

Comparative Study Between Automatic Irrigation System Using Soil Moisture Sensor and Conventional Flooding Method of Irrigation

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ABSTRACT: India is an agricultural country, wherein about 70 percent of the rural households still depend primarily on agriculture for their livelihood. By incorporating more technical methods we can produce maximum yield by utilizing water fully or by minimizing the volume of water wasted. Our project “ Automatic Irrigation System on Sensing soil moisture content ” is intended to create an automated irrigation mechanism which turns on pumping motor ON and OFF on detecting the dampness content of the soil. Field area has been selected inside the Loyola Institute Of Technology campus of size (18.5m * 9.8m). In this paper we have looked to minimize the water usage by integrating automatic irrigation based on soil moisture. It not only gives comfort but also reduces the energy, increase the efficiency and time saving. This automated irrigation project brings into play an ARDUINO UNO micro controller, which is programmed to collect the input signal of changeable dampness circumstances of the earth through dampness detecting system.

KEYWORDS: automatic; sensor based irrigation; efficiency; optimum usage of water; time saving.

I. INTRODUCTION

The shortage in water is one of the major problems in the world. Many different methods are incorporated for the conservation of water. Water is needed in each and every requirements of the humans, animals, plants, etc. and agriculture is one important field where water is required in higher quantities. Excess water supply is a major drawback in agriculture as there is a loss in water usage due to evaporation, water spills or through absorption by the deeper layers of the soil in the agricultural fields. Various techniques are used either to control the wastage of water or to conserve the water used in agricultural lands. We have implemented the use of automated irrigation systems using soil moisture sensors and Arduino uno systems in order to supply optimal water to fields.

II. IRRIGATION

Irrigation is the application of controlled amounts of water to plants at needed intervals. Irrigation helps grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of inadequate rainfall. Irrigation also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming.

Irrigation systems are also used for cooling livestock, dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the removal of surface and sub-surface water from a given area.

III. TYPES OF IRRIGATION

- Surface Irrigation
- Sub-Surface Irrigation
- Sprinkler Irrigation
- Micro Irrigation

From the above mentioned types, we have chosen the type of surface irrigation.

SURFACE IRRIGATION

A surface irrigation event is composed of four phases as illustrated graphically in Figure 1. When water is applied to the field, it 'advances' across the surface until the water extends over the entire area. It may or may not directly wet the entire surface, but all of the flow paths have been completed. Then the irrigation water either runs off the field or begins to pond on its surface. The interval between the end of the advance and when the inflow is cut off is called the wetting or ponding phase. The volume of water on the surface begins to decline after the water is no longer being applied. It either drains from the surface (runoff) or infiltrates into the soil. For the purposes of describing the hydraulics of the surface flows, the drainage period is segregated into the depletion phase (vertical recession) and the recession phase (horizontal recession). Depletion is the interval between cut off and the appearance of the first bare soil under the water. Recession begins at that point and continues until the surface is drained.

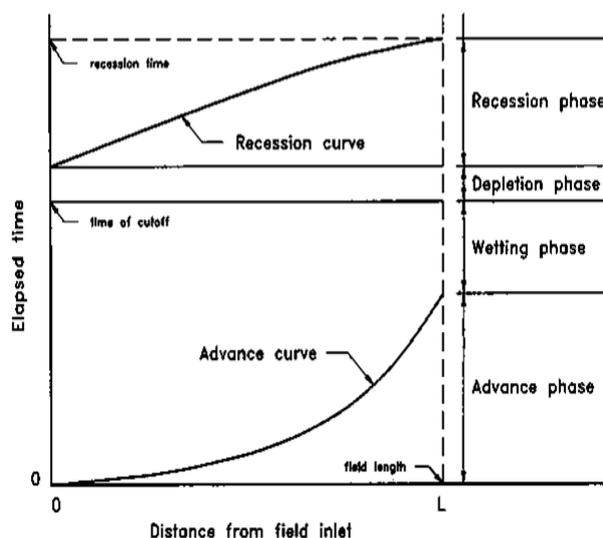


FIG.1

TYPES OF SURFACE IRRIGATION

A. BASIN IRRIGATION

Basin irrigation is the most common form of surface irrigation, particularly in regions with layouts of small fields. If a field is level in all directions, is encompassed by a dyke to prevent runoff, and provides an undirected flow of water onto the field, it is herein called a basin. A basin is typically square in shape but exists in all sorts of irregular and rectangular configurations. It may be furrowed or corrugated, have raised beds for the benefit of certain crops, but as long as the inflow is undirected and uncontrolled into these field modifications, it remains a basin.

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FIG.2

B. BORDER IRRIGATION

Border irrigation can be viewed as an extension of basin irrigation to sloping, long rectangular or contoured field shapes, with free draining conditions at the lower end. Figure 3 illustrates a typical border configuration in which a field is divided into sloping borders. Water is applied to individual borders from small hand-dug checks from the field head ditch. When the water is shut off, it recedes from the upper end to the lower end. Sloping borders are suitable for nearly any crop except those that require prolonged ponding. Soils can be efficiently irrigated which have moderately low to moderately high intake rates but, as with basins, should not form dense crusts unless provisions are made to furrow or construct raised borders for the crops. The stream size per unit width must be large, particularly following a major tillage operation, although not so large for basins owing to the effects of slope. The precision of the field topography is also critical, but the extended lengths permit better leveling through the use of farm machinery.

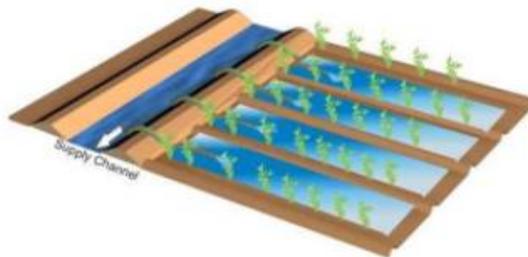


FIG.3

C. FURROW IRRIGATION

Furrow irrigation avoids flooding the entire field surface by channeling the flow along the primary direction of the field using 'furrows,' 'creases,' or 'corrugations'. Water infiltrates through the wetted perimeter and spreads vertically and horizontally to refill the soil reservoir. Furrows are often employed in basins and borders to reduce the effects of topographical variation and crusting. The distinctive feature of furrow irrigation is that the flow into each furrow is independently set and controlled as opposed to furrowed borders and basins where the flow is set and controlled on a border by border or basin by basin basis. It will provide better on-farm water management flexibility under many surface irrigation conditions. The discharge per unit width of the field is substantially reduced and topographical variations can be more severe. A smaller wetted area reduces evaporation losses. Furrows provide the irrigator more opportunity to manage irrigations toward higher efficiencies as field conditions change for each irrigation throughout a season. This is not to say, however, that furrow irrigation enjoys higher application efficiencies than borders and basins. For this project we have used the zigzag furrow flooding method of irrigation.



FIG.4

D. CHECK METHOD

In this method, the land to be irrigated is divided into a number of almost leveled plots (kiaries) surrounded by levees. Water is admitted from the farmer's field channels to these plots turn by turn so that the plots are flooded without overtopping the levees. Size of individual plots may vary from as small as one meter square (suitable for growing vegetables) to as large as one hectare or even more. This method is suitable for wide range of soils ranging from very permeable to much less permeable soils. The farmer has good control over the distribution of water in different parts of his farm. The water application efficiency is higher for this method. However, this method requires constant attendance for admitting and closing the supplies to the leveled plots. Also, there is some loss of cultivable area which is occupied by the levees. Sometimes, levees are made sufficiently wide to grow 'row' crops and, thus, compensate to some extent the loss of cultivable area on account of levees.



FIG.5

E. UNCONTROLLED FLOODING:

In the uncontrolled flooding method of irrigation, water is applied to a field for irrigation without any land preparation and without any levees to guide or restrict the flow of water on the field. Water is simply admitted at one end of the field, thus, letting it flood the entire field without any control. This method generally results in excess irrigation at the inlet region of the field and insufficient irrigation at the outlet region. This method has the advantage of low expenses on land preparation. Its main disadvantage is greater loss of water due to deep percolation and surface runoff. This method is, therefore, suitable when water is available in large quantities, the land surface is irregular, and the crop being grown is unaffected because of excess water.

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FIG.6

From the above mentioned surface irrigation is a method, furrow method is adopted for our irrigation.

Advantages to furrow irrigation include:

- Lower initial investment of equipment minimizing water loss inefficiencies in gravity irrigation systems will allow irrigators to save money and labor.
- Lower pumping costs per acre-inch of water pumped.
- Furrow irrigation practice can minimize irrigation costs and chemical leaching and result in higher crop yields.

IV.NEED FOR AUTOMATIC IRRIGATION

- Automatic irrigation system proves to be very helpful for every agricultural field.
- If designed and coded properly, automatic irrigation systems can be very cost effective and can do lot of water conservation.
- Automatic irrigation systems can be designed in such a way which gives required amount of water in a targeted area, and which will also promotes water conservation

V.OBJECTIVES OF THE PROJECT

- In today's world due to irrigation, there might be some possible wastage in water usage. It may be water wastages, wastages of crops and so on.
- In order to solve this issue, we introduce this automatic irrigation system.
- By using this system it will possibly reduce such wastages. So that better utilisation of resources can be made possible.
- It shows the basic switching mechanism of motors using sensor by sensing moisture present in the soil
- Identify the suitable amount of water to be delivered that will assist in maintaining the level of soil moisture monitor the level of water tank which stores the water that will aid in the irrigation system.
- Test the effect of varying moisture content of the soil to the plants with the following indications, at lower than optimized level and at higher than optimized level.

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VI.SCOPE OF THE PROJECT

- This technology can be used to improve use efficiency in semi-arid regions.
- Helps to reduce water wastage.
- Increase the yield of crops.
- Economic status of the agriculturalist can be improved.
- Optimum level of water for irrigation can be provided.
- It is used for small area garden design and focuses primarily on soil moisture content as the basis for the irrigation system, no other sensor will be implemented.
- Maintenance of the system still requires human intervention to keep irrigation on course and sensitive to weather condition which may interrupt the effectiveness of the soil moisture sensor.

VII.PRELIMINARY SURVEY

➤ **Size and location of land:**

This project commences with a land size of 18.5*9.8 in meter. This area is located at LOYOLA INSTITUTE OF TECHNOLOGY, Palanchur.

➤ **Soil Test:**

Soil sample of 2kg has been collected from the land at a depth of 3 feet. It was given for the testing of moisture content and nutrients present in the soil.

SAMPLE DETAILS					
Sample Description By Customer	Soil	Quantity Received	2 Kg	Sampled By	Customer
Date of Receipt	16.12.2017	Sample Condition	Good & Received in	Good & Received in	Probed Condition
Analysis Starting Date	18.12.2017	Analysis Completion Date	22.12.2017		

Test Results:
The above sample tested as received, and results are as follows:

S. NO	PARAMETERS	METHOD	UNITS	RESULTS
1	pH	EPA Method 9045 D Rev 4; 2004	-	6.4
2	Moisture	IS 2720 (Part 2) 1973 (RA.2010)	%	1.20
3	Sodium as Na		mg/kg	122
4	Nitrogen as N	IS 10158-1962 (RA.2003)	mg/kg	224
5	Potassium as K		mg/kg	210
6	Soluble Calcium as Ca		mg/kg	21
7	Soluble Magnesium as Mg	FAO Method (Pg.No.44) 2007 (EDTA Titrimetric method)	mg/kg	13
8	Available Phosphorus as P	FAO Method (Pg.No.75) 2007 (Olsen's method)	mg/kg	56.6
9	Total Organic Carbon	FAO Method (Pg.No.13) 2007 (walkley Black wet combustion method)	%	0.06

For Chennai Testing Laboratory Pvt Ltd
A. Raju
Authorized Signatory

TEST REPORT				
Report Number and date		CTL/CH/N-6399/2017-18 & 25.12.2017		
S.NO	PARAMETERS	METHOD	UNITS	RESULTS
10	Sulphate as SO ₄	FAO Method (Pg.No.80) 2007 (Turbidimetric method)	mg/kg	212
11	Chloride as Cl	FAO Method (Pg.No.49) 2007 (Titrimetric method)	mg/kg	96
12	Available Boron as B	FAO Method (Pg.No.92) 2007 (Cationic method)	mg/kg	0.21
13	Conductivity	IS 14767 - 2000	µs/cm	247
14	Iron as Fe	EPA 3050B-1996 (Rev-2)/EPA 7380 - 1986	%	1.02
15	Manganese as Mn	EPA 3050 B-1996 (Rev-2)/EPA 7460-1986	mg/kg	182.5
16	Zinc as Zn	EPA 3050B - 1996 (Rev-2)/EPA 7950 - 1986	mg/kg	28.6
17	Copper as Cu	EPA 3050B-1996 (Rev-2)/EPA 7210-1996	mg/kg	14.8
18	Molybdenum as Mo	EPA 3050 B-1996 (Rev-2)/EPA 7480-1986	mg/kg	BDL(DL:10.0)
19	Nickel as Ni	EPA 3050B-1996 (Rev-2)/EPA 7520 - 1986	mg/kg	29.2

BDL - Below Detection Limit; DL - Detection Limit

END OF REPORT

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SOIL TEST REPORT

VIII. SYSTEM SPECIFICATION

➤ **HARDWARE REQUIREMENTS:**

The hardware requirements may serve as basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system

- Microcontroller** : Arduino
- Soil moisture sensor** : 1 No
- Relay** : 1 No
- Jumper wire** : up to 7

➤ **SOFTWARE USED:**

Arduino Uno (c programming)

➤ COMPONENTS DESCRIPTION:

❖ **Soil moisture sensor** – the soil moisture sensor is a sensor connected to an irrigation system controller that measures soil moisture content in the active root zone before each scheduled irrigation event and bypasses the cycle if moisture is above a user defined set point.

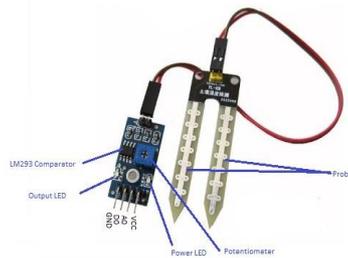


FIG.7

❖ **Arduino**-An open sources platform which consists of both a physical programming circuit board and a piece of software.



FIG.8

❖ **Relay** - Switches that open and close circuits electrically and electromagnetically. Control one electrical circuit by opening and closing contact in another circuit.



FIG.9

❖ **Jumper wire** -A jump wire is an electrical wire or group of them in a cable with a connector or pin at each end. It is used to interconnect the components of a breadboard or other prototype without soldering.

IX. BLOCK DIAGRAM

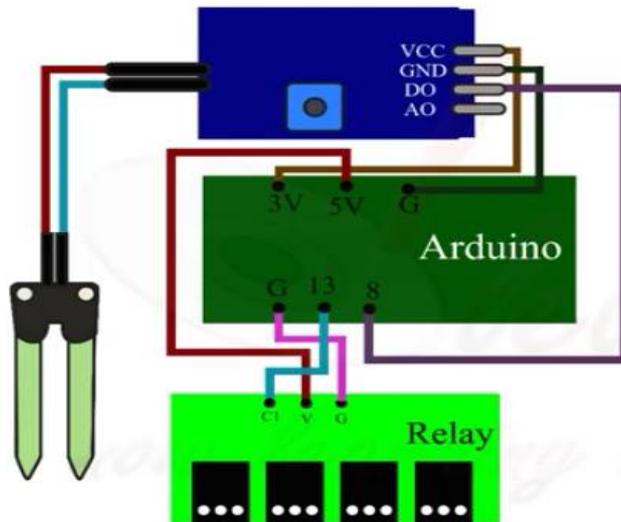


FIG.10

X. CODING

```
int WATER = 13;
int sensor = 8;
int val;
void setup() {
  pinMode(13, OUTPUT);
  pinMode(8, INPUT);
}
void loop() {
  val = digitalRead(8);
  if (val == LOW)
  {
    digitalWrite(13, LOW);
  }
  else
  {
    digitalWrite(13, HIGH);
  }
  delay(400);
}
```

XI. WORKING PROCESS

The project is designed to function as an automatic irrigation system which turns the pump or motor ON/OFF depending upon the moisture content of the soil. Firstly the soil moisture sensor senses the soil moisture level. Once the threshold level is reached the soil moisture is measured by the capacitive soil moisture sensor. The irrigation is provided soil moisture sensor provides that the water in soil is insufficient, and then the water gets irrigated. An LCD display is also interfaced to the microcontroller to display status of the soil and water pump.

Then the comparative study can be done by using water meter at the water supply tap so that the amount of water used for both conventional and automatic irrigation can be found. From the efficiency of water usage and water wastage can be obtained which helps us to conserve the water resource.

Water consumption for the field through conventional method of flooding is approximately 1500 litres and By doing a comparative study between automatic irrigation system using soil moisture sensor and conventional flooding method of irrigation, the efficiency of water can be found. By our observation, we found that the water irrigated through the conventional method of flooding to the field is approximately 1500 liters in one half part of our field. It will be conserved nearly quarter portion of water by automatic irrigation system using soil moisture sensor. Since the optimal level of water only will be irrigated by sensing the soil moisture content in the other half part of our field. That is nearly 375 liters will be conserved by the implementation of our project.

XII. CONCLUSION

The primary applications for this project are for farmers and gardeners who do not have enough time to water their Crops/plants. It also covers those farmers who are wasteful of water during irrigation. The project can be extended to greenhouses where manual supervision is far and few in between. The principle can be extended to create fully automated gardens and farmlands. Combined with the principle of rain water harvesting, it could lead to huge water savings if applied in the right manner. In agricultural lands with severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

YIELD OBTAINED:



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REFERENCES

- [1] Siyu Chen, Nicolas Fatras, Haoran Su. Smart Water Irrigation System. Civil and Environmental Engineering 186: Design of Cyber-physical System Professor: Scott Moura GSI: Eric Burger.
- [2] Rita Krushna Fasale , Jayesh Krishnadas Varule, Prof.M.R.Gaiker. Automatic Intelligent Plant Watering System Depending On The Soil Moisture. S.V.I.T, Chincholi, Nashik, Maharashtra, India.
- [3] 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
- [4] Marthaler, H.P., W. Vogelsanger, F. Richard and J.P. Wierenga, 1983: A pressure transducer for field tensiometers. Soil Science Society of America Journal, 47, pp. 624–627.
- [5] M. N. Umeh, N. N. Mbeledogu, S. O. Okafor, F. C. Agba, "Intelligent microcontroller-based irrigation system with sensors", American Journal of Computer Science and Engineering, vol. 2, no. 1, pp. 1-4, 2015.
- [6] Bircher, S., Skou, N., Jensen, K.H., Walker, J.P., & Rasmussen, L. (2011). A soil moisture and temperature network for SMOS validation in Western Denmark. Hydrol. Earth Syst. Sci. Discuss., 8, 9961-10006.