 6. Circuit connection of proposed system



(a) (b)

Figure 7. Experimental results (a) moisture level representation and (b) moisture content in the soil vs time

A motor driver circuit links the 12 V DC pump to the soil moisture monitor. The path of the current flowing from the DC motor determines which of its two working directions clockwise or counter clockwise it will operate in. The microprocessor will supply the inputs A and B. The soil moisture sensor detects the amount of moisture in the soil; if the moisture is low, it sends a value of 1 or higher to the DC pump, which then supplies water; if the moisture is adequate, the sensor sends a digital value of 0, which turns off the pump. In the circuit, there is an LED illumination setup. The LDR detects light intensity all day long; when the intensity reaches 500, signifying nighttime, the LEDs begin to glow.

5. CONCLUSION

This project uses an Arduino UNO, a soil moisture sensor, and an LDR to decrease manual labour, improve efficiency, and conserve water. The method works well because it automates and regulates plant watering without the need for manual labour. In accordance with the sort of soil, it gives the plant water. According to the digital values obtained from the soil moisture sensor, the motor driver circuit in this system, which operates the DC immiscible pump, can be remotely controlled to control the flow of water. Additionally, cost-effective, this technology can support agriculture in dry regions. This design’s limitation is the requirement for manual testing in the event that any specific component or gadget fails.

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