International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

# Cooperative Automatic Irrigation System using Arduino

**Getie Dereje Derib**

28 Xianning W Rd, Xian Shi, Shaanxi Sheng, China, 710048

**Abstract:** ***This paper presents an effective system of irrigation. The designed system basically have two inputs and two outputs. The inputs are moisture sensor and level sensor whereas the outputs are pumping motor and a solenoid valve. What makes this project unique is a level sensor and moisture sensor works together for the efficient use of irrigation. The level sensor determines our pumping motor to run or not for fetching water from the ground to a reservoir. The moisture sensor determines whether the plant must be irrigated or not by measuring the water content of the soil in which the plant grow up. We can turn on and off the valve using soil moisture sensor alone but what is going to be done suppose the water in our reservoir gets finished during irrigation time. Absolutely there must be a man to take the sake of pouring water. This project makes things easier, simple and time efficient at low power consumption. No one can have a doubt regarding the idea because a human being has had alive in cultivation indeed***

**Keywords:** Arduino Uno, Soil Moisture Sensor (SMS), level sensor, Liquid Crystal Display (LCD).

## 1. Introduction

The continuous increasing demand of food requires the rapid improvement in food production technology. In developing countries, where the economy is mainly based on agriculture, still they are not able to make full use of agricultural resources. One of the reasons is due to unplanned use of water in which a significant amount of water goes to waste. The other major problem is to fetch water from a river or underground to fill a tanker. These problems cause wastage of human resource and time. Hence, we have to build automation systems for the rectification of these serious problems.[1-2]

Agriculture is one of the fields where water is required in remarkable quantity. Wastage of water is a major problem in agriculture. Every time excess of water is given to the fields. There are many techniques to save or to control wastage of water from agriculture. Plants irrigating controller is intended to signal when a plants need water

## 2. Block Diagram

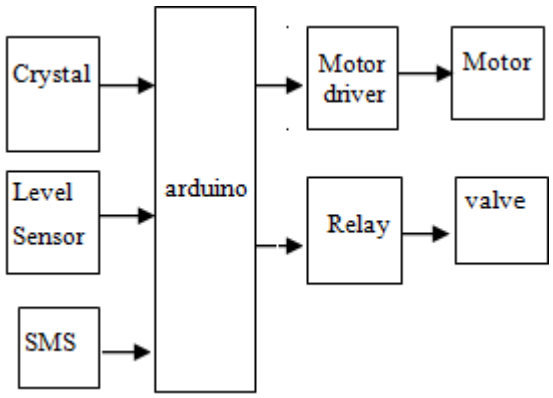


**Figure 1:** Block diagram of the system

The block diagram of the system has been shown in Fig 1. It consists of:

**1.1 Crystal Oscillator-** A crystal oscillator is an oscillator circuit, which uses the mechanical resonance of a vibrating to create an electrical signal with a very precise frequency. The crystal oscillator is used in the system to provide clock signal to the microcontroller.

**1.2 Soil moisture sensors** measure the volumetric water content in soil. 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.[8]

**1.3 Liquid Crystal Display**- The LCD is a dot matrix liquid crystal display that displays alphanumeric characters and symbols. 16X2 LCD digital display has been used in the system to show the room temperature in the soil (water content).

**1.4 Motor Driver**- Motor driver is used to control motors through a microcontroller. Here a transistor is used for driving a motor.

**1.5 Relay**: is an electrically operated switch and uses an electromagnet to operate a switching mechanism mechanically. It is used where ever necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. A type of relay used here is a high power, required to directly control an solenoid valve. It is used as a means of providing a signal to open the valve for supplying water.

**1.6 Arduino Uno**: The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started[6].

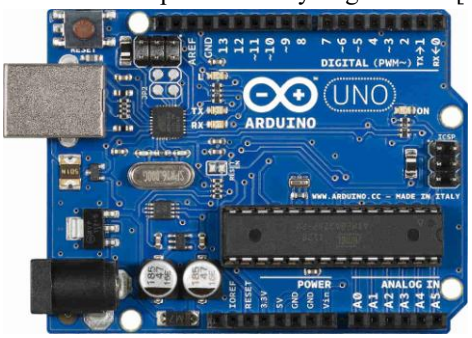


**Figure 2:** Arduino kit

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-To-Serial Converter.

## 3. Power Supply

Five Volts Power Supply W.R.T Ground Is Needed For The Operation Of The Microcontroller. Fig 2 Shows The Schematic Of The Power Supply Used By The Microcontroller.

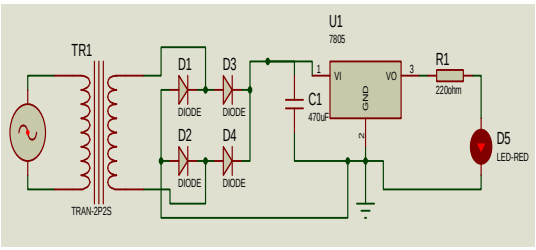


**Figure 3:** Power Supply Schematic

The Power Supply Consists Of A Step Down Transformer Which Is Used To Convert 230 V, 50 Hz AC Voltage To 12 V AC, 50 Hz. This 12 V AC Voltage Is Given To The Bridge Rectifier, Which Converts It Into 12 V Dc. A Voltage Regulator 7805 Is Used To Convert The 12 V Dc Into 5 V Dc Which Is Needed By The Microcontroller. Capacitors Are Used For Smoothening The Output Voltage. This Five Volts Dc Thus Produced Is Given To The Microcontroller For Its Operation.

## 4. Flow Chart

The two flow charts are independent, one can run without the effect of the other.

### 4.1 Flow chart 1

The following figure is the flow chart that shows the relationship between the level sensor and the pumping motor. The Arduino is a communication link between the two. It receives a signal from the level sensor and compares with a pre-set threshold value. If the level that is detected by the sensor is below the threshold value, the Arduino send a message signal to the motor to fetch water. But when the level detected by the sensor is above the pre-set value the motor doesn't rotates. The Arduino always accept a signal from the sensor.

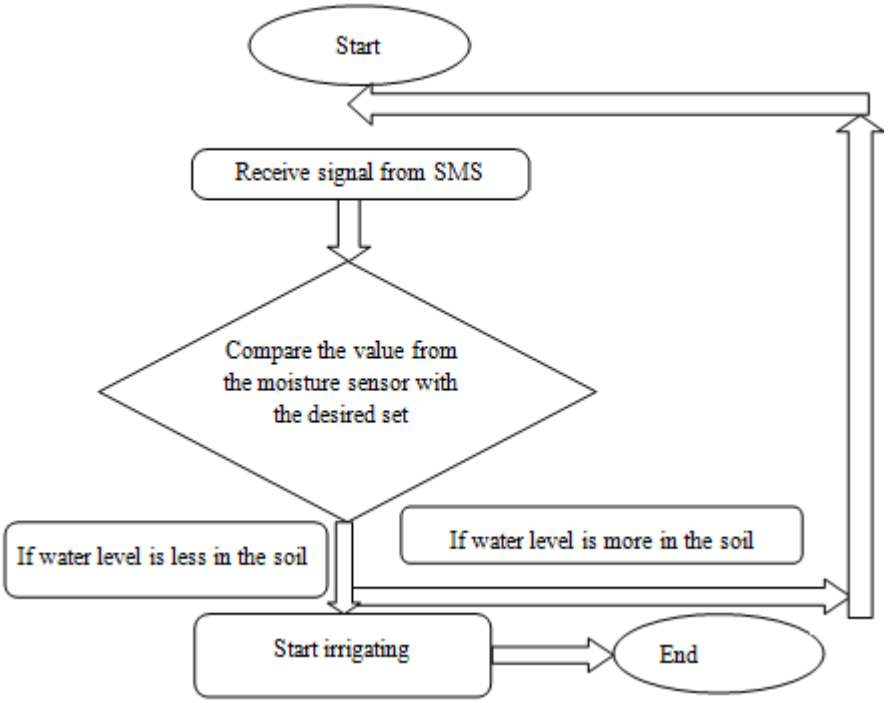


**Figure 4:** Flow chart that relates soil moisture sensor and the controller

### 4.2 Flow Chart 2

The following figure is the flow chart that shows the interaction between the SMS and the relay via the solenoid valve. The Arduino is a communication link between the SMS and the relay. The Arduino compares the temperature detected by the SMS and a pre=set value which is 30 o c in this case. When the temperature is below 30 o c, the relay doesn't gate a signal from the Arduino, hence the valve is closed implies no irrigation. Whereas the temperature of the soil is above 30 o c, the valve activates and irrigation starts.

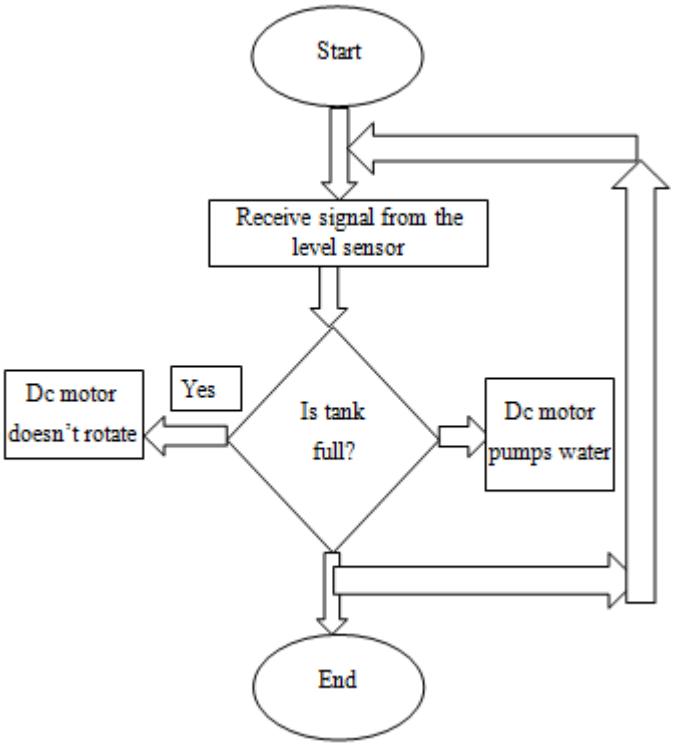


**Figure 5:** Flow chart that relates level sensor and the controller

### Arduino Compiler

The Arduino Software (IDE) allows you to write programs and upload them to your board.[7]

```
Automatic_Irrigation_DEREJE

float c;
float lmap;
float lmeter;
void setup() {
pinMode(13, OUTPUT);
pinMode(1, OUTPUT);
pinMode(0, OUTPUT);
lcd.begin(32, 2);
}

void loop() {
c=map(analogRead(A1), 0, 1023, 0, 500);
lmap= (5*analogRead(A0))/1023;
lmeter=lmap*4;
if(c<30){
  digitalWrite(1, LOW);
  digitalWrite(0, LOW);
  lcd.setCursor(0, 1);
  lcd.print("wet:");
  lcd.setCursor(7, 2);
  lcd.print(c);
}
if(c>30){
  digitalWrite(1, HIGH);
  digitalWrite(0, HIGH);
```

Figure 6: Arduino compiler with the source code

## 5. Circuit Simulation

The simulation of the system has been done on Proteus Professional Software v8.0. Arduino Uno microcontroller based on Modified Harvard architecture is used in the system. Coding of the system has been done in Embedded C language. 16X2 LCD display has been used which is connected to PORT D of the microcontroller.

The fig below shows the level sensor result and simulation when, when the level of the tank is above 10 meter. Hence the motor doesn't rotates to fetch water because the tank is just enough full for irrigation.
The level of the tank is indicated on the LCD screen. The LED is OFF implies that the tank is full.

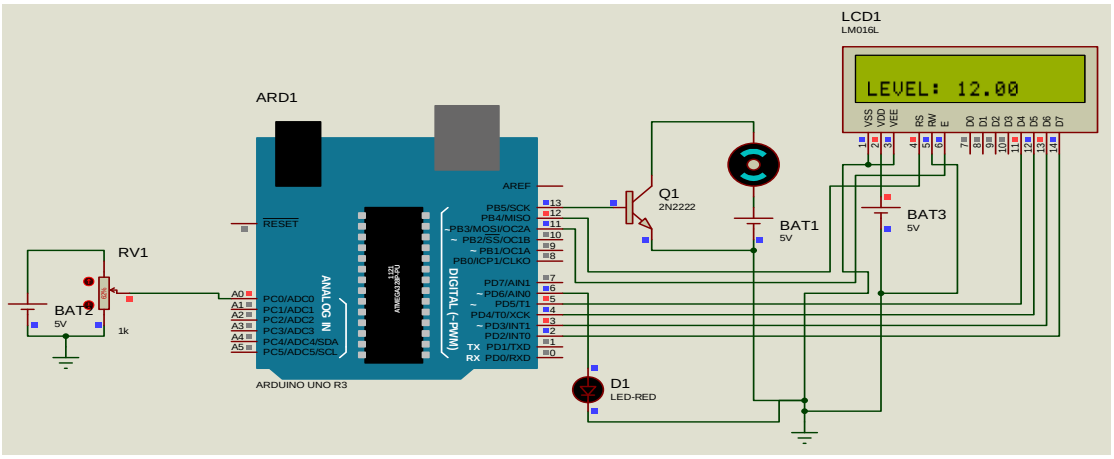


**Figure 7:** When the level of reservoir is above the threshold value

The fig below describes that when the level is below 10 meter, the motor rotates and the LED blink RED. This implies that the tank is doesn't have much enough water for irrigation. The corresponding level is indicated on the screen also which is 8 meter.

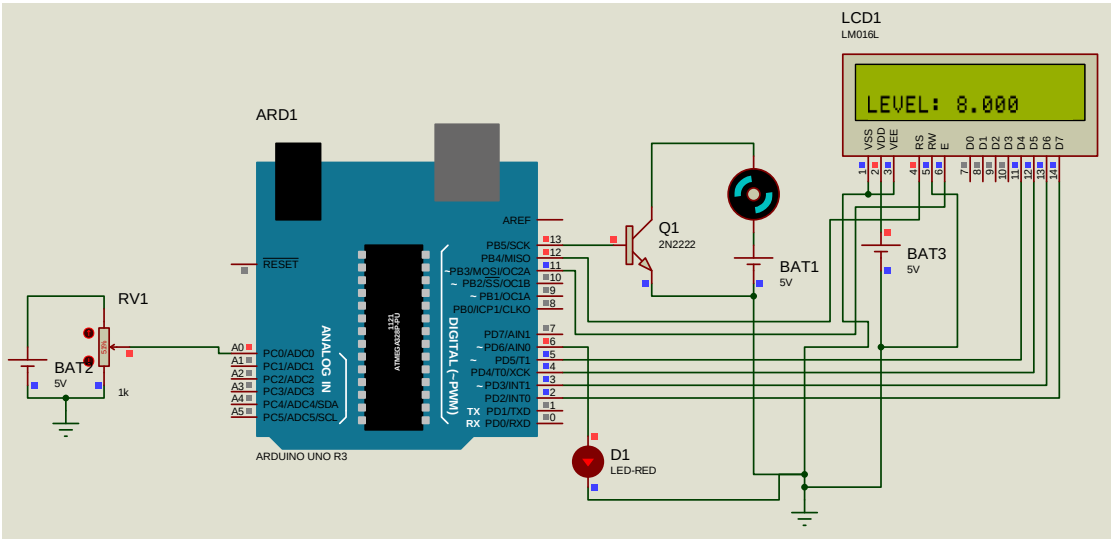


**Figure 8:** When the level of reservoir is below the threshold value

The fig below shows that when the temperature is below $30^0$C, the LCD displays wet (enough water content) in the soil which is here $29^0$C. There is no current that passes through the relay switch and hence the valve doesn't activated (here the valve is replaced by LED) for the sake of simulation.

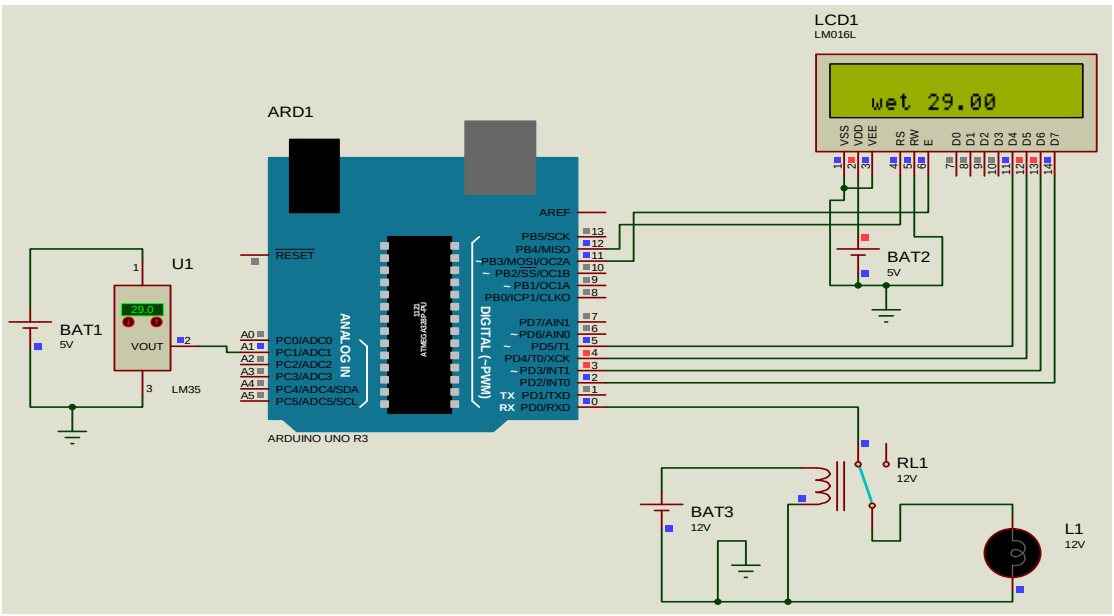


**Figure 9:** When the moisture level is below the optimum point

The fig below shows that when the temperature is above 30 o c, the LCD displays dry (no much water content)in the soil. Here the screen indicates that the soil temperature is 32 o c. here the switching relay gates a signal from the Arduino so that the valve is activated (valve is replaced by LED) for the case of simulation hence as shown the LED blinks RED meaning that irrigation is going on now.

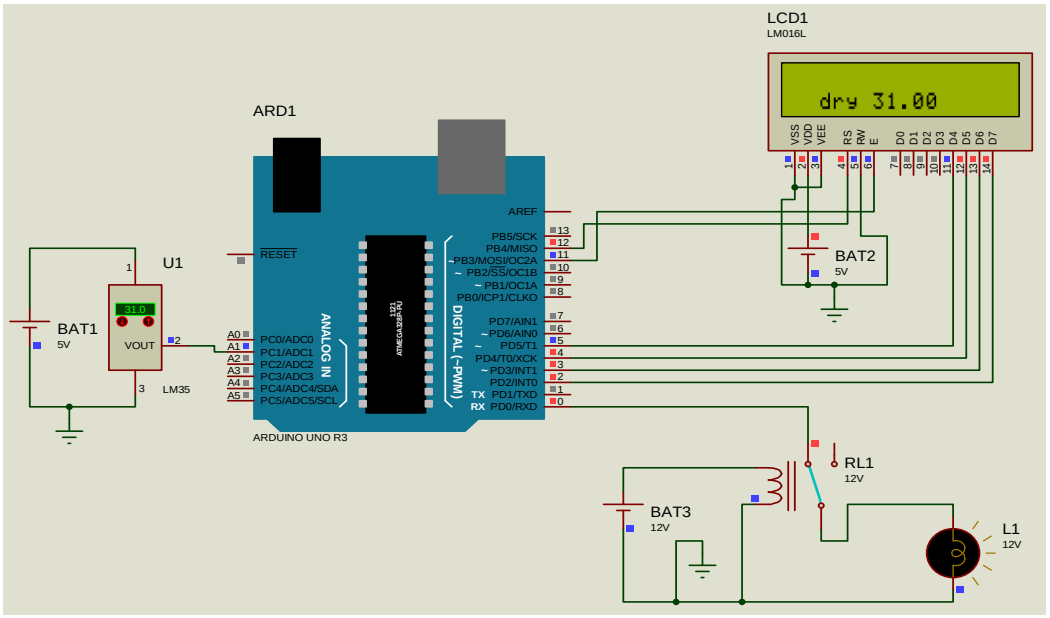


**Figure 10:** when the moisture level is above the optimum point

## 6. Overall System Design and Result

The system design in short has two inputs and four outputs. The inputs are the level sensor and soil moisture sensor where the outputs are flashing of the LED, LCD display, motor rotation and the valve controlling. The LCD displays the level of the tank and the temperature of the soil. LED: will flash when the value of temperature is above 30 $^{\circ}C$ in which it indicates that the plants need water. The valve is triggered ON/OFF based on the signal of the switching relay. There is a relay between microcontroller and the valve which interfaces these devices together. The motor fetches water when the level is above 10 meter.

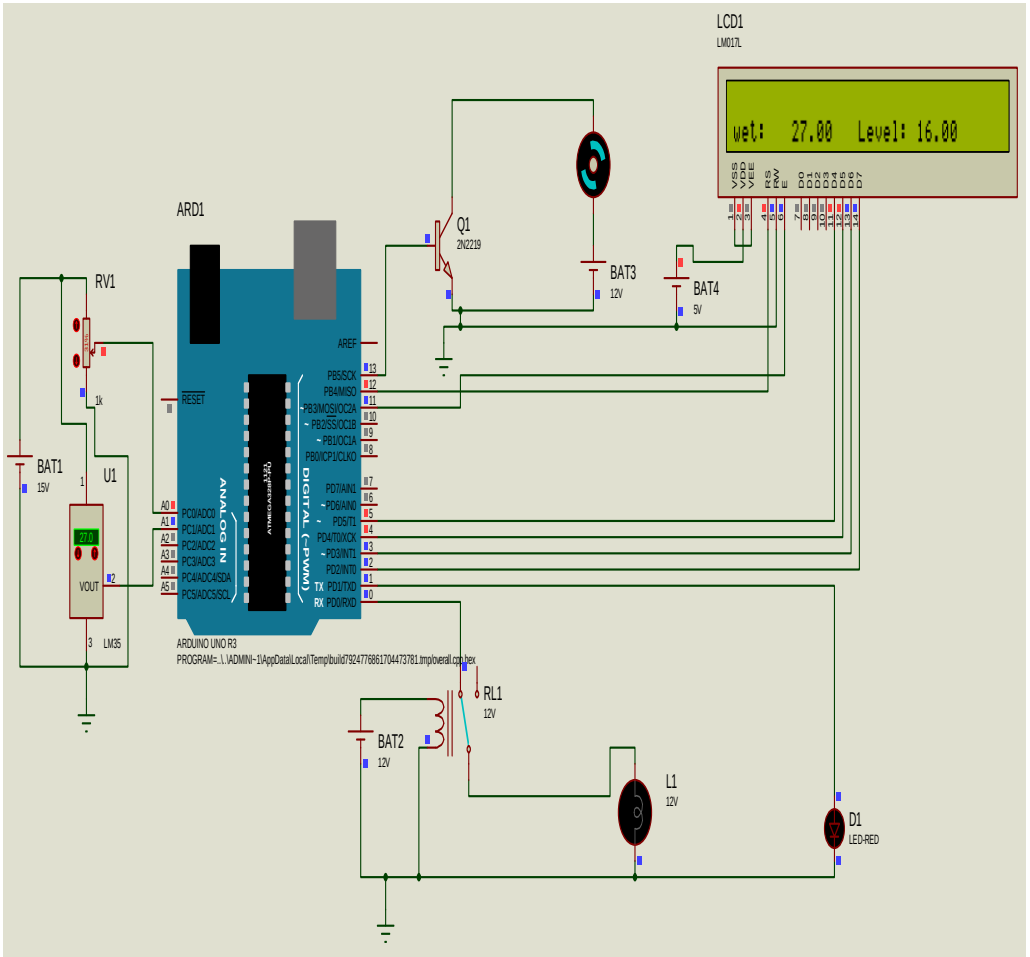


**Figure 11:** Overall system simulation when the soil is wet and reservoir level is above

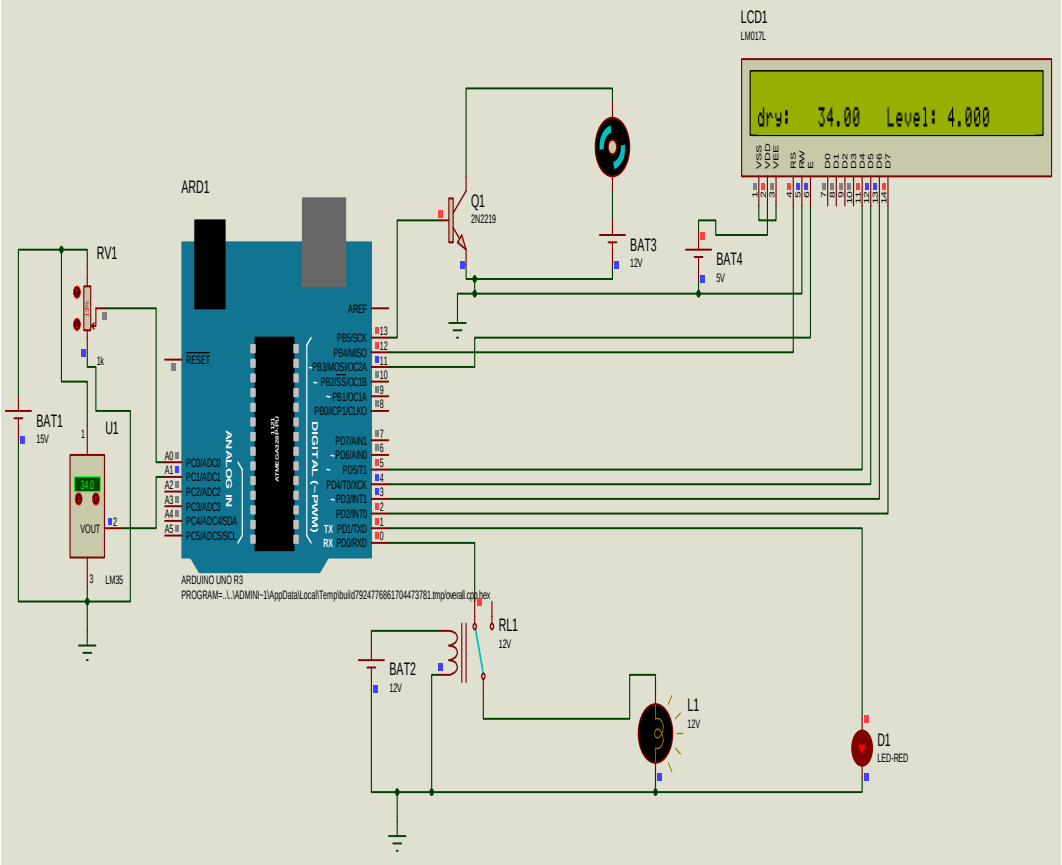


**Figure 12:** Overall system simulation when the soil is dry and reservoir level is below

## 7. Conclusion

The Arduino Based Automated Irrigation System is a valuable tool for accurate soil moisture control in highly specialized greenhouse vegetable production and it is a simple, precise method of irrigation. It also helps in time saving, removal of human error in adjusting available soil moisture levels and to maximize their net profits. Salient features of the system are: Closed loop automatic irrigation system, moisture and water usage monitoring. User can easily preset the levels of the Moisture and is regularly updated about current value of all Parameters on LCD display. The switching mechanism of the valve can be done automatically with the help of microcontroller using relays. The proposed controller eliminates the manual switching mechanism used by the farmers to ON/OFF the irrigation system. The moisture sensors measure the moisture level (water content of the soil) of the different plants. If the moisture level is found to be below the desired level, the moisture sensor sends the signal to the Arduino board which triggers the water pump to turn ON and supply the water to respective plant using the sprinkler. When the desired moisture level is reached, the system halts on its own and the water pump is turned OFF. Thus, the functionality of the entire system has been tested thoroughly and it is said to function successfully. In future, other important soil parameters namely soil pH, soil electrical conductivity will also be incorporated in the system.

## 8. Future Scope

We know that agriculture is the most important source of income in countries like Ethiopia, so to improve agricultural products irrigation system is the first method to achieve this goal. It is recommended to implement the project for sends a message using GSM to a personal computer that happens during irrigation for the sake of system reliability. Also it interesting if the project manipulated including the power source of the system, especially solar power which is always accessible and can be implemented everywhere. Generally the irrigation system is built to solve social, economic, and environmental and societal problems for one's country which it will lead to development.

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