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# Smart Irrigation System By Using Arduino R3

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**ABSTRACT** Current global technology plays an important role in the field of agriculture. Automation is the technology with which a procedure or process is executed without human assistance. The main objective of this work is to determine how a person can use the automatic irrigation system of his own moderately economical facilities in a few hours to connect some electronic components and other materials. An automatic irrigation system based on sensor-based systems has been designed and implemented as one of the most widely used and advantageous automatic systems. This will help people in their daily activities, thus saving them time and hard work. This system uses sensor technology with the microcontroller, relay, DC motor and battery. Behave as an intelligent switching system that detects the soil moisture level and irrigates the plant if necessary. The ON / OFF motor will automatically be based on the dryness level of the soil. Sensor readings are transmitted to a computer to generate graphs for analysis. This type of irrigation system is easily controlled and controlled using a computer. In general, this system applies automatically for small and large gardens, nurseries, greenhouses and green roofs. This will also save time and energy, as well as minimize water loss. It will also help the farmer to benefit from the plantation without solving irrigation planning problems.
**Keywords:** Smart irrigation, agriculture, engineering, intelligent switching, sensor-based systems

## INTRODUCTION

Irrigation is the artificial application of water for the success of crop production in the field. Irrigation has been a central feature of agriculture for over 5,000 (five thousand) years worldwide (Shanan, 1987). In the field of irrigation has reached a rapid development of mechanization. In modern times, irrigation efficiency has become important because of groundwater depletion (Haider et al., 2015). Therefore, adequate planning for irrigation is required. In Bangladesh, the flood irrigation method was selected mainly for its simplicity (Sarker, 2016b). But in this method, water is wasted about 50% to 60% in evapotranspiration, infiltration, infiltration and percolation (S & P), dead storage, additional water consumption of weeds (Ali et al., 2015). To improve irrigation efficiency, an intelligent irrigation system has been introduced (Gutiérrez et al., 2013). In recent days, smart irrigation is the subject of popular discussion for researchers (Reche et al, 2015; Keswani et al, 2018. Jiang, 2018; Dobbs, et al,2014 Ososanya, 2015 Kinjal et al., 2018). The

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irrigation system is the smart climate monitoring system, soil conditions, evaporation, using plant water and automatic irrigation program (Kinjal et al., 2018). Intelligent irrigation systems beautify watering schedules and automatically running times to meet the specific needs of the landscape (Caetano et al, 2015; Houstis et al, 2017). The controllers significantly improve the efficiency of outdoor water use (Sarker et al., 2017). There are several options for smart irrigation controllers, such as climate-based soil moisture sensors (ETs) and on the site. The right solution depends on the geographical solution and the landscape environment (Prodhan et al., 2017). Time Based controllers also known as evapotranspiration (ET) controllers, using local meteorological data to regulate irrigation schedules (Sarker, 2017). Evapotranspiration is the combination of soil surface evaporation and the transpiration of plant materials (Sarker& Sultana, 2017; Islam et al., 2018; Sarker et al, 2015; Sarker, 2016a; Islam et al., 2015). These drivers collect local weather information (Sarker et al, 2018. Sarker et al., 2018. Sarker&Jie, 2017. Sarker et al, 2019) and make irrigation water adjustments to the landscape receive the right amount of water (Islam et al. 2015; Sarker et al, 2016; Islam et al., 2018; Sarker et al., 2007; Sarker, 2016c). Forecast evaporation data use four meteorological parameters such as temperature, wind, solar radiation and humidity. It is the most accurate way to calculate the climatic needs of the landscape. There are three basic forms of these ET drivers based on time. The user's signal-based controller uses weather data from an available audience. The source and value of ET are calculated for a grassy area at the site. The ET data is sent to the controller via a wireless connection. Historical ET controllers use a pre-programmed water usage curve based on historical water usage in different regions. The curve can be adjusted for temperature and solar radiation. Those responsible for on-site climate measurement use the climatic data collected on the site to calculate the continuous measurements of ET and water accordingly (Sahu and Behera, 2015). When buried in the root area of the lawn, trees or shrubs, the sensor accurately determines the level of moisture in the ground and transmits this reading to the controller. Two different systems are available based on soil moisture sensors: suspended cycle irrigation systems configured as traditional timers, with irrigation programs, start time and duration. The difference is that the system will interrupt the next irrigation program when there is enough moisture in the ground. The water system on request does not require the scheduling of the irrigation duration. It has a user-defined lower and upper threshold, which initiates irrigation when soil moisture level does not reach those levels (Reche et al., 2015; Keswani et al., 2018). From today, in the age of advanced electronic technology, the life of the human being should be simpler and more convenientMany automated systems are needed that can replace or reduce human effort in their daily activities. The automatic system of irrigation of plants or intelligent irrigation systems is one of the best examples of electronic technology in the field of agriculture that makes the best use of water in plants (Dobbs et al., 2014). In Bangladesh, agricultural land decreases day by day due to population growth. Almost 0.2 million people are added to the total population each year, while the estimated annual reduction of agricultural land is about 0.08 million hectares (Ziauddin & Zia, 2014). That's why we need to increase food production every year, but our amount of land is not enough for this purpose. Smart technology is the best solution for this problem. By using intelligent technology, it is possible to increase the efficiency of each irrigation site and save the economy. Now days, roof gardening and greenhouse plants are the most popular for growing exotic fruits, flowers and vegetables, which are a very mild climate in Bangladesh. In these cases, the system based on control is very efficient. In irrigation systems, most of the important things that are taken into account is the drainage system, but like this system of drainage of small plants, the waste of the arable land and water make the system of irrigation intelligent / systems Automatic irrigation systems save both, and this technology gains popularity all over the world. The automation of the large-scale water system structure refers to the operation of the structure with fewer manual intercessions (Kadam et al., 2017)A picture of the entire controlled water system is one that simplifies the single distribution to improve the cost-benefit ratio. The mechanization of the structure of the small-scale water system includes an understanding of the planning of the water system. The automated plant irrigation systems estimate and measure the existing plant and therefore provide the desired amount of water from the plant. Minimizes the excessive use of water and keeps the plants healthy. The economy is mainly based on agriculture and the climatic conditions are isotropic and the full use of agricultural resources. The main reason is the lack of rain and the scarcity of water from the terrestrial tank. It is very essential to use resources appropriately. Therefore, a system is required to manage this activity automatically (Senpinar,2018).This document is based on the project which is an integrated system consisting of Arduino UNO and a system of soil moisture sensors. Arduino UNO is processing and controlling the units of this system that receives and processes sensor data. The sensor will be placed on the ground to measure the degree of dryness of the soil. If the drying speed is equal to or higher than the indicated value, the engine will start and irrigation will start. When it reaches a saturated condition, the motor will stop automatically. Intelligent irrigation or irrigation automation is also the most important for the hydrophone system. Where all the works

are controlled by different sensors and the plants grow in water. The current reality is one in which everything can be controlled and worked in a natural way. However, there are still a couple of vital segments in our nation where computerization has not been received or has not been used for unquestionable use and may be due to some of the reasons why one of these reasons is being spent. One of these fields is agriculture. Agriculture has been one of the essential occupations of men after just-in-time development. In addition to this development, irrigation plays an important role. The objective of this study is to design and implement an automatic irrigation system with microcontroller to increase irrigation efficiency, saving time and energy for farmers. MATERIALS AND METHODS Equipment Required Arduino UNO board Arduino is a single card microcontroller designed to make the application more appreciable, that is interactive objects and the surrounding environment. The UNO board of Arduino is a microcontroller based on ATmega328. It has 14 digital input and output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power connector and a reset button. Contains all the necessary support controller required (Baraka et al., 2013). It is presented by ATmega16U2 (Atmega8U2 up to R2 version) programmed as USB serial converter. It is a simple USB interface system. This allows the interface. This allows the USB interface since it is like a series. The chips on the card connect directly to the USB port and are compatible with the computer as a virtual serial port. The advantage of this configuration is that serial communication is an extremely simple protocol that has been proven over time and that USB connects to modern computers and makes it comfortable (Sahu and Behera, 2015). It is easy to find the microcontroller brain that is the Atmega328 chip. It is an open source project and there is an advantage to be open source, since it has a large community of people who use it and solve it. This facilitates the help in debugging projects. It is very convenient to manage the energy inside and has an integrated voltage regulation function. This can also be powered directly from a USB port without an external power supply. It is connected to an external power supply up to 12 V and adjusts the digital pins of the 5v and 3.3v.13 and 6 analog pins. This type of pin allows you to connect the hardware to the UNO board of Arduino externally (Senpinar, 2018). Simply connect the electronic devices and sensors to the plugs that correspond to each of these pins and are ready to work. Moisture Sensor The humidity sensor is used to measure the water content (moisture) of the soil. This sensor reminds the user to irrigate their plants and also controls the moisture content of the soil. It has been widely used in agriculture, irrigation and the land botanical garden (Shahidul Islam et al., 2015). The ground moisture operating voltage is 5 V, the current required is less than 20 mA, the interface is analog type sensors and operate between 10 and 20°C. The soil moisture sensor uses capacitance to measure the dielectric permittivity of the surrounding soil. In the soil, dielectric permittivity is a function of water content. The sensor creates

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a voltage proportional to the dielectric permittivity and, therefore, to the water content of the soil. The sensor calculates the average water content over the entire length of the sensor. The soil moisture sensor is used to measure the loss of moisture over time due to evaporation and plants. Monitor soil moisture content to control irrigation in greenhouses and improve bottle biology experiments. The hardware and software needed for the soil moisture sensor is Arduino IDE (Senpinar 2018) humidity sensor software, and the Arduino Uno board. The soil moisture brings connected to the VCC% v of Arduino UNO, GND soil moisture and interconnected sensor Arduino UNO and the last door of the A0 sensor connected to the 0 Arduino analogue board (Baraka et al., 2013). The program will generate the sensor value as output. Take different types of terrain and insert the sensor into the ground. As a result, you will get the value of moisture present in the soil. For demonstration purposes, the user can keep the sensor on the ground. On the serial monitor. Note that the sensor will read the moisture on the floor and show the output.

Relay

A relay is an electrical main voltage switch. This means that it can be turned on or off, letting the current flow or not. Controlling a relay with Arduino is as simple as controlling an output like a motor (Senpinar, 2018). There are many types of modules, such as single channels, double channels, four channels and eight channels (Souza et al., 2017). A type of relay able to handle the high power required to directly control an electric motor or other loads called contractors. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overloads or failures. In relation to the mains voltage, the relays have 3 possible connections. There is a common pin (COM), usually a pin (NO) and a normally closed pin (NC). There is no contact between the common pin and the normally open (NO) pin. We activate the relay to connect the COM pin and the power supply is supplied to a load. There is a contact between the COM pin and the NC pin. A connection between the COM and NC pins is always required, even when the relay is switched off. When we activate the relay, the circuit opens and there is no power supply for a load (Reche et al., 2015). All the pins of the forwarding. The connection between the relay module and the arduino is really simple. The GND of the relay goes to ground. IN1 relay port connected to the Arduino digital pin. Check the first channel of the relay.

Water Pump (DC, 12V)

For this study a water pump is required, which must be DC, 12V. The DC motor is the commonly used motor and has DC power distribution systems (Sethumathavan et al., 2016). Some rotors carry magnets and the stator grabs the conductors. The supports are used to allow the rotor to rotate continuously towards its axis (Reshma and Babu, 2016).

Jump Wire

A jump cable is used to connect the test plate, the prototype or the internal circuit with other non-joined instruments.

Arduino IDE Software

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, MacOS, Linux) written in the Java programming language. It is used to write in the java programming language. It is used to write and load programs on the Arduino board. The source code for the IDE is published under the GNU General Public License, version 2. The Arduino IDE supports the C and C ++ language using special code structuring rules (Souza et al., 2017). The Arduino IDE provides a software library of the wiring project, which provides many input and output procedures (Reche et al., 2015).

Block Diagram of Automatic Irrigation using Arduino UNO

The required connection of the automatic irrigation system is (1) indicates the power supply, (2) indicates the relay module, (3) indicates microcontroller, (4) indicates the soil moisture sensor, (5) indicates the humidity probes of the soil, (6) indicates the plant in the pot, (7) indicates the water pump and (8) indicates the water container or the water source. In the first cable of 3 bridges connected to the soil moisture sensor, 3 jumper cables, one connected to GND, one connected to the VCC and the last one connected to the A0 port. Therefore, another part of the jumper cables connected to the Arduino board, i.e. the VCC of the bridge cable is connected to the Arduino 5v, the GND connected to the GND and the ground moisture sensor port A0 is connected to the analog port 0 of the Arduino board. These connections are shared between the soil moisture sensor and the Arduino board. Therefore, the connection between the relay module and the Arduino board has been established. The GND port of the relay goes to ground. The first IN port is connected to an Arduino digital pin and this connection controls the first relay channel. When we connect the battery to the relay, a supply is supplied to a load. There is always a connection between the

COM pin and the NC pin even when the relay is switched off. After connecting all the equipment, the main operation begins. The measurement of soil moisture is carried out by the sensor that sends the information and parameters relating to soil moisture to the microcontroller that controls the pump. If the soil moisture levels fall below a certain value, the microcontroller sends the signals to the relay module, which then drives a pump and a certain amount of water is delivered to the system (Chavan and Karande, 2014). Once the water has been delivered to the system, the water pump is automatically shut down.

**RESULT AND DISCUSSION**

Design and Implementation Figure 1 shows the results of our experiment in the form of a general representation of our automatic irrigation system tested on the basis of the microcontroller and the Arduino sensor technology. When the program was loaded onto the Arduino, the soil moisture sensor began to show the value of soil dryness (Chavan and Karande, 2014).

Figure 1. *Automatic Plant Watering System*

If the drying value is higher than the given value 400, the pump will turn on and start to irrigate in the system, when the value is equal to or lower than the given value, the pump will switch off and irrigation in the field will be completed. If we want to flood the system or the field, the humidity sensor remains at a higher level or the programming value must be lower than the previous fixed value. The graph shows that when the dry value is higher, the engine starts to irrigate and, sometimes later, in a saturated state, the engine switches off to reach a balanced position. Previous humidity sensor system, connected to Arduino and humidity sensor (Parameswaran and Sivaprasath, 2016). At the beginning, we measure the specific volume of water from the measuring cylinder that the water in a vessel in which we place the engine. Before starting to irrigate in the plant, we must observe the time by means of a stopwatch to see the time difference between automatic irrigation and manual irrigation in the plant. Therefore, as soon as the engine starts at the same time, we start to see the time on the stopwatch after 3.23 minutes, the plant reference point will be satisfied. So we stopped watering the plant. So, we see that more water than sensor-based is needed. Here we can see that when we placed sensor in the soil the dryness value is 669 and watering started as dryness value excess the maximum dryness level we defined in the program. After watering 1min when it fulfills the demand the motor was stopped automatically then few seconds later surrounding of the plant was dry and the dryness value was 420 the motor again started and watering few seconds then stopped automatically and given a constant value (Figure 2).

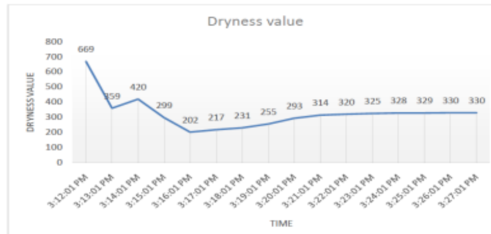


Figure 2. *Graphical representation of dryness level of soil for saturation watering*

Data Calculation

From the previous calculation, we observed that the water requirement is high when we irrigate the plant manually. But when we use the sensor, we save 300ml of water and can save about 21 seconds. The efficiency of irrigation is greater when we use the pump sensor due to the reduction of water loss (Reddy and Rao, 2016). In the Arduino-based sensor system, the extra water does not go to the stove because the engine switches off when a quantity of vital water is flushed.

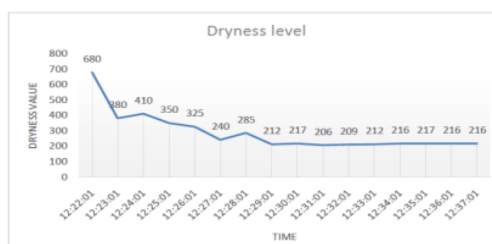


Figure 3. *Graphical representation of dryness level of soil for flooding water level*

If we want a flooded water level in the plant, we must change the defined value from 400 to 250 in the program. The first drying value was 680 and then the 2 minute irrigation meets the water level saturation request, so we have to change the defined value from 400 to 250. Then, the motor will restart and irrigate the plant for 1 minute and will meet the flood-level demand. The motor will stop automatically (Figure 3). A few seconds later, when the drying value exceeds the defined value, the engine resumes irrigation for a few seconds, then stops again and is assigned a constant value.

Calculation of Manually Water Required Just with Pump About 1350ml of water is needed in the automatic irrigation system, but 1650ml of water is needed in the manual irrigation system. There were water leaks in the manual irrigation system. So, if we adopt the plant's automatic irrigation system, we save water and even time. Most farmers in our country do not have sufficient knowledge of irrigation and think that more water means more agricultural production, but in reality, it does not happen. All crops need an optimal level of water for agricultural production, but they cannot find the optimal point. But the automated irrigation system will help the farmer find the optimal spot. The relationship between crop yield and water is linear to curvilinear. This means that when we start to water the plant, the yield of the first harvest increases with the application of water. But rarely later, there is a point where crop production does not increase. This point is called the maximum irrigation requirement for maximum performance. In the sensor-based system, we can find this point but in the manual system we cannot find this point, so the additional water is applied in the field that is the loss of water. Performance with respect to the irrigation function represents firm decisions on the choice of the soil, the system and the operating procedures as well. Optimal irrigation planning will provide a basis for optimizing seasonal irrigation / acre levels in terms of maximizing water use efficiency, net gain or other objectives (Figure 4).

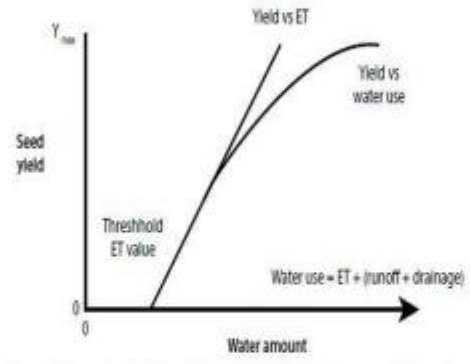


**Figure 4.** *Relationship between yield and water amount (Water use)*

The response of crop yield to an irrigation application or to a specific irrigation management practice is of paramount importance to assess the economic value of irrigation applications and to design economic strategies for irrigation management (Gutiérrez et al.,2013). The uses of water production functions and methods of analysis depend on the circumstances for which water planning is carried out.

**CONCLUSION**

In this study, an intelligent irrigation system based on a microcontroller was developed. The microcontroller circuit has been made with few components and the circuit is highly reliable. This circuit consisted of Arduino UNO, relay, soil moisture sensor, motor (12 v) and battery. We guarantee the success of this project after checking the soil dryness data shown on the computer. This system uses information from soil moisture

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sensors to irrigate the soil, which helps prevent excessive irrigation and insufficient irrigation. This system works as a potential solution to the problems faced in manual irrigation in the plant. This intelligent irrigation system was designed for flood saturation and irrigation. Both operations were performed on clayey and sandy soil in a pot. From the result, for the saturation, the total water required for0.045m2 was 7.67 ml / sec and for the irrigation from full the water needed for the same area was 7.42 ml / sec and the time required was 3.02 min. But every time the water applied manually in the same vessel with the same total capacity of the engine was found in 8.12 ml / s and the time required was 3.23 minutes. Total water losses were 0.70 ml / s and time losses were 23 seconds. This study revealed that the sensor-based irrigation system required less water and less time than the manual irrigation system. Increased irrigation efficiency. The sensor-based irrigation system is the most reliable system and has worked automatically without help. It makes the system more efficient and convenient. The main limitation of this study is that it is tested on a small scale; further studies are needed for largescale agriculture.

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