Structure of Soil Moisture Sensing Electronic Irrigation System

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***Abstract* — Appropriate environmental conditions are necessary for optimum plant growth, improved crop yields, and efficient use of water and other resources. Automating the data acquisition process of the soil condition allows plant growth with less labor requirement. This project on "Structure of Soil Moisture Sensing Electronic Irrigation system" is intended to create an automated irrigation mechanism that turns the pumping motor ON and OFF on detecting the moisture content of the earth. In the domain of farming, utilization of appropriate means of irrigation is significant. The benefit of employing these techniques is to decrease human interference and still make certain appropriate irrigation. The objective of this project is to design a simple, easy-to-install microcontroller-based circuit to monitor and record the values of soil moisture levels that are continuously modified and controlled to optimize them to achieve maximum plant growth and yield. This automated irrigation project brings into play an Arduino board ATmega328P microcontroller used is a low power, cost-efficient chip by ATMEL that is programmed to collect the input signal of changeable moisture circumstances of the earth via a moisture detecting system. An integrated Liquid crystal display (LCD) is also used for the real-time display of data acquired from the sensor and the status of the various devices. Also, the use of easily available components reduces manufacturing and maintenance costs. The design is quite flexible as the software can be changed at any time. It can thus be tailor-made to the specific requirements of the user This makes an efficient system for optimization of yield with minimum use of water. This system is also economical, portable, and user-friendly.**

Keywords: Arduino, Irrigation, Soil Moisture Sensor, Electronic Irrigation Mechanism.

I. INTRODUCTION

85% of water is used in agriculture in the world water resources, this percentage will not change keeping mind the rate of population growth and hence leading to the high demand of food [1]. Some of the countries are mainly known for agriculture and it can play a vital role in economic growth and development; such as Bangladesh, China, India, etc. Cultivation is the process of trying to acquire or develop a quality or skill. Although there are numerous factors that always want to monitor depending on environmental conditions such as soil moisture, water level, and temperature and farmers need to keep records. But agricultural lands are so far from home thus farmers need to go there and write the records which are so tedious work to maintain and remember it. Furthermore, farmers need to know about these factors for some period of time so that they can take appropriate actions such as to manage hardware (i.e. to switch on/off water motor), to spray pesticides, to keep records of factors, to achieve these activities farmer has to go to the farm field which is hectic work in this technological era. We can do these work utilizing a smart device, such as "Soil Moisture Sensing Automatic Irrigation System (SMSAI)" for smart irrigation. This device will regulate water flow in soil without human intervention while maintaining the moisture of the earth. This system will allow farmers to view farm field information such as sensor values, moisture level of soil, water level in the farm field.

II. RELATED WORK

lots of scientists are researching trying to reduce the water wastage amount used for irrigation of plants, using the different types of technology. It is a simple project more useful in watering farmland automatically without any human interference. Sometimes we forget to shut down the pump; also we delay starting the pump. As a result, there is a chance to get the plants damaged. This project is an excellent solution for such kinds of problems. Some of such researches in the agriculture field are summarized below. Many irrigation systems exit such as 1. Monitoring of rice crops using GPRS and wireless sensors for efficient use of water and Electricity. 2. Wireless Sensor Based Remote Monitoring System for Agriculture Using ZigBee and GPS. 3. Design of Embedded System for the Automation of Drip Irrigation. 4. A Survey of Automated GSM Based Irrigation System. 5. Wireless Sensor Networks Agriculture: For Potato Farming. 6. Design and Implementation of GSM-based Irrigation System Using ARM7. 7. Automated Irrigation System Using a Wireless Sensor Network and GPRS Module. 8. Automated Irrigation System Using Solar Power. 9. Review for ARM-based agriculture field monitoring system. 10. Automatic Irrigation Control by using wireless sensor networks. 11. Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network.

III. RESEARCH METHODOLOGY

Automation of the irrigation system is gaining importance as there is a need to use water resources efficiently and also to increase field productivity. This system turns the pump ON or OFF automatically as per the water requirement of the plants. The system is used for sensing, monitoring, and controlling purposes. It consists of sensors, a microcontroller, an LCD display, and a water pump or motor. The working method of the project is divided into two parts: firstly, parameter measurement; secondly, execute the irrigation system. The moisture sensors are inserted into the soil, which will record the value and transfer it to the microcontroller. The microcontroller then displays this value on an LCD screen. The values will be displayed on the screen one by one at an interval of 10 seconds. The second part of the circuit is the automatic irrigation system. A moisture sensor is inserted into the soil, this sensor will record the moisture level in the soil and send this value to the microcontroller. The microcontroller then compares this value with a certain predefined value. This predefined value can be set by us as per the crop because different crops need different amounts of water. If the moisture level in the soil drops to a particular value, the water pump will be turned ON and the process of irrigation will begin. During this time, the moisture sensor will continually send the moisture value in the soil to the microcontroller. After some time when the moisture level in the soil reaches a particular level, the water pump will be automatically switched OFF. In this way, the circuit performs the task of irrigation.

IV. IMPLEMENTATION DETAILS

A. Block Diagram and Working Principle:

There are two functional components in this project. They are the moisture sensors module and the motor driver for the motor pump. The function of the moisture sensor is to sense the temperature level in the soil, and also it measures moisture level in the soil. The motor driver interrupts the signal to the water pump which supplies water to the plants. This project uses a microcontroller to control the motor and monitor soil moisture. Follow the schematic to connect the microcontroller to the motor driver, and the driver to the water pump. The motor can be driven by a 5-volt battery; we can also supply power from an external source.

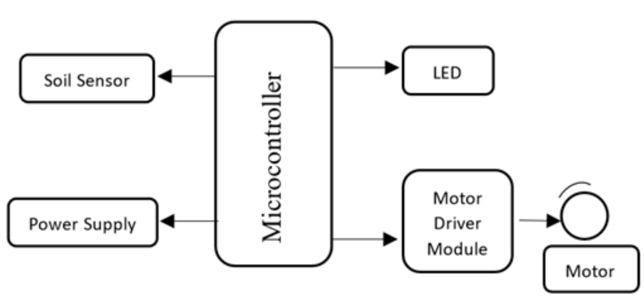

Fig. 1. Block diagram of the system

The above fig.1 shows Microcontroller based irrigation system proves to be a real-time feedback control system that monitors and controls all the activities irrigation system efficiently. The present proposal is a model to modernize the agriculture industries on a small scale with optimum expenditure. Using this system, one can save manpower, water to improve production and ultimately profit.

B. Circuit Diagram:

Here in this fig.2 soil moisture sensors are connected to Arduino A0 pin for analog input, so we can get the temperature content present in the soil. Vcc pin is connected through 5V Arduino pin; GND pin is representing ground connect all components. D7 is known as a digital pin, so it is connected with transistors to amplify low power. Motor driver module Vcc pin-connected through D13 pin of Arduino board, based on temperature monitor it passes the current to the motor pump, D7 pin is used for Ground. We can write values as output. D7 is connected through resistors 1k and the same connection goes through transistors for low amplifying current.

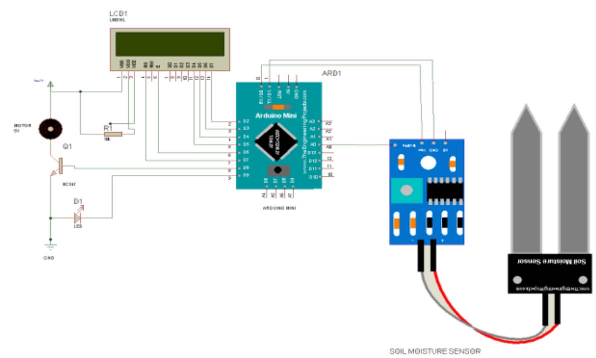

Fig. 2. Architecture diagram

List of the components used in the system:
1. Arduino Pro mini 2. ATmega328P microcontroller 3. YL-69 Moisture sensor 4. Digital Potentiometer 5. Comparator 6.LCD (16*2) 7. Motor 8. Transistor 9.LED 10. Resistor 11. Power supply

Programing Structure:

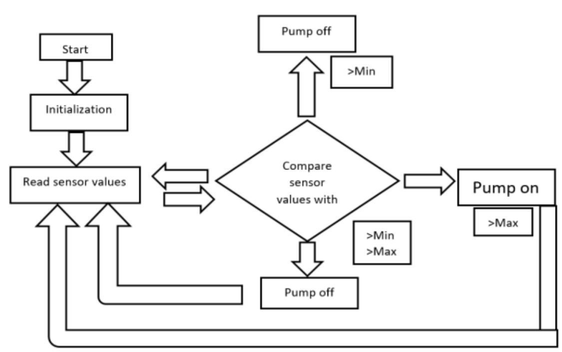

Fig. 3. The program flow Diagram

Program Pseudo code: READ sensorvalue COMPARE sensorvalue with set threshold IF sensorvalue > maximum set value TURN-ON pump DISPLAY soil condition on LCD LIGHT dry soil LED ELSE IF sensorvalue < maximum set value > minimum set value TURN- OFF pump DISPLAY soil condition on LCD LIGHT moist soil LED ELSE IF sensorvalue < minimum set value TURN-OFF pump DISPLAY soil condition on LCD LIGHT soggy soil LED.

Experimental Analysis: When the system is OFF, process will shut down, otherwise it will go beyond the certain limit and LED will be turned on according to the humidity, temperature, and other sensing elements. Likewise, it will be displayed on the LCD display to check and control the process. This analysis done without manpower by automatically and LED will be turned ON and it will improve the efficient use of energy-saving.

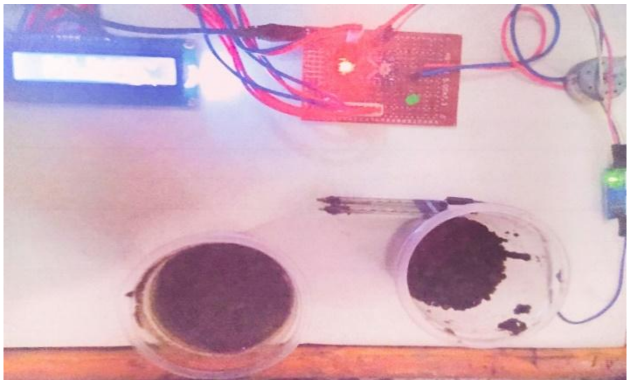

Fig. 4. Final Design of the Project

Hardware design: **Control Unit**: ATMega328 microcontroller on Arduino platform *ATMega328 the* microcontroller on the Arduino platform was selected as the control unit of the microcontroller. Arduino Pro mini was selected from the expansive Arduino family. Arduino Pro mini has a total of 20 inputs pins of which 14 are digital and 6 are analog inputs. The digital pins can be used as either inputs or outputs and also 6 of the 14 pins can be utilized as PMW. The board has a 16 MHz ceramic resonator, a USB connection, and a power jack. In the design of the system, analog pins were selected as the Arduino input and digital pin was selected as the Arduino output pins. Other important pins on the Arduino board are shown in the table below.

TABLE I. IMPORTANT PINS ON ARDUINO

AFER	***Analog Reference pin***
GND(Digital Side)	Digital Ground
Vin	Input Voltage (External Power Source)
5V	Regulated Power to the microcontroller
3.3V	3.3V Generated by the on-board FTDI chip
GND	Ground

Appendix

Source Code;

Microcontroller code;

TABLE II. ARDUINO PROGRAMING CODE

```
# Objectives: Micro-controlled Irrigation System
# Behavior: When the soil is dry-Water pump starts
running
# Author: MD. Tariqul Islam

// include the lcd library code:
#include <LiquidCrystal.h>
// pins definition
intsoggyLEDPin = 8;
intmoistsoilLEDPin = 9;
intdrysoilLEDPin = 10;
intPumpPin = 7;
// initialize the library with the
numbers of the interface pins
LiquidCrystallcd(12, 11, 5, 4, 3, 2);
// variables
intmoistureSensorValue;
// stores the moisture sensor values
int j = 0;
void setup(){
// serial initialization Serial.begin(9600);
44
// Arduino pins initalization
pinMode(soggyLEDPin, OUTPUT);
pinMode(moistsoilLEDPin,OUTPUT);
pinMode(drysoilLEDPin,OUTPUT);
pinMode(PumpPin,OUTPUT);
// set up the LCD's number of columns and rows:
Icd.begin(16, 2);}

void loop(){
moistureSensor Value = analogRead(4);
// reads the sensor
if(moistureSensorValue< 300){
//Serial.println("The soil is too Soggy");
// in case of soggy soil:
Serial.println (analogRead(4));
//LED for Soggy lights up
digitalWrite(drysoilLEDPin,LOW);
digitalWrite(moistsoilLEDPin,LOW);
digitalWrite(PumpPin,LOW);
        digitalWrite(soggyLEDPin,HIGH);
// system messages via LCD
Icd.clear();
Icd.setCursor(0,0);
Icd.print("Soil Soggy");
}
// in case of moist soil:
if((moistureSensorValue< 700) &&
(moistureSensorValue>300)){
//Serial.printin("Moisture
// in case of moist soil:
if((moistureSensorValue< 700) &&
(moistureSensorValue>300)){
//Serial.printin("Moisture
Content is OK");
Serial.printin (analogRead(4));
45
//LED for moist lights up
digitalWrite(drysoilLEDPin,LOW);
digitalWrite(moistsoilLEDPin,HIGH);
digitalWrite(soggyLEDPin,LOW);
digitalWrite(Pump Pin,LOW);
//system messages via LCD
Icd.clear();
lcd.setCursor(0,0);
Icd.print("Moisture OK!");
}
```

```
//in case of dry soil:
if(moisture Sensor Value> 700){
//Serial.print In("The Soil too dry");
Serial.print In (analog Read(4));
I/LED for DRY lights up
Digital Write(drysoil LED Pin,HIGH);
digital Write(moistsoil LEDPI,LOW);
digital Write(soggy LED Pin,LOW);
digital Write(Pump Pin,HIGH);
// system messages via LCD
Icd.clear();
Icd.set Cursor(0,0);
Icd.print("Soil Dry!");
Icd.set Cursor(1,1);
lcd.print("Pump Running"); {delay(1000); }
```

V. RESULT AND DISCUSSION

A. Results

The VWC of sand soil, red soil and loam soil were calculated. The raw data collected from the soil moisture sensor was recorded as shown in table 3. The soil was measured in equal amount of 250gramms. Water was added in the soils in steps and the sensor values recorded.

TABLE III. SENSOR VALUES

Soil Water Content (cm^3)	Sensor Reading		
	Loam Soil	***Sand Soil***	***Red Soil***
0	1021	1022	1020
50	580	546	781
75	360	243	568
100	237	243	295
125	203	184	274
150	191	180	235
175	180	170	220

B. Discussion

The data obtained from the sensor reading and recorded in table.3 was used to plot a graph of Soil water content against sensor reading.

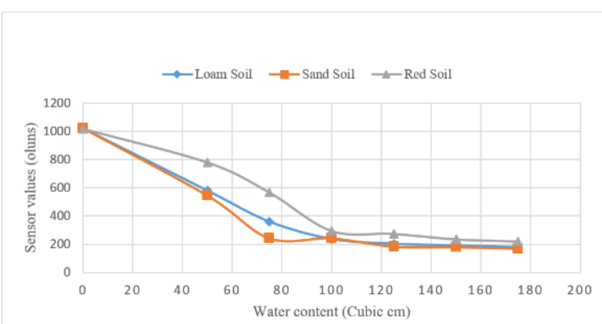

Fig. 5. ine diagram of sensor values

The SMS (YL-69) used is a resistance sensor type. Its output is the resistance in the soil between the two SMS probes. The obtained graph is an exponential one. The value of the soil resistance decreases with an increase in water content to a certain point. To come up with the results the three soils were dried using a frying pan until all the moisture content was lost. 250 grams was measured for the red soil, loam soil, and sand soil. Water was added in steps of $25cm^3$ and sensor value was recorded. The value of the soil sensor at dry soil was almost equal for the three soils at 1021, 1022, 1020 for loam soil, sand soil, and red soil respectively. On adding $50cm^3$ the resistance value reduced drastically to the range of 500. On adding more water, the resistance value kept reducing. At around $100cm^3$ of water, the reduction on the soil resistance stated reducing at a much lower rate. This is because at this point the soil is now becoming saturated with water and thus adding more water has a small effect on the soil resistance. The sensor was calibrated and three states defined. The states are soggy, moist, and dry. When the dry state was achieved the control unit (microcontroller) switched the water pump on via a relay circuit. The three states were indicated using three different LEDs and an LCD. The LCD also indicated when the pump was running. The control circuit and the sensor circuit were powered using a 9V alkaline battery which was connected via a voltage regulator with an output of 5V.

Summary: The output from the moisture sensor and level system plays a major role in producing the output. Irrigation becomes easy, accurate, and practical with the idea above shared and can be implemented in agricultural fields in the future to promote agriculture to the next level.

VI. CONCLUSION AND RECOMMENDATIONS

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 rainwater harvesting, it could lead to huge water savings if applied in the right manner. In agricultural lands with the severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

***Main Limitations and Constraints*:** The key factors where attention should be focused towards resource-efficient soil-moisture based irrigation practices are reported below.

- Preliminary evaluation of site-specific conditions.
- Adequate selection of soil moisture sensors.
- Proper site-selection, sensors installation and maintenance.
- Correct interpretation and use of soil moisture data.

Future Scopes of the Work: The proposed system can be extended in the future by adding the feature for remotely monitoring sensors that can detect crops growth and livestock feed levels. In the future adding of feature that remotely manages and controls their smart connected other irrigation types of equipment in the proposed system.

Recommendations: To improve on the effectiveness and efficiency of the system the following recommendations can be put into considerations:

Cost effective techniques to overcome the limitation of requiring a soil specific calibration should be employed.

- Integrating GSM technology can be used, such that whenever the water pump switches ON/OFF, an SMS is sent to the concerned person regarding the status of the pump.
- The pump should also be controlled via SMS.
- The system can be integrated with temperature and humidity sensors to monitor the weather conditions in the farm.

Based on the gathered results and obtained data, the following recommendations were drawn: The researchers recommend that this research may be used as a reference for further development of new methods and devices for watering and protection system of the plantation, such as: adding a CCTV camera to monitor the daily watering of plants and animal disturbances, adding a light post within the vicinity or corners of the plantation area, adding and mixing of fertilizer to water which may flow in every plot that can help the plants grow faster and lastly, it can expanding the system and study the implementation of the system in a large scale plantation.

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