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# DESIGN AND PERFORMANCE TEST OF AN AUTOMATIC IRRIGATION SYSTEM

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## Abstract

*To improve irrigation system water utilize effectiveness, diminish cost of irrigation water, this paper on designing and construction of "Automatic Irrigation System on Sensing Soil Moisture Content and water level indicator" is proposed to make an automated irrigation system component which turns the pumping engine ON and OFF on identifying the clamminess substance of the earth and sensing the water level. In the area of cultivating, usage of fitting methods for water system framework is huge. The advantage of utilizing these strategies is to lessen human obstruction and still make certain proper irrigation system. This mechanized irrigation system extend brings into play an Arduino board ATmega328 small scale controller ,is customized to gather the information flag of variable clamminess conditions of the earth by means of sogginess distinguishing framework.*

**Keywords:** Moisture sensor, Water level indicator, Automatic, Mechanized system, irrigation system.

## 1. Introduction

Automation of large scale water system framework alludes to operation of the framework with least manual intercessions. An all-around controlled water system framework is one which streamlines the unique and worldly dissemination to boost the advantage cost proportion. Mechanization of small scale water system framework includes comprehension of water system planning [1].

Bangladesh major source of income is from agriculture sector and 80% of stating and general people count after the agriculture. In Bangladesh the majority of the irrigation systems are operated manually. These types of outmoded techniques are substituted with automated and computerized techniques. The available traditional techniques are just like for get water sources, terraced, irrigation, get water sources, sprinkler system. In this report, an automatic water sources system is suggested to reduce the water suggestions and human intervention, while satisfying the plant's needs. The objectives and the scope of the task described. Some general methods to the design are reviewed. The global water sources scenario is categorized by increased with regard to higher farming productivity, poor performance and decreased availability to drinking water for agriculture. These problems can be appropriately solved if we use computerized system for irrigation [2].

Water sparing is the principle point of our work. Small measure of water is helpful for every single living being and it's the person who is basically in charge of wastage of water. There are many sources by which human makes the water perilous for other living life forms in addition to there are numerous routes by which individual is in charge of wastage of water. One noteworthy reason of which is pointless wastage of water in horticulture field because of ignorance of agriculturists about adequate supply of water [3].

There are many plants that are exceptionally touchy to water levels and they required particular level of water supply for appropriate development, if this not they may pass on or brings about uncalled for development. It's not really conceivable that each rancher must have the ideal learning about developing details of plants if there should arise an occurrence of water supply. In Bangladeshi economy 80% section is rely on upon agribusiness and under this condition if there will be any framework which will give exact level of water to plants then it will prompts useful for our economy. So to help them we are making an endeavor by presenting our venture "Mechanized Irrigation System". By utilizing sensors in our work we will make them mindful about changing states of stickiness level as indicated by climate so as indicated by changing states of moistness they will have the capacity to plan the best possible planning for water supply [4].

## 2. Theoretical aspect and literature review

Irrigation system framework utilizes valves to turn water system ON and OFF. These valves might be effectively mechanized by utilizing controllers and solenoids. Computerizing homestead or nursery water system permits ranchers to apply the perfect measure of water at the correct time, paying little respect to the accessibility of work to turn valves on and off. What's more, agriculturists utilizing robotization gear can decrease spillover from over watering soaked soils, abstain from flooding at the wrong time of day, which will enhance trim execution by guaranteeing sufficient water and supplements when required. Programmed Drip Irrigation is a profitable device for exact soil dampness control in profoundly specific nursery vegetable creation and it is a straightforward, exact strategy for water system. It likewise helps in efficient, evacuation of human mistake in altering accessible soil dampness levels and to boost their net profits .Irrigation is the counterfeit utilization of water to the dirt as a rule for helping with developing yields. In yield creation it is for the most part utilized as a part of dry zones and in times of precipitation setbacks, additionally to ensure plants against ice.

Types of Irrigation

- Surface irrigation
- Localized irrigation
- Drip Irrigation
- Sprinkler irrigation

The conventional irrigation methods like overhead sprinklers, flood type feeding systems usually wet the lower leaves and stem of the plants. The en tire soil surface is saturated and often stays wet long after irrigation is completed. Such condition promotes infections by leaf mold fungi. The contrary the drip or trickle irrigation is a type of modern irrigation technique that slowly applies small amounts of water to part of plant root zone. Water is supplied frequently, often daily to maintain favorable soil moisture condition and prevent moisture stress in the plant with proper use of water resources. Irrigation saves water because only the plant's root zone receives moisture. Little water is lost to deep percolation if the proper amount is applied. Drip irrigation is popular because it can increase yields and decrease both water requirements and labor. Drip irrigation requires about half of the water needed by sprinkler or surface irrigation. Lower operating pressures and flow rates result in reduced energy costs. A higher degree of water control is attainable .Plants can be supplied with more precise amounts of water. Disease and insect damage is reduced because plant foliage stays dry. Operating cost is usually reduced. Federations may continue during the irrigation process because rows between plants remain dry [5].

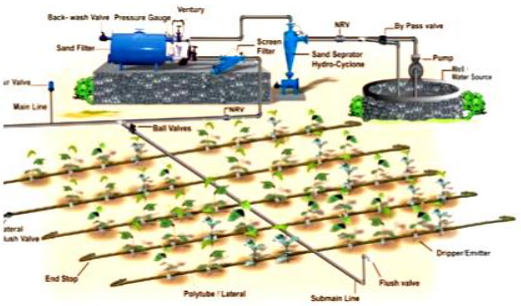


**Figure. 1.** Overview of Automated Irrigation System

The above fig 1 explains about important parameters to be measured for automation of irrigation system are soil moisture. The entire field is first divided into small sections such that each section should contain one moisture sensor. These sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the micro controller to turn on the relays, which control the motor. In proposed system, automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the dampness content of the earth. In the domain of farming, utilization of appropriate means of irrigation is significant. The benefit of employing these techniques is to decrease human interference. This automated irrigation project, the soil sensor senses the moisture content by giving input signal to an Arduino board which operates on ATmega328 micro-controller, is programmed to collect the input signal of changeable dampness circumstances system.[6]

## 3. Equipment of control unit

### 3.1 Hardware requirements

a. Arduino Uno
b. Transformer
c. Breadboard.
d. Grove- moisture sensor.
e. Relay.
f.Water level sensor.
g.Water pump.
h.Jump wire.

### 3.2 Software Requirements

a. Arduino software (IDE)
b. Proteus software (for circuit design and simulation)

Description of the equipment are given below: [7]

**Arduino:**

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world


**Figure. 2.** An Arduino Uno

**Breadboard:**

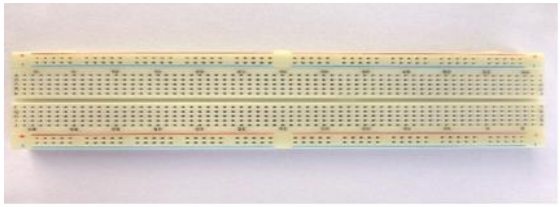

**Figure. 4**. A Breadboard (77 series-1/8in. skin)

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solderless breadboard (AKA plugboard, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these.

**Grove- moisture sensor:**

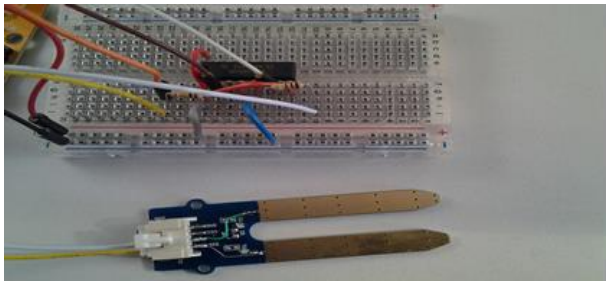

**Figure. 5**. A Grove- moisture sensor

Soil moisture sensors measure the volumetric water content in soil.[1] Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors.

**Water level sensor:**

A water detector is an electronic device that is designed to detect the presence of water and provide an alert in time to allow the prevention of water damage. A common design is a small cable or device that lies flat on a floor and relies on the electrical conductivity of water to decrease the resistance across two contacts. The device then sounds an audible alarm together with providing onward signaling in the presence of enough water to bridge the contacts.

**Figure. 6.** A Water level sensor

**Bilge water pump**

A bilge pump is a water pump used to remove bilge water. Since fuel can be present in the bilge, electric bilge pumps are designed to not cause sparks. Electric bilge pumps are often fitted with float switches which turn on the pump when the bilge fills to a set level. Since bilge pumps can fail, use of a backup pump is often advised. The primary pump is normally located at the lowest point of the bilge, while the secondary pump would be located somewhat higher. This ensures that the secondary pump activates only when the primary pump is overwhelmed or fails, and keeps the secondary pump free of the debris in the bilge that tends to clog the primary pump.

**Figure. 8.** A Bilge water pump

## 4. Design

### 4.1 Design Consideration

Irrigation system uses valves to turn irrigation ON and OFF. These valves may be easily automated by using controllers and solenoids. Automating farm or nursery irrigation allows farmers to apply the right amount of water at the right time, regardless of the availability of labor to turn valves on and off. In addition, farmers using automation equipment are able to reduce runoff from over watering saturated soils, avoid irrigating at the wrong time of day, which will improve crop performance by ensuring adequate

water and nutrients when needed. Automatic Irrigation is a valuable tool for accurate soil moisture control in highly specialized paddy production and it is a simple, precise method for irrigation

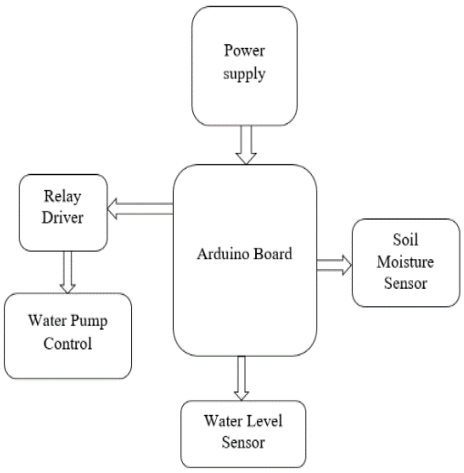


**Figure. 10.** A Schematic arrangement of system

## 4.2 System Flow Diagram

A simple flowchart is shown in Figure 3.2 and described the flowchart below:

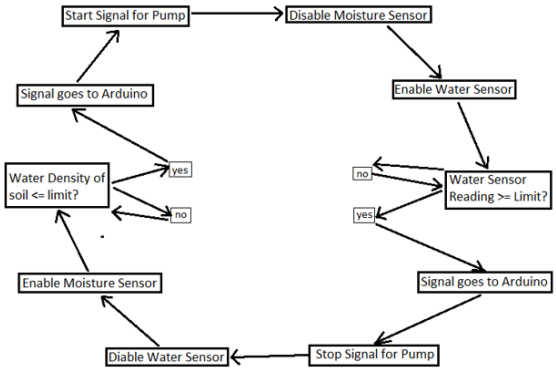


**Fig. 11**. Flow diagram

Flow diagram shows that when the moisture content of soil will reach below limit then the pump will start and again moisture content of soil will remain enough then the pump will remain stop. If water will not touch the water sensor then pump will run until the water will touch the water sensor .When water will touch the water sensor then the pump will stop.

## 4.3 Main Circuit Diagram

The main circuit diagram which is simulated in proteus software is shown in Figure 3.3:

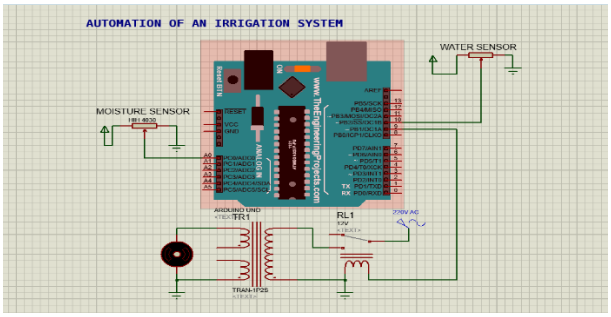


**Figure. 12.** Automation of an irrigation system

## 4.4 Description of circuit diagram:

In circuit diagram Arduino Uno board is used. As a microcontroller, AT Uno microcontroller is used in this circuit diagram. Microcontroller is attached with the Arduino board. Two Sensors moisture and water sensor plugged on A0 and 10 pin. And relay pin on 9. Here relay is used to control High Voltage component, Pump by sensing value from those two sensors. A transformer is used to invert the voltage from 220V AC to 24V AC. A program is installed in the microcontroller after designing the circuit and +5V dc power is supplied in this circuit.

## 4.5 Design Calculation

**Pump:**

Theoretical specification:
Pump dia: .75 in
Voltage rating: 24V
Flow Rate: 750GPH
Current Rating: 2.5A

Theoretical discharge=750/60 GPM
=12.5GPM

Actual discharge=670/60GPM
=11.16GPM

Efficiency of pump=Actual discharge/Theoretical discharge
=11.16/12.5
=0.8928
=89.28%

Small size, high efficiency, low current submersible pump.

**Grove-moisture sensor:**

This Moisture Sensor can be used to detect the moisture of soil or judge if there is water around the sensor, let the plants in your garden reach out for human help. They can be very to use, just insert it into the soil and then read it. If you are a farmer, you can use this sensor to know when your plants need to be watered.

**Grove water sensor:**

It is part of the Twig system. This sensor works by having a series of exposed traces connected to ground and interlaced between the grounded traces are the sens traces. The sensor traces have a weak pull-up resistor of 1 MΩ. The resistor will pull the sensor trace value high until a drop of water shorts the sensor trace to the grounded trace. Believe it or not this circuit will work with the digital I/O pins of your Arduino or you can use it with the analog pins to detect the amount of water induced contact between the grounded and sensor traces.

## 5. Working principle

### 5.1 Working principle of irrigation system:

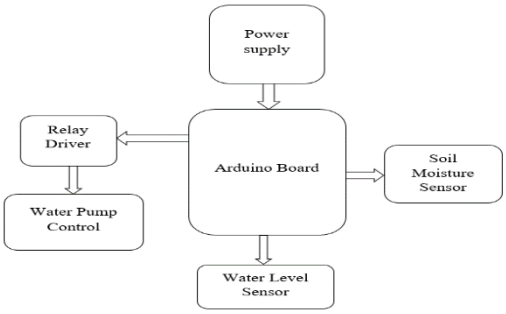


**Figure. 13**. Block diagram of the system

The above fig 13 shows Microcontroller based irrigation system proves to be a real time feedback control system which monitors and controls all the activities of irrigation system efficiently. The present proposal is a model to modernize the agriculture industries on a small scale with optimum expenditure. Using this system, one can save manpower, water to improve production and ultimately profit.

## 6. Performance test

### 6.1 Performance Test

An automatic irrigation system was constructed and it was attached with a paddy plant for the performance test.

Calculation:

- Pump dia:.75 in
- Voltage rating:24V
- Flow Rate :750GPH
- Current Rating:2.5A

Small size, high efficiency, low current submersible pump.

Power,p=vi

=24*2.5

=60 watt

**Figure. 14**. Final prototype irrigation system

## 7. Conclusion and development area

### 7.1 Conclusion:

The essential applications for this project are for agriculturists and plant specialists who don't have enough time to water their products/plants. It additionally covers those agriculturists who are inefficient of water amid water system. The project can be stretched out to nurseries where manual supervision is far and few in the middle. The guideline can be reached out to make completely computerized patio nurseries and farmlands. Joined with the rule of rain water reaping, it could prompt gigantic water reserve funds if connected in the correct way. In horticultural grounds with extreme deficiency of precipitation, this model can be effectively connected to accomplish awesome outcomes with most sorts of soil.

### 7.2 Future development:

In future research,

- It can be used to operate irrigation motor remotely using cell phone.
- Using collecting data we can get an overall concept about weather of an area.
- Making a server of a data collected from this device we can easily make annual forecast.
- This set is so completed that we can use it to operate any type of motor for irrigation.

Overall its research open a door to farmer to connect with digital world.

## 8. References

[1] Klute, A. (ed.), 1986: Methods of Soil Analysis, Part 1: Physical and Mineralogical Methods. American Society of Agronomy,Madison, Wisconsin, United States, 1188 pp.

[2] Knight, J.H., 1992: Sensitivity of time domain reflectometry measurements to lateral variations in soil water content. Water Resources Research, 28, pp. 2345–2352.

[3] Ayars, J.E., Phene, C.J., Hutmacher, R.B., Davis, K.R.,

Schoneman, R.A., Vail,S.S. and Mead, R.M. (1999). Subsurface drip irrigation of row crops: a review of 15 years research at the Water Management Research Laboratory. Agricultural Water Management 42: 1-27.
[4] Yan Xijun, Lu limei, Xu Lizhong, “The Application of wireless sensor network in the Irrigation Area Automatic System”, International Conference on Networks Security, Wireless Communications and Trusted Computing 2009, pp. 21-24.
[5] Magagi, R.D., Kerr, Y.H., 1997. Retrieval of soil moisture and vegetation characteristics by use of ERS-1 wind scatterometer over arid and semi-arid areas. Journal of Hydrology 188-189, 361–384.
[6] Marthaler, H.P., W. Vogelsanger, F. Richard and J.P. Wierenga, 1983: A pressure transducer for field tensiometers. SoilScience
Society of America Journal, 47, pp. 624–627.
[7] https://en.wikipedia.org/wiki (March, 2017)
[8] Attema, Evert, Pierre Bargellini, Peter Edwards, Guido Levrini, SveinLokas, Ludwig Moeller, BetlemRosich-Tell, et al 2007. Sentinel-1 - the radar mission for GMES operational land and sea services. ESA Bulletin 131: 10-17.
[9] Bircher, S., Skou, N., Jensen, K.H., Walker, J.P., & Rasmussen, L. (2011). A soil moisture and temperature network forSMOS validation in Western Denmark. Hydrol. Earth Syst. Sci. Discuss., 8, 9961-1000 .