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# Designing Automatic Plant Irrigation System based on GSM, Moisture and Ultrasonic Sensors

## (Case Study: Rwanda Irrigation System)

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**Abstract:- This paper on "Designing Automatic Plant Irrigation System Based on GSM, Moisture and Ultrasonic Sensors" is developed to create an automated irrigation mechanism which turns the pumping motors where one is water tank pump placed inside the river in order to take water to the tank placed in the farm and it will turn ON and OFF according to the level of water inside the tank using ultrasonic sensor and other one is water irrigation pump that placed inside the tank that used to make irrigation in the farm and it will be ON and OFF according tothe moisture content of the soil using the soil moisture sensor without the intervention of human. The benefit of employing these techniques is to decrease human interference, water wasted, and the time used to finish irrigation and it is also quite feasible and affordable. This designing irrigation system project is using proteus 8 professional, an Arduino Uno is programmed to collect the input signal according to the moisture content of the soil andthe water level inside the tank.Its output willdecide the motor pumps to be ON and OFF and then send a short message to the farmer's mobile phone.**

***Keywords****: Arduino Uno, Irrigation, Relay, Soil Moisture Sensor, Ultrasonic Sensor, Water Pump.*

## I. INTRODUCTION

In today's society, automated irrigation systems have become a mandatory need in many places and continue to spread rapidly[1][2]. Manual, tank, sprinkler, drip, or subsurface drip irrigation systems are the current method used to make irrigation in Rwanda, they require pumps and some high tech-components[3]. These result in loss of water, higher initial cost, require much labor and it difficult to determine the conditions of soil like humidity and temperature[4]. Rwanda is a country in quick progress to sustainable economic development and whose economy is mostly based on agriculture over 90% of the population depends on the substance of agriculture fortheir livelihood. Due to the increase in populations and climate changes, they need to sustain agriculture and we know that agriculture is an industry that needs a lot of water[5][6]. An automatic plant irrigation system has many positive effects where the distribution of water on the field is easier and also doesn't need an operator to control the system[7][8]. In particular, such a system uses information on the volumetric water content of soil by using soil moisture sensors to control an irrigated control that opens a solenoid valve whenever the volumetric water content drops below a certain threshold[9][10].Reduction of labor, reduced time wasted by cultivators when they irrigate manually, and efficient production for better accuracy, is one of several solutions to designing automatic plant irrigation systems[11][12][13].

In present days, agriculture farmers are facing major problems in watering their crops because they work it manuallywhere much water is wasted, and use many labours to pour their field and those result in loose much money and time. They need to pump water and wait until the field is properly watered, which compels them to stop doing other activities, and thus they loss their precious time and efforts[14]. Rwanda country as a land of thousand hills, this makes difficult to irrigate the farm that placed on the top of the mountain and also spending a lot of time to bring water (long distance between farm and water source like lake, river, …). Agriculture is an industry that uses a lot of water[15][16]. Most of the time, this resource is not used efficiently and substantial amount of water are wasted and those result in decreasing of crops production[17][18]. The one's who manage this resource efficiently will be winning time and money.

The specific objective of this research project is to design an automatic plant irrigation system used moisture content in the soil, monitored on farmer's mobile phone via short message service and getting water from source (lake, river, …) to the tank placed in the farm place without any human intervention.

We achieve this research with proteus 8 professionalsoftware by using ultrasonic sensor to measure water tank level, moisture sensor to know moisture content in the soil and GSM module to send short message to the farmer.

## II. MATERIALS AND METHODS

### *A. The System Model*

This system is to be designed for big farmers and cooperatives to increase their agricultural production by automatic plant irrigation system placed in the field with monitoring by GSM via short message service. We achieved this by setting up a test system and conditioning relay programming to use the analogue data from the soil moisture detector to decide if irrigation is required or not so that it should tell the motor what to do and also get data from level of water inside the tank by ultrasonic sensor to tell motor pump placed into river what to do. In this view, a number of photos and snapshot views of the system outcomes are illustrated accordingly to figure 1 below:

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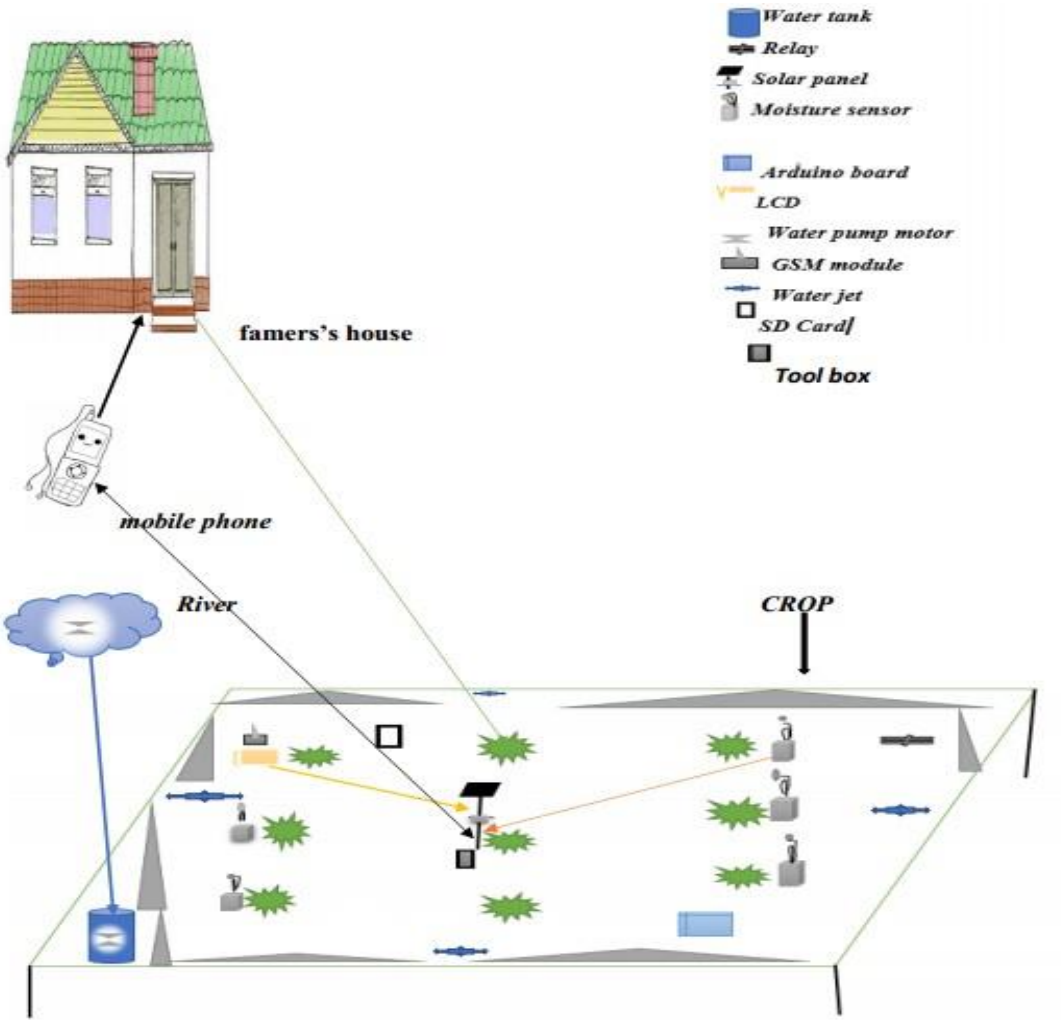


Fig. 1: System model

*B. The Schematic Diagram*

We have implemented the system that may be summarized in the block diagram in figure 2:

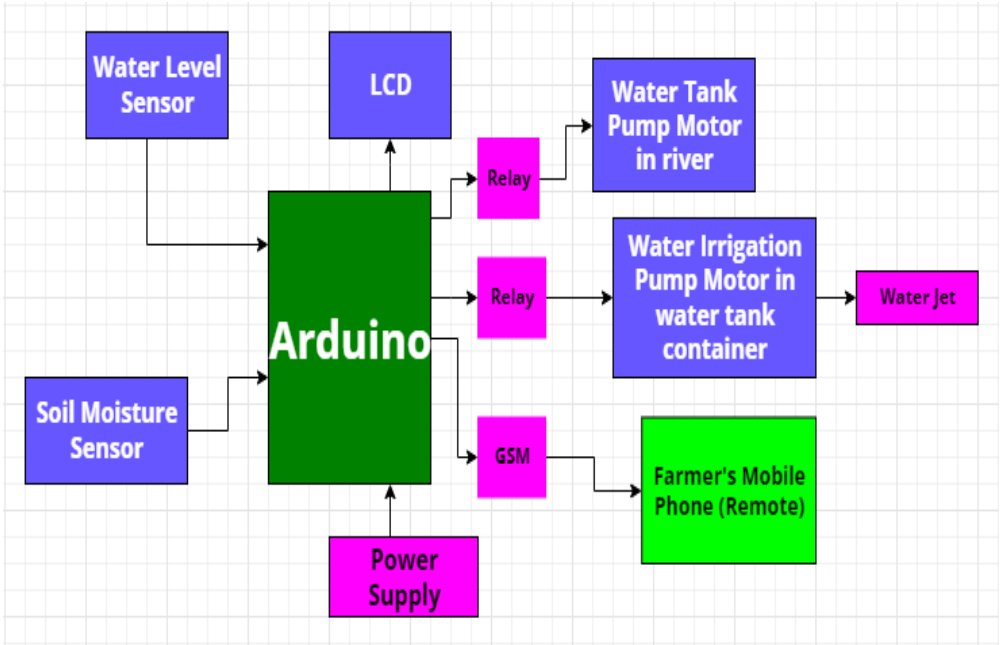


Fig. 2: System Block diagram

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*C. Main Components list*

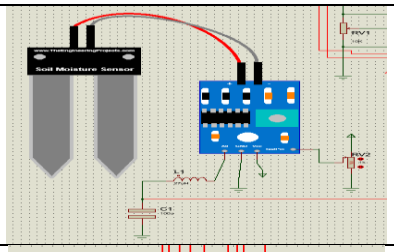
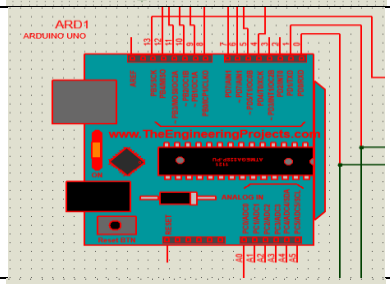
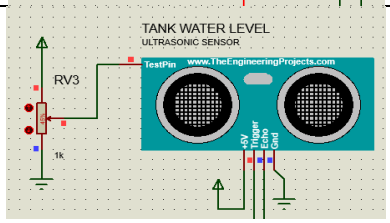
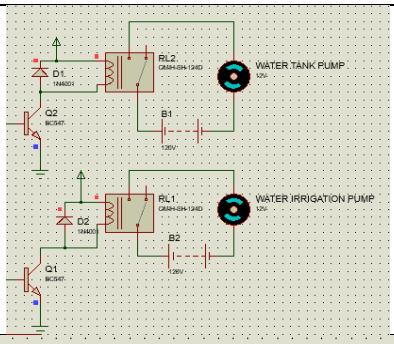
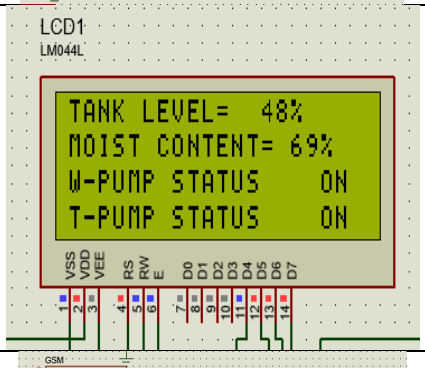
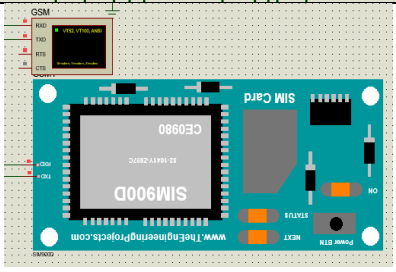
| NAMES | SHAPES | DESCRIPTIONS |
|---|---|---|
| Soil Moisture Sensor |  | A soil moisture sensor is needed in our system to measure the moisture content in the soil and that content will be also displayed on LCD in percentage form. It is a core parameter of the system. It determines if the soil needs irrigation or not. |
| Arduino Uno Board |  | It processes all the commands performed in this system. It is the core of the system. It is like the brain of the system. All other devices are functioning due to this Arduino board. It converts analogue data into an electrical signal. |
| Ultrasonic Sensor |  | Ultrasonic sensor also called water level sensor that is used to measure the level of water inside the tank. |
| Relay, Water Irrigation Pump and Water Tank Pump |  | 1. A relay works like a bridge between Arduino and the (water, tank) pumps. It automatically turns on or off the pump according to the decision of Arduino.<br>2. The water irrigation pump is used to supply water from the tank to the farm<br>3. The water tank pump is use to supply water from the source like a river or lake to the tank placed in the farm field. |
| Liquid Crystal Display |  | LCD, the screen of the system. We used this device to display the values of moisture content and also the level of water inside the tank in the percentage form. It is also used to display the status of two pumps or whether on or off for the tank pump or also for the watering pump |
| GSM and SD Card |  | 1.GSM module is used to send the text messages to the farmer's mobile phone via SMS on the status of the pumps<br>2. SD Card used for the purpose of storing information about the system's performance |

Table 1: Main Components list

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## III. SIMULATIONS AND RESULTS

### A. *Software Implementation*

Search all materials needed in proteus gallery and then connect point to point careful. Your design will look as the figure 3 below:

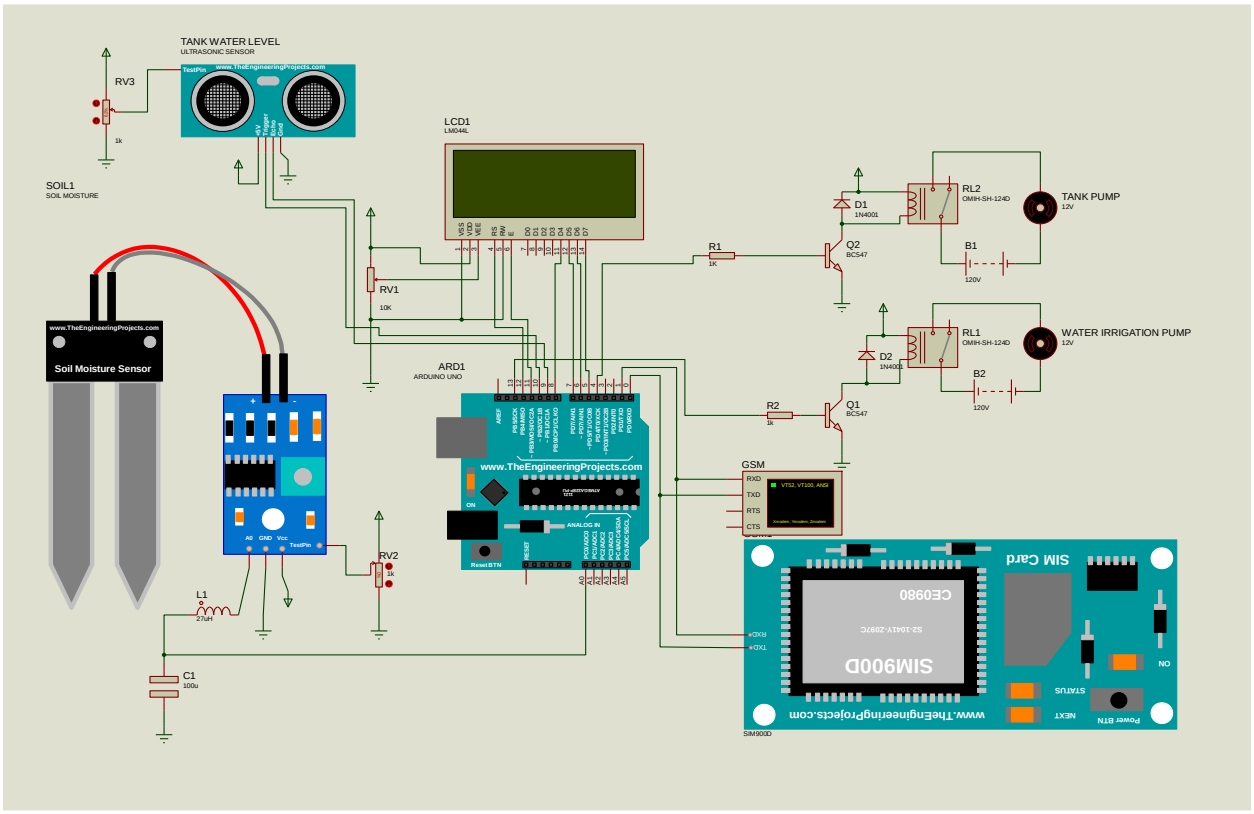


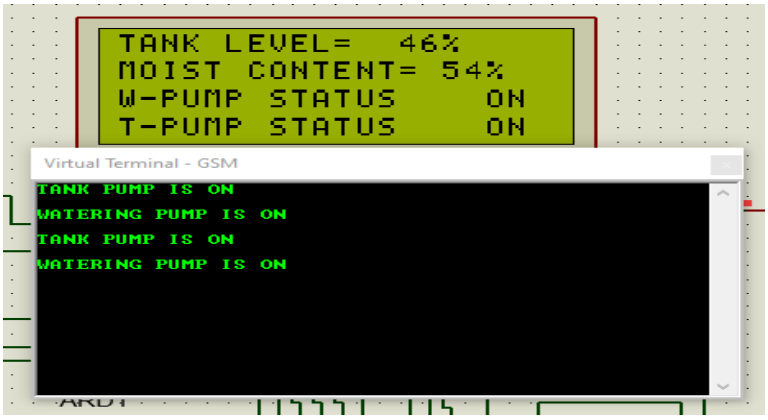

Fig. 3: The system simulation schematics

We have already defined the threshold values for the moisture content in the soil and water tank level in our Arduino code. So, when:

- The moisture sensor detects value under 86% immediately relay turns ON water irrigation pump placed inside the tank to make irrigation, otherwise relay turns OFF the pump.
- The ultrasonic sensor measures the water level inside the tank under 65%, relay turns ON water tank pump that placed inside the river to bring water into the tank, otherwise relay turns OFF the pump.

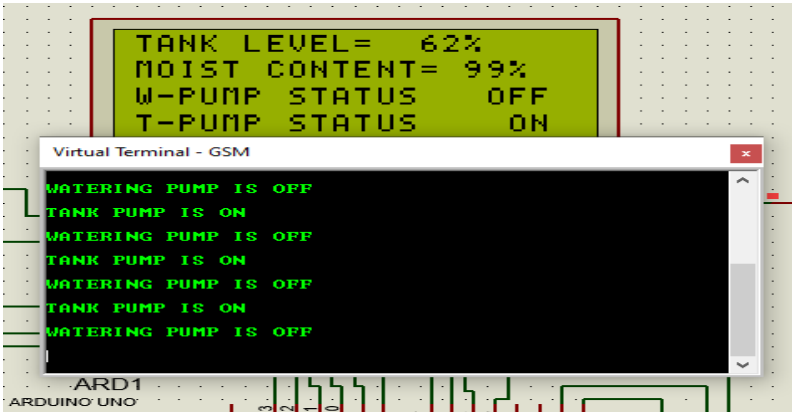
➢ *Case 1*

Both moisture content and water tank level are under threshold values, so relays turn ON pumps.



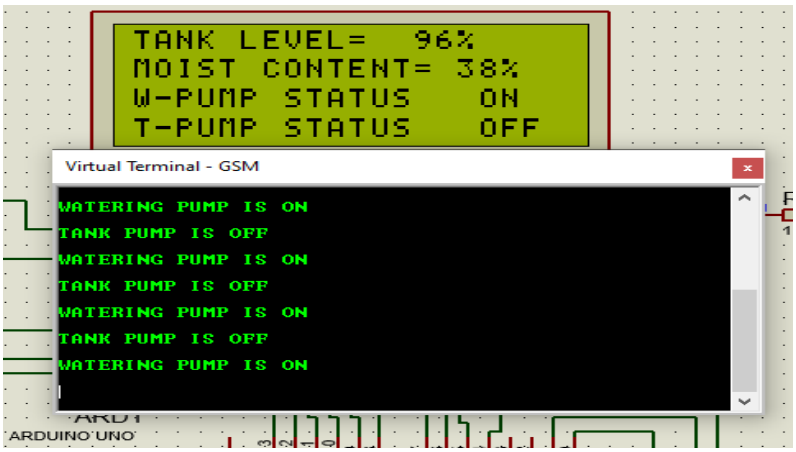
➢ *Case 2*

Moisture content is over threshold value, then water irrigation pump is OFF. Water tank level is under threshold value, then water tank pump is ON.



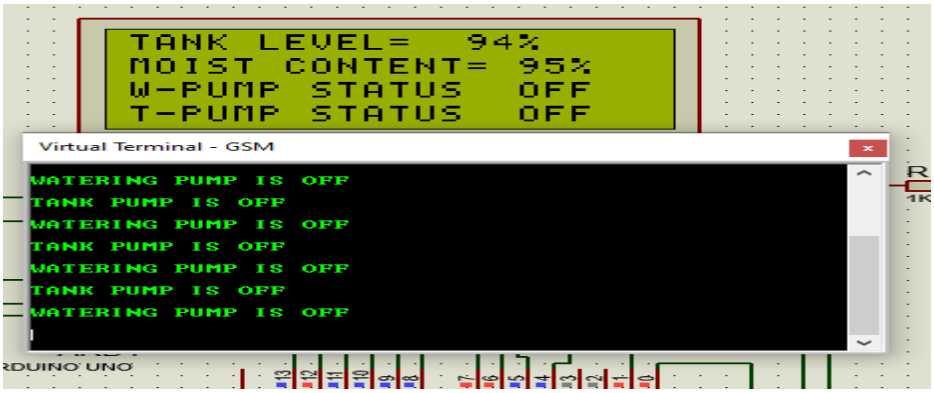

➢ *Case 3*

Moisture content is under threshold value, then water irrigation pump is ON. Water tank level is over threshold value, then water tank pump is OFF.




➢ *Case 4*

Both moisture content and water tank level are over threshold values, so relays turn OFF pumps.




*B. Working Water Pump.*

- Water tank pump will be ON if the Ultrasonic sensor measures the level of water inside the tank which is under **X threshold,** otherwise it will be OFF.
- Water irrigation pump will be ON if the Moisture sensor measures the soil moisture content which is under **X threshold,** otherwise it will be OFF.

*C. On site experiment*

Thissection demonstrates some onsite experiments carried out with physical devices. By achieving this we used three vessels. The first vessel (black) containing soil and the second vessel (white) containing water for irrigation and last vessel (red) contains water as a river as shown in figure 4.

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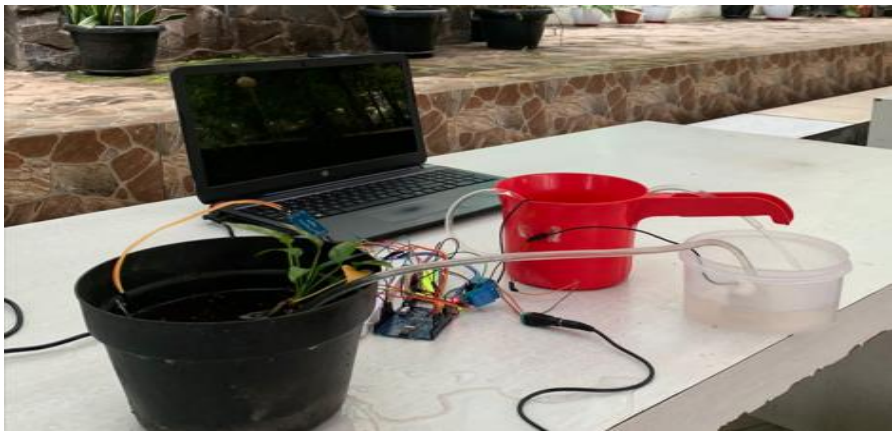

Fig. 4: Overview of the project kit

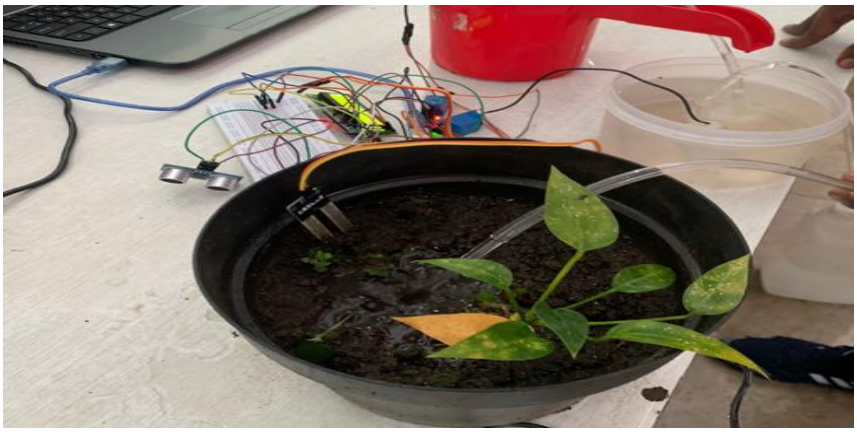

Fig. 4(a): Soil moisture is dry and water irrigation pump ON

Fig. 4(b): Soil moisture is wet and water irrigation pump OFF

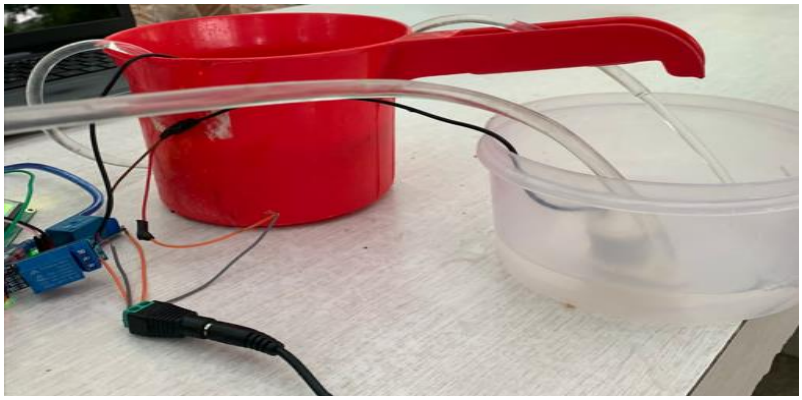

Fig. 4(c): Water level is low and water tank pump ON

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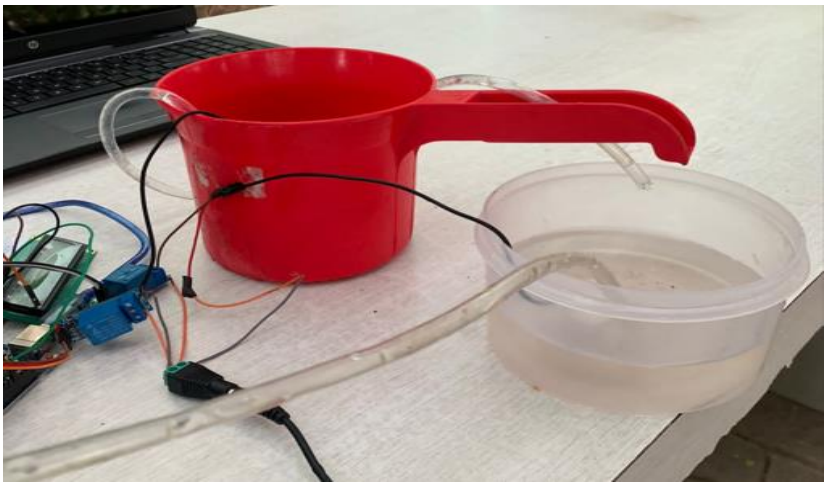

Fig. 4(d): Water level is high and water tank pump OFF

## IV. WATER PUMPS FLOWCHARTS

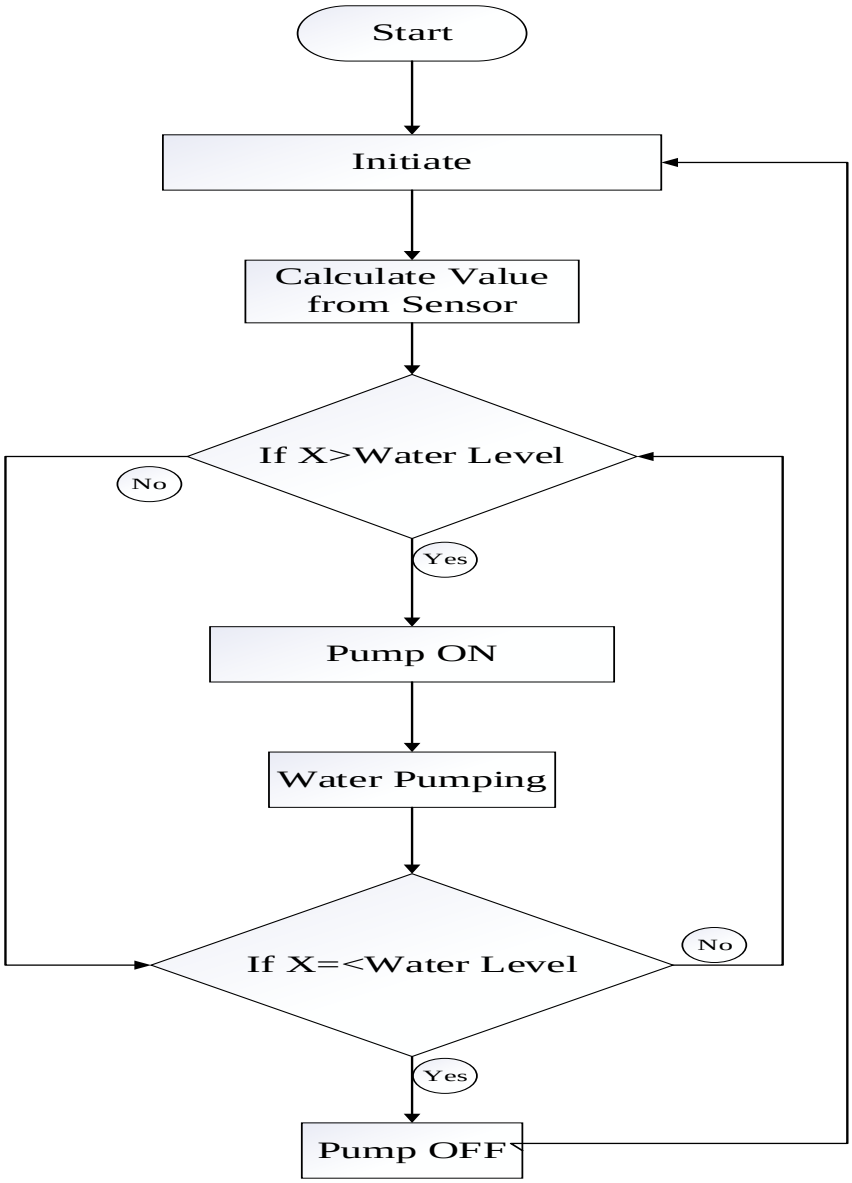


Fig. 4: Water Tank Pump Flowchart

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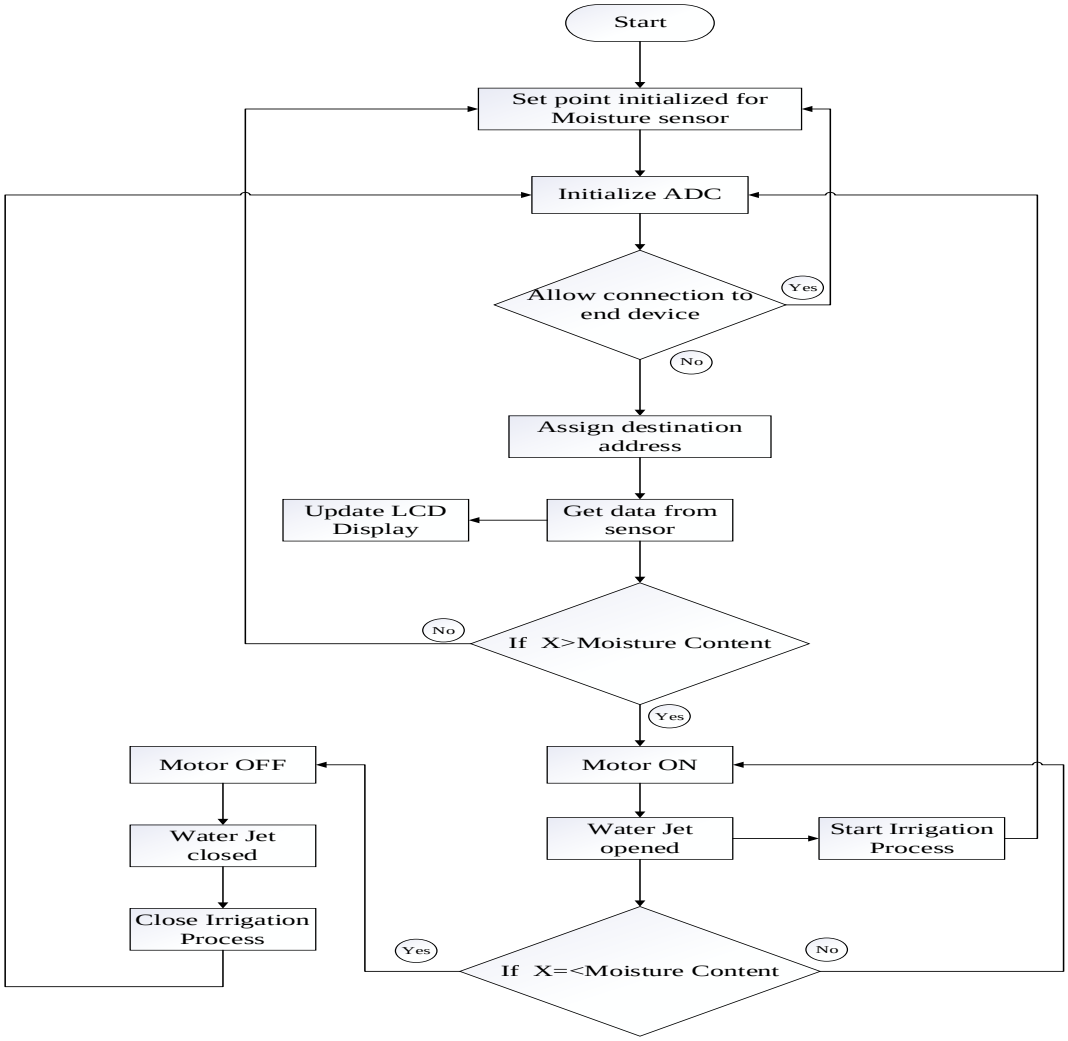


Fig. 5: Water Irrigation Pump Flowchart

## V. DISCUSSION

The ultrasonic sensor will tell relay to turn ON water tank pump, when it measures the level of water from 65% up to 98%, when water irrigation pump is making irrigation (take water from tank to the farm), Ultrasonic sensor tells relay to turn OFF water tank pump from 98% till 65%.

The moisture sensor will tell relay to turn OFF water irrigation pump when the soil is wet, otherwise relay turns ON the water irrigation pump as shown in table 1 below:

| **Input Command** | | **Output** | |
|---|---|---|---|
| | | ***Control Valve state*** | ***Motor state*** |
| Ultrasonic (Water tank level) sensor | Max (L = 98%) | Close valve | Stop running |
| | Optimal 98%< L< =65% | Open if the water coming in tank | Continue running |
| | | Close if the water getting out the tank | Stop running |
| | Min (L < 65%) | Open valve | Start running |
| Soil moisture sensor | If the soil is wet | Close valve | Stop running |
| | If the soil is dry | Open valve | Start running |

Table 1: System Output and Action.

## VI. CONCLUSION

Automation of the various components around us has been widely increased to reduce human intervention. The water tank overflows as the height of water in the tank cannot be randomly guessed and the soil does not know by itself how much water it needs, those leads to extra energy consumption which is high in the present where people need to wait and stop doing their activities until the tank is full and the soil is wet. Hence, here is an idea that senses and indicates the water level and moisture content in the soil, so that the pumps can be switched off at the appropriate time.

This system will be able to send every single activity to the farmer by text message to his/her mobile phone that will help farmer to know how the system is going on and also ourirrigation system design iseasyto install anduse.

## RECOMMENDATION

This project work could be recommended to the future work for researchers that may introduce:

- Real-Time Clock (RTC) Module that must care about the real time to irrigate like making irrigation in the morning and in the afternoon when there is sun set.
- Another monitoring systems like internet, email or others
- May introduce also IC Timer 555.

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