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Development of Automated Powered Precise Watering System for Large Framing in Desert

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Abstract- The aim of the study is to develop automated irrigation system since water scarcity is high in the deserts and high temperature zones around the world. The project is designed to reduce over irrigation and manpower to look after the plants and crops. This project consists of electric circuit board of electronic devices assembled such as humidity sensor, electronic solenoid valve, LCD, relay, ARV microcontroller and 12 Volts battery. Humidity sensor is inserted in the plant soil. The humidity sensor shows higher and lower level of humidity present in the soil and deliver message to the control unit. Once control unit receive data from humidity sensor display on LCD and send message to solenoid on/off valve. Valve automatically start function once received message from control unit and water supply to the plant soil until humidity level achieve in the soil. Sensor measure low and high level of humidity so once desired level achieve sensor sent message to control unit and to stop water supply. This system will run when humidity in the soil is lower in the result microcontroller receive message from sensor and automatically water supply provided with the help of solenoid on/off electric valves. The process continues till humidity level is achieved and water supply will automatically stop to prevent over irrigation or wastage of water.

Keywords*- Automated Irrigation, Water System, Large Farming*

I. INTRODUCTION

In recent times the demand of water has been augmented because of the upsurge in the populace and the accessibility of water has turned out to be more critical than ever before. Huge quantity of groundwater is utilized for the agriculture irrigation purpose across the world [1-2]. In the plant growth water has fundamental role and proper management of water supply to the plant is important. Importance of agriculture cannot ignore for the economy and enough food production of the country for survival is crucial.

An energy source for employing modern agriculture is correspondingly an immense difficulty in desert countries. Desert soil is useful for the purpose of agriculture if sufficient water is supplied to the plants and tree in the desert [3]. The development of agriculture land irrigation is the key source to supply sufficient water to the plants [4]. There is no supporting infrastructure or roads in several remote deserts. The usage of renewable energy is striking for agricultural purposes in distant zones of several Asian and African deserts. Carrying of renewable energy schemes, for instance solar irrigation system is considerably simpler than the other kinds since they can be conveyed in parts and reconstructed on location. Solar energy creation is acknowledged as a significant portion of the upcoming energy production. So, it can be vital for agriculture in desert areas in many countries. Conventional method of agriculture irrigation consumes huge water [1]. Farmers in the desert area need more effective and efficient way of irrigation to the plants for proper water resource to maintain plants production capacity. Numerous work has been done and introduce many techniques to irrigate desert land to increase crops yields and keep plants in survival but always need manpower to look after and manager the water quantity. Farmers' encouragement and motivation to cultivate and increase yield of the crop in the desert required well managed irrigation/ watering system. The irrigation systems developed in the past is not automated. These irrigations system need to operate manually and in the consequences plants receive over or less irrigation and also not sufficient water to fulfill plants requirement. Precise amount of water ensured to be supply for the healthy growing of the plant because excessive and decisive water supply affects the plants. Moreover excessive water supply can be manage and reduce water utilization. The automated water irrigation system utilizes solar energy and to operate automatically water supply based on moister contents present in the soil. The system will activate if moister content is less than the predetermined level. Development of automated solar powered irrigation system is the key objective of the study.

II. LITERATURE REVIEW

According to [5] appropriately installed soil moister sensor possibly reduces water up to 62% and also reduces conventional method of over irrigation to increase plants resistance against diseases. Study conducted in University of Florida shows that soil moister sensors installed in residential plantation purpose can reduce water up to 50%, based on irrigation system and plants moister level sensor can be reduce water application to the plant almost half and discourage conventional means of watering system. The purpose of this document is to establish the reputation of the baseline soil moisture sensor as a valuable irrigation tool and to help professional irrigators meet their challenges by raising their awareness of the issues related to effective watering [6-8]

Fenton et al., (2009) advantages of using soil moister sensor in irrigation system;

- Reduce water consumption
- Can be adjust in lower and upper threshold to maintain optimum soil moisture contents and plants saturation
- Can contribute plants deeper root growth
- Can be reduce soil run off
- Provide less favorable condition to the insects and fungal dieses

Study of [9] modeled power auto watering system for the irrigation on small scales in India. Soil moisture sensor is used for real-time collection of crop root soil moisture content and converting it into a signal in the range of 0 - 1 V; and the signal will transformed as knowledge of water requirement of crop. Soil moisture content at the root zone of different crops is collected by using the soil moisture sensor. The concept of intelligent irrigation auto watering system and components is shown in the figure 1.

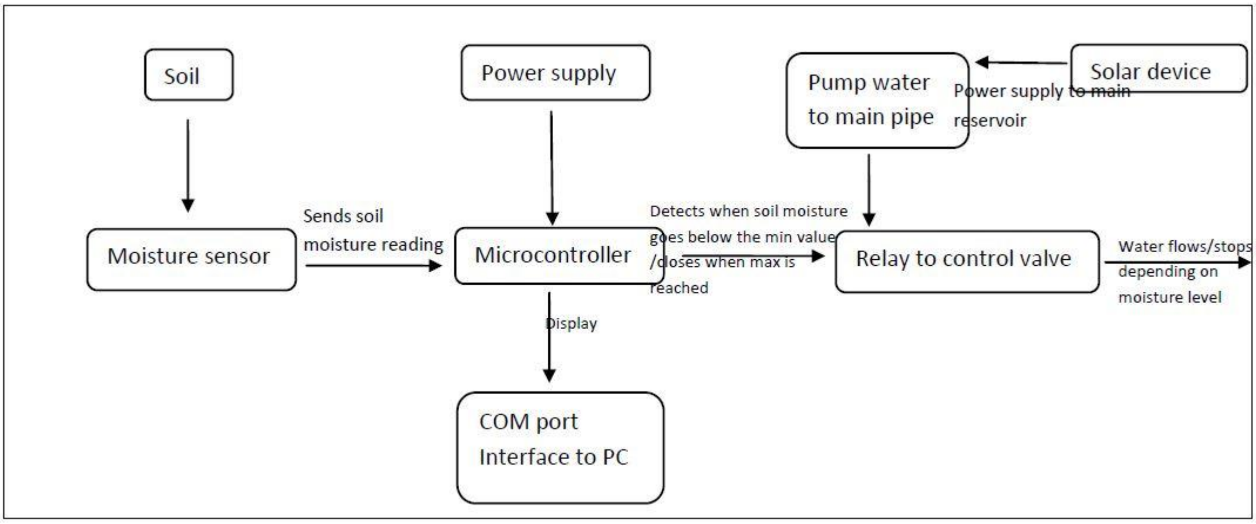

Figure 1. Components of auto watering irrigation system [7]

A. Factors Affecting Soil Moister Sensor

To study and understand the water level present in the soil following factors highly impact on the moister contents in the soil and affect measurement of present moister contents.

1) Saturation

The condition of soil filled with water and has no free space, after saturation of soil has no more capacity to consume water and over flowing occurs. As study reported that saturated condition of soil to the plant cut off the oxygen supply chain and effect the plant but at the saturation level, gravity pulls water downward through the soil more rapidly.

2) Field Capacity

Field capacity is the excessive water from the certain limit and drained freely from the soil, same like the sponge dip into the water and when pull out from the water excessive water drain from the sponge. Study suggested that when the water in the root zone of the plant reaches to field capacity should be stop before drain situation. In the process of design and development of soil moister sensor field capacity is taken into account and use this values as the basis for the other settings.

3) Maximum Allowed Depletion (MAD)

The condition plants showing some sign for stress or need water, in other words the moisture contents in soil decrease from certain level and plants required water. Usually, irrigators provide water to the plants when see in stress condition so to solve such issue baseline can be design in soil moister sensor to show maximum allowable depletion (MAD). The Baseline soil moisture sensor can automatically set a MAD threshold based on the measurement of field capacity.

4) Soil Characteristic

Generally all types of soils provide food and water to the plants through roots. Soil is made off different types and each type of soil has different characteristic. In soil naturally pores occurs which allow water to penetrate through cohesion and adhesion process and complete the circle. Normally, in sandy soil the pores and particles adjustment compare to clay soil is larger and soil particles and water retaliation compare to clay soil in sandy is low. Soil characteristic and water absorption capacity is important to understand for the plant water irrigation, as stated depending on the type of the soil and available pores space, water will either penetrate and drain quickly (as in coarse-textured soil made up largely of sand) or water will penetrate and drain slowly (as in fine-textured soils made up largely of silt or clay). The Baseline soil moisture sensor makes this process much easier by simply measuring the moisture content in the soil.

III. XPERIMENTAL SETUP

The development of automated irrigation system is mainly consist of three stages; electric circuit board simulation, hardware assembling and hardware testing.

A. Simulation of the Electric Circuit Board

Proteus ISIS Professional 7 software is used in this study. This software is a simulation and PCB design software. Integrated real time simulation of the electronic circuit is designed to check whether working properly or not. Simulation of the circuit is shown in Figure 2; the proposed circuit consists of LCD display, electric solenoid valve for water, relay and humidity sensor. This simulation is successfully test by assembling real time hardware.

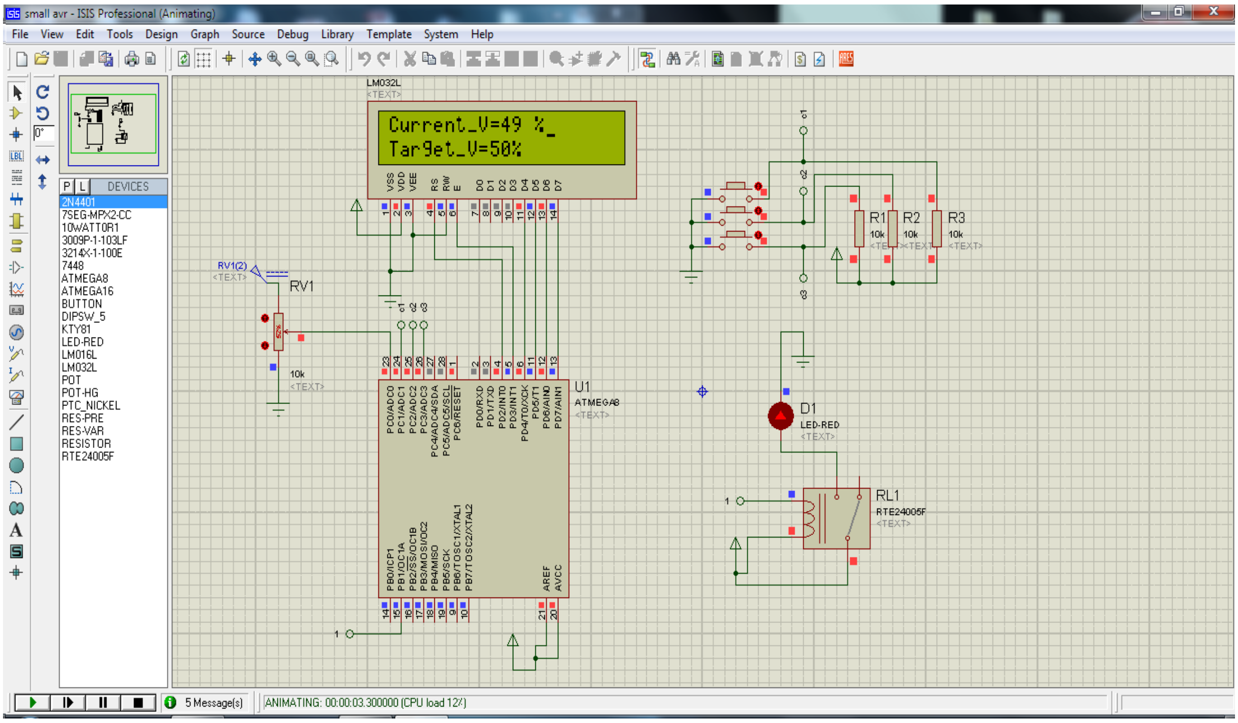

Figure 2. Simulation of circuit board

B. List of hardware Accessories Used

1- Humidity Sensor
2- Amplifier of the Soil Humidity
3- Electric Solenoid Valve for water
4- Relay
5- Protection circuit
6- Liquid crystal Display (LCD)
7- 12 Volt Battery or (PV panel)

1) Humidity Sensor

To detect moisture contents in the soil humidity sensor is used in this study. The sensor is assembled in the circuit board according to the design and pins are inserted in the soil to detect the percentage of soil moisture. The output of the sensor is high when the soil is wet and it is low when the soil is dry. This situation happens because of the presence a lot of OH- and H2 from water molecule (H_2O) and vice versa. Figure 3 and 4 shows the humidity sensor and schematic diagram.

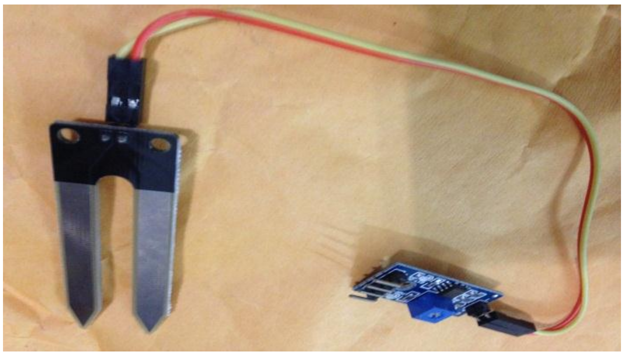

Figure 3. Humidity Sensor

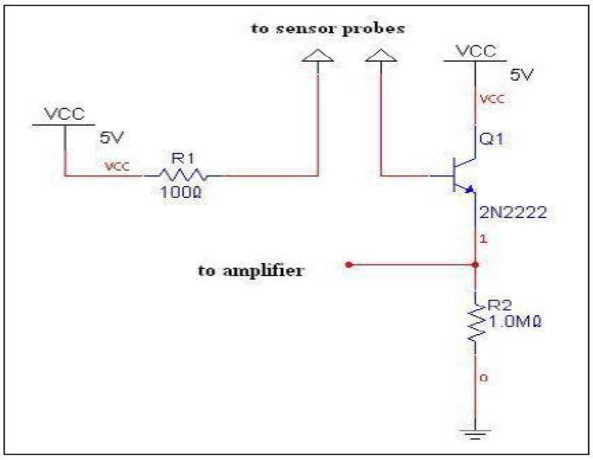

Figure 4. The Schematic Diagram of Humidity Sensor

2) Amplify the Soil Humidity

By measuring the output voltage value of the soil humidity sensor we realized that the maximum voltage produced by the sensor is 2.86 Volts. The maximum voltage reference applied to AVR microcontroller is 5 Volt. In order to get accurate conversion of the voltage analog value to digital, the voltage of the sensor must be amplify to the highest value equal to maximum voltage reference (5 Volt) for better calibration. Figure 5 below show the pin diagram for the operational amplifier.

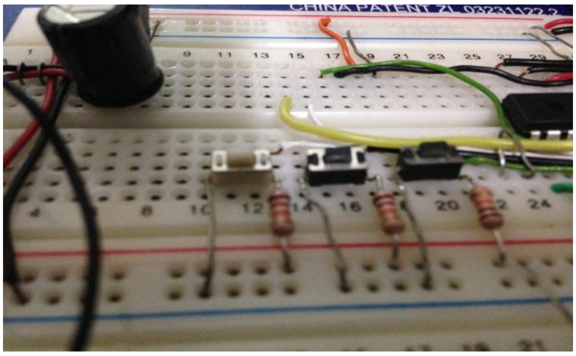

Figure 5. Pin diagram for the operational amplifier

3) Relay

A 5-pin single pole double throw type relay is used in this study. Relay circuit consist of a transistor used to amplify the small IC current to the larger value for the required relay coil. Also protection diode is used to prevent from the high voltage that is produced when a relay is switched off. Figure 6 shows the connection of the relay circuit.

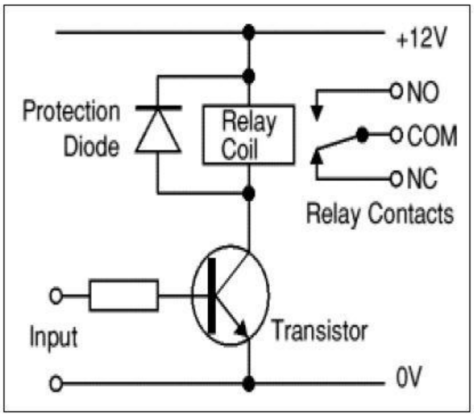

Figure 6. Relay Circuit

4) Electric Solenoid Valve for Water

Automatic switch on/off water supply pipe connection value is installed in this project. Figure 7 shows the valve used in this study and according to the moister content detector activation the valve will be automatically on and once the required water is supplied to the plant the valve will be automatically closed.

Figure 7. Automated on/off valve

5) Liquid Crystal Display (LCD)

LCD is used to display the humidity value percentage in the soil and measure by the sensor. LCD display is used in this project is 2x16(Two rows and 16 Columns). Figure 8 shows interface connection of LCD.

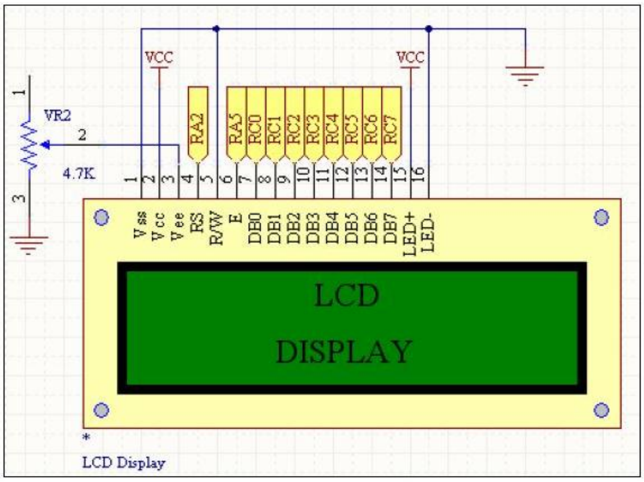

Figure 8. LCD Display Schematic Diagram

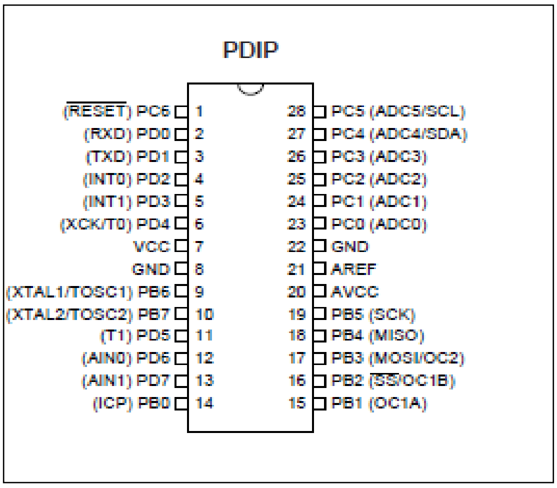

Figure 9. MEGA 8 AVR pin diagram

6) Control unit

AVR microcontroller is selected as a control unit and its interface among sensor, LCD and relay. Control unit receive the data from sensor. The control unit selected for this project is AVR microcontroller manufactured by ATMEL Company. The control unit is used to interface among sensor, LCD display and electric solenoid valve. It will receive the calibrated humidity data in form of voltage, convert them and sent the data to be displayed on the LCD. The microcontroller type is ATmega 8. The characteristic of the mega 8 AVR microcontroller is listed in the Table 1 and Figure 9 shows the pin diagram of control unit.

TABLE I. CHARACTERISTIC OF AVR

Feature	AVR ATMEGA 8
Operating Frequency	16 MHz
Program memory	8 KB
DATA EEPROM	512 Bytes
Interrupt Sources	External and Internal Interrupt Sources
INPUT/OUTPUT Lines	23 Programmable I/O Lines
Internal SRAM	1K Byte Internal SRAM
Timers	Two 8-Bit Timer and One 16-Bit Timer
Time Counter	Real Time Counter with Separate Oscillator
Accuracy Channels	Four Channels 10-bit And Two 8-bit
Sleep Modes	Idle, ADC Noise Reduction, Power-save, Power-down, and Standby
Operating Voltages	4.5 - 5.5V
Speed Grades	0 - 16 MHz
Power Consumption at 4 Mhz, 3V, 25°C	– Active: 3.6 mA – Idle Mode: 1.0 mA – Power-down Mode: 0.5 µA
Package	28 Pin
Security	Programming Lock for Software

IV. HARDWARE ASSEMBLING

In the circuit board designed, microcontroller is connected directly from AC to DC adaptor. The function of the microcontroller is to supply power and switch on the control unit.

The humidity sensor installed in the soil will start function to measure present humidity and data will sent to the control unit in voltage and will proceed to Mega 8 AVR microcontroller unit because microcontroller has ability of 8-bit analog to digital converter. Digital converter will change the data into actual value of humidity and displace on the connected LCD. Based on design and instructed humidity if find less control unit will sent message to the Electric Solenoid Valve to start supply water to the plant until desired quantity supply and then switch off to stop overflow or extra supply of water because this project stress to reduce water supply and provide enough water to the plant according to the humidity and requirement of the plant. Figure 10 shows the designed circuit board used in this study.

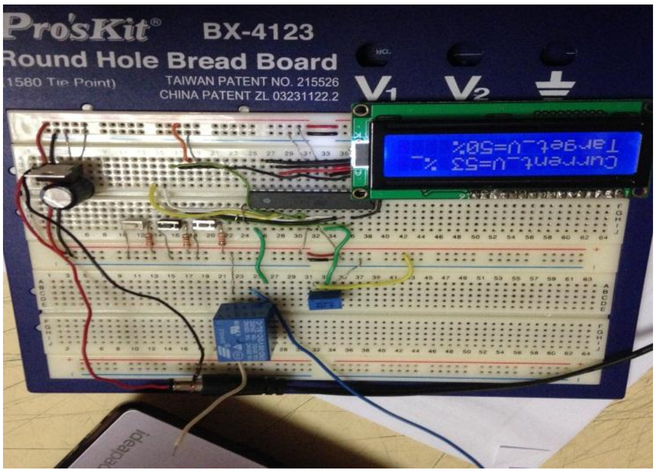

Figure 10. Hardware / circuit board

V. DISCUSSION

The circuit board/hardware configuration was completed and sensor is installed in the soil for the Tomato tree plant as shown in the Figure 11. Electric power is supplied from the connected 12 V battery, LCD screen start function and showing welcome. Electric solenoid valve has inlet and outlet pipes inlet is connected to the source of water (Tub) while outlet is connected to the plant showing water supply from the source of water to the plant soil after receive instruction from control unit in case humidity is less than the required limit so water supply has successfully made from the source to the plant soil.

Figure 11 shows the circuit board is connected accordingly such as sensor was inserted into dry soil, Electric solenoid valve is connected between water tub and the plant soil and control unit is connected with power supply from 12 volts battery. Moreover, power supply switch on and sensor sent data to the control unit. Control unit pass the data to LCD to display and sent data to Electric solenoid valve to open and water supplied to the soil sensor inserted. Once the required humidity level achieve in soil sensor sent data to control unit and water supply discontinue automatically.

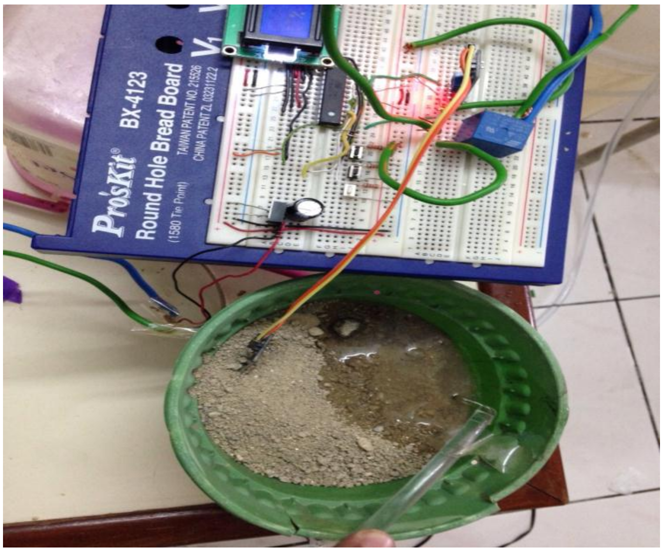

Figure 11. water supply to the soil

Experimental study has been carried out in this project; by simulation and assembled hardware consist of humidity sensor connected with control unit. If humidity sensor found less moisture contents in the soil send data/message to control unit which convert and display on the LCD screen further message generate and send to the on/off water supply valve. As the electric solenoid valve receive the message take the water from the inlet source and supply to the soil where sensor is fitted. When the water level reach to required level of humidity sensor generate another message to discontinue water supply and this way this automated irrigation may function.

VI. CONCLUSION

The aim of the project was to develop automated water supply system to the plant for irrigation based on the humidity present in the soil. The scope of the study is to reduce over irrigation and reduce water supply. This project consists of circuit simulation and hardware design. Several hardware components were installed in the circuit to ensure hardware safely work on all conditions. Sensor, 8-mega AVR microcontroller, LCD and electric solenoid valve plays major role in this project.

Humidity sensor used in this project to measure the present humidity in the soil and send the data to the control unit which instructed further to complete the process of water supply to the plant sensor is fitted. Once the required level of humidity is achieved in the soil another message sent to the control unit to stop water supply and instruction is followed by electric valve connected in circuit. Designed project was tested and operation function was noted during the process and successful practice of this project recommend to use in the irrigation project to save the water and over irrigation.

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