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AUTOMATED IRRIGATION SYSTEM USING ARDUINO AND SOIL MOISTURE SENSOR

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Abstract — Agriculture is one of the most important sectors in the world. Without Agriculture the world ceases to exist as everyone one of us needs food. In recent years, where technology has reached great heights Agriculture as a sector has been excluded from it. Not many Farmers are exposed to cutting edge technology. Very few can afford it. Many still use the traditional ways of farming, which is not only expensive but also very time consuming and gives a poor yield as compared to farming with technology. Irrigation is the process of providing water to the crops through an external source and not being dependent only on rain water. This type of irrigation system can lead to poor yield, wastage of water, damage of crops and various other problems. In order to overcome this problem, we have a created an "Automated Irrigation System" which will automize the process of irrigation for the farmers. This system is equipped to carry out automatic cycles of irrigation on its own without any human intervention and prevent any wastage of water with the help of our tank level sensor. This system is affordable and cost effective and can be adopted by small scale farmers as well. This will not only save the cost of man power but will also help in better yield as the water is distributed uniformly to all crops.

Keywords —Soil Moisture Sensor, Automated Irrigation Mechanism, DC Water pumps, Embedded Systems

I. INTRODUCTION

The domain is Agriculture is very widely explored and tested. Our project aims towards automizing a very key process in farming. There are many people who have done research on the different sections of Agriculture. Irrigation remains unique and there are a lot more things which are yet to be explored. Supported on the soil moisture level from the soil, the system will let the water pump for automatic supply of water to the plant when it's too dry and switch off the water pump when the soil of the plant is wet. A proper usage of irrigation system is extremely important because the most reason is that the shortage of land, reserved water because of lack of rain, unplanned use of water as a result large amounts of water is wasted.

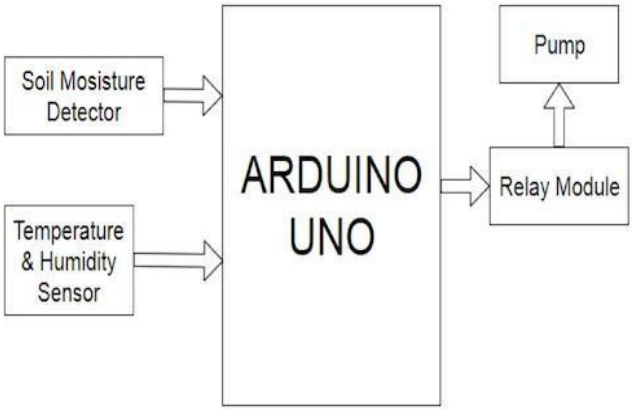

Figure 1- Block Diagram of the System.
<https://www.electronicsforu.com/electronics-projects/prototypes/smart-irrigation-system>

II. LITERATURE REVIEW

Ali Nathim et.al [1] very recently reported about the working and interfacing of Soil Moisture Sensor with Arduino.

Rajendra Udathu et.al [2] recently reported about the real-world implementation of the irrigation and how we can customize our irrigation in different ways.

K. K. Namala et.al [3] recently reported the working of embedded systems with respect to agriculture as a domain. Along with the interfacing of Sensors.

K. Taneja et.al [4] recently reported about the different applications of Arduino in the Agricultural Domain.

Debo-Saiye et.al [5] very recently reported in detail implementation of Drip Irrigation System using Arduino and various Sensors.

Rahman et.al [6] very recently reported the use of loops in coding a micro-controller based upon our requirements and specific applications.

C. M. Devika et.al [7] recently reported about the details of the circuit diagram of the irrigation system and what all components need to be used. Along with their individual and combined contribution to the project.

D. Dhatri P V S et.al [8] recently reported about the detailed analysis of system using Arduino along with its features like cost-effective and high efficiency.

III. METHODOLOGY/EXPERIMENTAL

A. *Components Used*

Arduino Uno

The Arduino is one of the most common and diverse board available in the world today. It's easy to handle and understand whilst performing a very wide spectrum of applications. The Term "Uno" is of Italian origin which means one suggesting that Arduino Uno is one of its kind and can perform variety of tasks with the help of only one board and its microcontroller. The Arduino Uno comes with a very powerful single chip microcontroller called as **ATmega328**. The ATmega328 is designed by ATMEL company and is a part of the AVR Family of microcontrollers. This was all about the introduction of the component now let's dive into the specifications. The Arduino Uno board has an operating voltage of 5V, there are total 14 Digital input/output pins and 6 analog input pins. It has a Flash memory of 32 KB and has a clock speed of 16MHz. The Arduino Uno Board is built with analog pins, digital pins, power pins, TX and RX pins etc. The Arduino Uno has very specific types applications which mainly consist of developing basic circuit designs and automation systems. Its is also used for do-it-yourself projects and get creative and use it in any way to solve a problem or automate a particular procedure.

Figure 2- Arduino Uno
<https://www.elprocus.com/atmega328-arduino-uno-board-working-and-its-applications/>

Soil Moisture Sensor

This sensor is mainly used in agricultural domain. The soil moisture is used to interpret the moisture content present in the soil sample. It primarily measures the volumetric presence of water inside the soil and gives moisture level as output. The sensor provides both digital and analog outputs. The module has 4 pins namely, VCC, GND, A0 and D0. The VCC is used for giving input voltage, the GND is used to ground the sensor. A0 and D0 are analog and digital output pins respectively. Since this project has been done in the form of a simulation, we are only using A0 pin and an additional pin called test pin is introduced where a potentiometer is connected to vary the resistance. The sensor uses a LM393 Comparator and an on board 10 kilo-ohm pot.

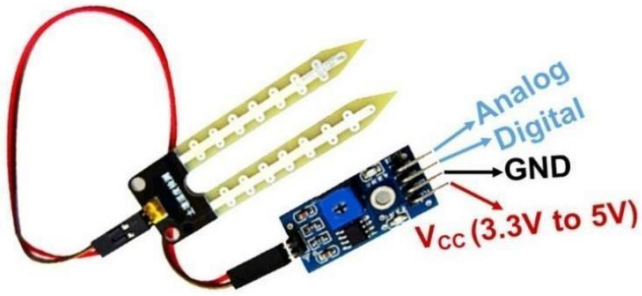

Figure 3- Soil Moisture Sensor Module
<https://components101.com/modules/soil-moisture-sensor-module>

Ultrasonic Sensor

Ultrasonic Sensor are one of the most important type of sensor as it can be used for many applications and is very cheap as compared at others. This sensor is also used to detect obstacles as well as the distance between the obstacle and sensor. We have used HC-SR04 Sensor as it is most commonly used and fits perfectly for the project. The sensor has 4 Pins which are Trigger, Echo, GND, VCC. The Trigger pin acts as a Transmitter and the Echo pin Acts a receiver. The operating Frequency of the sensor is 40KHz. The Ultrasonic waves are emitted from the Trigger Pin which then hit an obstacle nearby and are deflected back to the sensor and received by the Echo pin. The time Period of this is calculated by the Sensor which is then converted to Distance in our project.

Figure 4- Ultrasonic Sensor [HC-SR04]
< https://components101.com/sensors/ultrasonic-sensor-working-pinout-datasheet>

Figure 5– Working of an Ultrasonic Sensor
< https://components101.com/sensors/ultrasonic-sensor-working-pinout-datasheet>

Temperature Sensor

The Temperature Sensors are used to measure the temperature of a particular body or an environment. There are two types of temperature sensors viz Analog and Digital. We gave used an analog sensor named LM35. It is a temperature measuring device which has analogous output voltage to the temperature. The sensitivity of LM35 is defined as 10mV/degree, The temperature and output voltage are directly proportional to each other. LM35 provides more

accurate and precise output than thermistor. It has 3 pins which are VCC, GND and OUT. OUT pin provides output voltage. The LM35 has a temperature range from -55C to 150C.

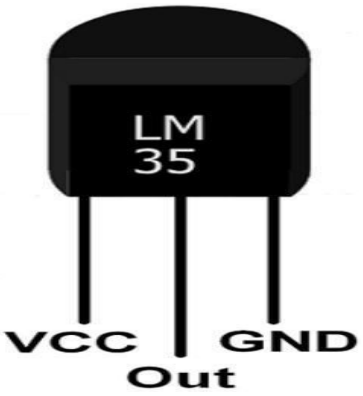

Figure 6- LM35 Temperature Sensor
<https://www.electronicwings.com/components/lm35-temperature-sensor>

LCD Display

LCD stands for Liquid Crystal Display. LCD Displays come in different variants based upon the size and length of the content we need display. For this project we have used 20x4 Alphanumeric Display. We have displayed 4 parameters viz, Tank level, Soil Moisture content and the status of both the water and tank pumps.

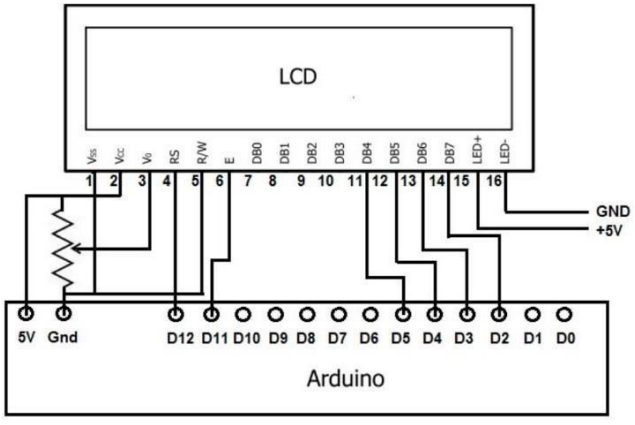

Figure 7- Pinout Diagram of LCD Display interfacing with Arduino
<https://www.instructables.com/Interfacing-20x4-LCD-with-Arduino/>

B. Circuit Diagram

The Circuit Diagram is one of the main parts of the project. It has been designed in Proteus Circuit Simulation Software.

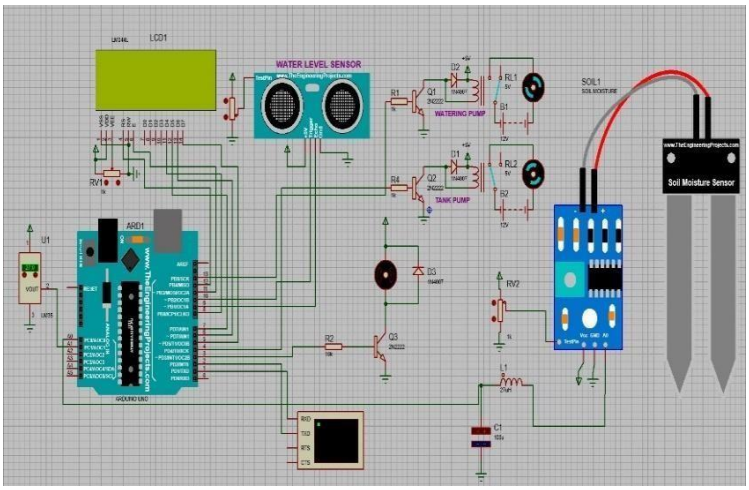

Figure 8- Circuit Diagram of the Project

The Arduino Uno is the brain of the Project and all the decisions within the circuit are made by the Arduino according to the Program that has been fed to it. Starting with the interfacing of the Different Sensors used. Soil Moisture Sensor and temperature Sensor are analog sensors, they need to be connected to the analog pins of the Arduino. The Soil Moisture Sensor has been connected to pin A0, while Temperature Sensor has been connected to pin A1. Coming to the Digital Sensor Used that is the Ultrasonic Sensor. As mentioned, the Ultrasonic Sensor has 4 pins, two of which need to be connected to the Arduino that are Trigger (Transmitter) and Echo (Receiver). The Trigger pin has been connected to pin 10 (Digital PWM) while the Echo has been connected to pin 9. The interfacing of the two pumps that are the Water Pump and the Tank Pump has been done to pin 13 and pin 4 respectively. There are two types of Displays being used in the Circuit Diagram that are LCD Display and Virtual Display. The LCD terminals are connected to pins 12,11,8,7,6,5. The Virtual Terminal has two pins named RXD and TXD which are connected to Pin1 and Pin 2 respectively.

C. Code Section

The code for this Project has been written in Embedded C in Arduino IDE. The Code has been divided in such a way that each function inside the code represents a feature of our project. Dividing the code in functions helps in better understanding of the Project. The snips of the different sections of the code will be attached here followed by the Explanation of that particular section.

```
//MAIN WORKING
void condition()
{
if (distance_percent>50 && moist_percent<70)
{
LCD_3();
digitalWrite(tank_pump,LOW);
digitalWrite(watering_pump,HIGH);
delay(1000);
}

else if (distance_percent<65 &&moist_percent>85)
{
LCD_2();
digitalWrite(tank_pump,HIGH);
digitalWrite(watering_pump,LOW);
delay(1000);
}

else if (distance_percent>65 &&moist_percent>85)
{
LCD_4();
digitalWrite(tank_pump,LOW);
digitalWrite(watering_pump,LOW);
delay(1000);
}

else if (distance_percent<65 &&moist_percent<85)
{
LCD_1();
digitalWrite(tank_pump,HIGH);
digitalWrite(watering_pump,HIGH);
delay(1000);
```

Figure 9– Code Section 5

The 5th Section of the Code comprises of the main working of the Project. In this section we had specified 4 different conditional statements, with 2 parameters. The two parameters are distance percent and moist percent. Based on the 4 different combinations of values for the parameters a LCD function corresponding to that combination is called. The called function then prints the 4 values on the LCD Display.

```
//DIFFRENT LCD DISPLAY FUNCTIONS
void LCD_1()
{
lcd.clear();
lcd.setCursor(0,0);
lcd.print("TANK LEVEL= ");
lcd.print(distance_percent);
lcd.print("%");
lcd.setCursor(0,1);
lcd.print("MOISTURE STATUS= ");
lcd.print(moist_percent);
lcd.print("%");
lcd.setCursor(0,2);
lcd.print("WATER PUMP:");
lcd.print("ON");
lcd.setCursor(0,3);
lcd.print("TANK PUMP:");
lcd.print("ON");
}

void LCD_2()
{
lcd.clear();
lcd.setCursor(0,0);
lcd.print("TANK LEVEL= ");
lcd.print(distance_percent);
lcd.print("%");
lcd.setCursor(0,1);
lcd.print("MOISTURE STATUS= ");
lcd.print(moist_percent);
lcd.print("%");
lcd.setCursor(0,2);
lcd.print("WATER PUMP:");
lcd.print("OFF");
```

Figure 10 – Code Section 6.1

```
void LCD_3()
{
lcd.clear();
lcd.setCursor(0,0);
lcd.print("TANK LEVEL= ");
lcd.print(distance_percent);
lcd.print("%");
lcd.setCursor(0,1);
lcd.print("MOISTURE STATUS= ");
lcd.print(moist_percent);
lcd.print("%");
lcd.setCursor(0,2);
lcd.print("WATER PUMP:");
lcd.print("ON");
lcd.setCursor(0,3);
lcd.print("TANK PUMP:");
lcd.print("OFF");
}

void LCD_4()
{
lcd.clear();
lcd.setCursor(0,0);
lcd.print("TANK LEVEL= ");
lcd.print(distance_percent);
lcd.print("%");
lcd.setCursor(0,1);
lcd.print("MOISTURE STATUS= ");
lcd.print(moist_percent);
lcd.print("%");
lcd.setCursor(0,2);
lcd.print("WATER PUMP:");
lcd.print("OFF");
lcd.setCursor(0,3);
```

Figure 11 – Code Section 6.2

Code Section 6 is the LCD Display section. This Section has 4 functions named LCD1, LCD2, LCD3 AND LCD4. Each of these functions contains 4 display parameters inside them which are Moisture level, Tank Level, Water Pump status and Tank Pump Status. These parameters are printed on 4 different new lines of the LCD which is 20x4 alphanumeric display. The parameters are printed using command lcd.SetCursor .That was it for the code of the project, Lets see the 3-D model which we had created.

IV. RESULTS AND DISCUSSIONS

The results of this Project are quite accurate and precise. It can successfully create cycles of irrigation automatically with the help of real time data provided by Sensors. The Ultrasonic Sensors provides the information about the water level in the tank and controls the tank pump. On the other hand, the soil moisture sensor handles the watering pump which actually supplies the water to the crops. The LCD Display is used to display 4 parameters viz. Soil Moisture Content, status of the two pumps and the water level in the tank. All of these things put together form the circuit of the project and work together according to their assigned tasks to give automated cycles of irrigation in a very efficient way.

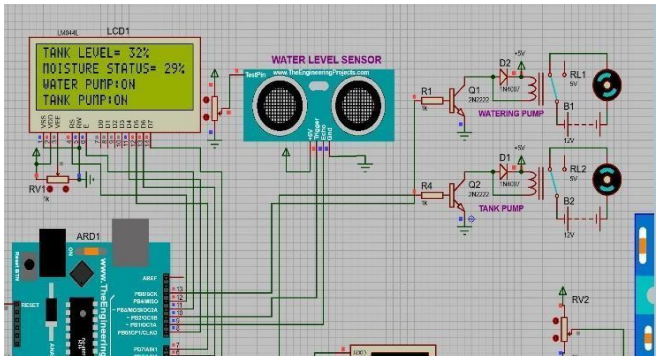

Figure 12 – Working model 1

In this snip as you can see on the LCD display the 4 parameters are shown, as both the levels that are the moisture level and the water level are low, both the pumps are on and are doing their specific tasks.

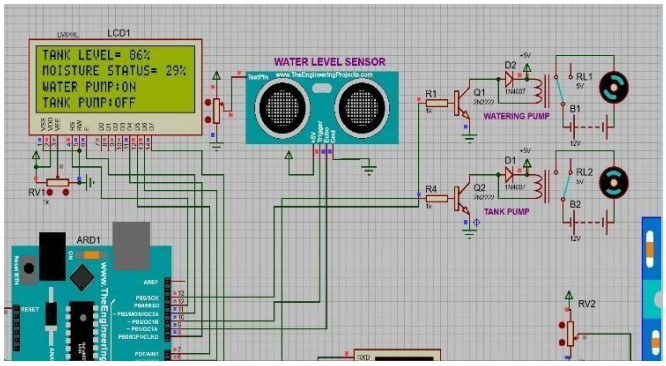

Figure 13 – Working model 2

In this snip the water level in the tank has risen to 89%. Hence, the tank pump status is off while the watering pump is still on because the moisture level is above the prescribed level in the code.

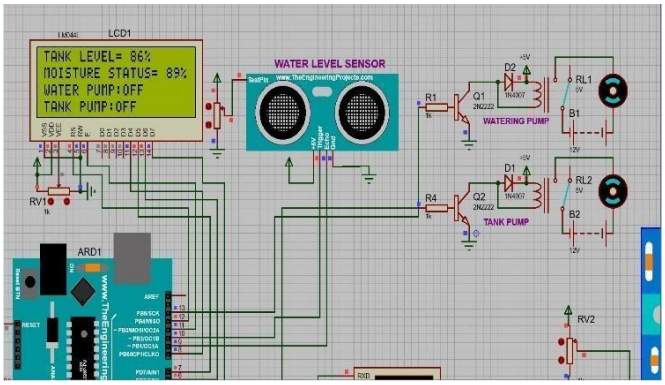

Figure 14 – Working model 3

In this model both the pumps are off as the levels of both moisture and water have risen above the prescribed level in the code.

V. CONCLUSION

Irrigation becomes easy, accurate and practical with the thought above shared and should be implemented in agricultural fields in future to promote agriculture to next level. The output from soil moisture sensor and water level system plays major role in producing the output. Thus, the project has been designed and tested successfully. It's been developed by integrating all the features of all the components used. Presence of each and every module has been reasoned above and placed carefully so on contribute to the sole working of its ability. The system has been tested to function automatically. The moisture sensors measure the moisture level (water content) within the soil of the assorted plants. The functionality of the whole system has been tested thoroughly and it's said to function successfully.

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