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Effect of Moisture Content in the Sandy, Clay and Loamy Soil using Humidity Sensor YL69

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Abstract: ***This paper focuses on automated irrigation system. YL69 (Humidity sensor) measures and analyses the behavior of the moisture content in the soil. The UNO Arduino and PID controllers are adopted to obtain the data for different percentage of moisture content present in the soil. GSM module provides information regarding the moisture content of the soil to the farmers. Fraction of total volume of soil occupied by water is measured. Results show that the moisture content of the soil increases linearly from 0% to 25% with the change in percentage of water present in sandy soil, loamy soil, clay soil and becomes constant after it reaches 20%, 25% and 30% respectively. The above technique automatically operates and controls the watering system of farmers***.

Keywords: YL69 Humidity sensor, UNO Arduino, PID Controller, GSM Module

1. Introduction

India is an agricultural country and agriculture is the main occupation here, two – third of population is dependent directly or indirectly on agriculture. The Indian economy is basically agrarian. Agriculture is backbone of Indian economy in spite of Industrialisation and economic development. As Mahatma Gandhi said "India lives in villages and agriculture is the soul of Indian economy". Agriculture does not only provide source of income but also provide nourishment of our daily intake. Without giving serious attention to agriculture any country can become economically unstable and paralyzed. To improve agriculture sector in India automation is required. This Automated irrigation system focuses on controlling and analyzing healthy water balance in irrigation system. This results in expanding crop production rate and crop quantity which in turns reduces cost of production for farmers and food cost for consumer and even make crop more nutritious. It also minimizes the wastage of water.

This Automated system mainly consist of 3 units i.e. sensing unit, processing unit, actuating unit. For sensing operation various sensors are used. Some of them are Tensiometer, Heat dissipation sensor, homemade moisture sensor and YL69 moisture sensor.

Tensiometer measures moisture content by measuring surface tension of the soil. Homemade sensor uses soil conductivity to measure moisture content and Heat dissipation sensor measures amount of heat dissipated by soil to estimate moisture content but none of the above sensors are accurate. YL69 moisture sensor is used in this system because of its accuracy and low power consumption. It consist of two electrodes, the current is pass through these electrode and the value of resistance is measured. Sensor panel is attached with a printed circuit board which consist of LM933 comparator chip and a digital potentiometer. This board has both digital and analog output. YL69 sensor can be used for comparative study of soil moisture sensor material by using different types of soil [1] and for measuring moisture content with different Arduino base automated irrigation system [2].

For processing operation UNO Arduino is used. Other controllers can also be used for this unit, some of them are 8051 microcontroller, PIC microcontroller, AVR Microcontroller. 8051 microcontroller is one of the oldest chip available commercially but it does not have inbuilt memory bus and ADC. PLC microcontroller is slightly older than 8051 with low pin count and its programming part is very tedious. AVR is a single chip controller loaded with C-Compiler and free IDE (Integrated development environment) but it is difficult to work with it because of CISC processor. In this system UNO Arduino is used. Arduino is an open source electronic prototype platform enables the user to write code and load to the Arduino memory so that system can respond the physical change. It has its built in 32K byte of flash memory, 1K byte EEPROM, 2Kbyte of RAM. It also have 8-bit bi-directional I/O port with internal pull-up registers. UNO Arduino can be used with low cost homemade moisture sensor [3]. UNO Arduino platform can also be used to teach digital control of power electronics [4] and data acquisition [5].

For actuating unit, servo motor and T-Type valve is selected. Servo motor is used because of its smooth functioning, high torque, fast and accurate rotation. It rotates between 0^0 to 180^0.For networking purpose GSM shield is used. All the above units combine to form an irrigation system which can detect the moisture content and set the actuator so that required set point range of moisture content is achieved.

2. Experimental Analysis

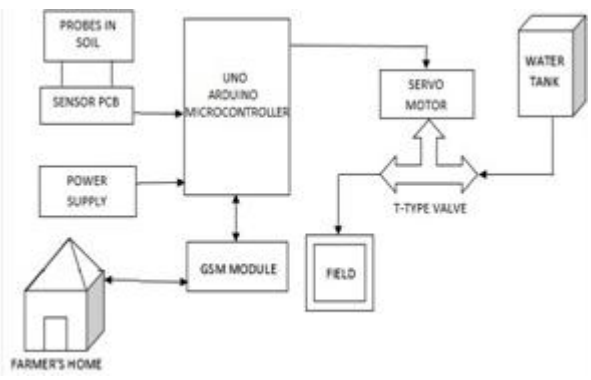

Figure 1: Block Diagram

Figure 1 shows the block diagram of the automated irrigation system. YL69 Soil moisture Sensor is connected with Arduino processor through sensor PCB chip. GSM shield and servo motor are also connected with Arduino. Shaft of Servo motor is connected with T-type valve which is connected with water tank from one end and irrigation pipe from another end. GSM shield is connected with Arduino to make connection with farmer's home for transmitting the data.

2.1 Sensor

The soil moisture sensor YL-69 shown in Figure 2 commercially available is used to sense the moisture content of the soil. It requires 3.3 volt to 5 volt power supply and its signal output voltage is 0 to 4.2 volt. Its panel dimension is 6cm x 2cm.Distance between two sensing probes is 1.3 cm. For better and accurate output 3cm of sensor panel is dipped inside the soil exactly perpendicular to the soil surface. It consist of two probe s1 and s2 provides analog voltage which is praportional to moisture content of the soil. The voltage developed accross the probes is the differential voltage. The principle involved in this is the conductivity of soil is in turn is directly praportional to the moisture content of the soil.

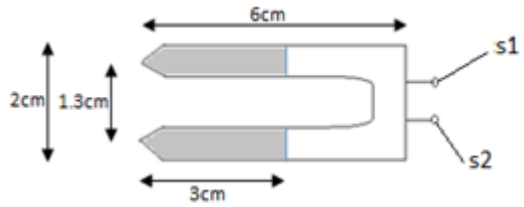

Figure 2: YL69 Soil Moisture Sensor

The differential voltage of the sensor output is compared with the reference voltage using LM933 comparator which is derived from calibrated potentiometer as shown in Figure3.

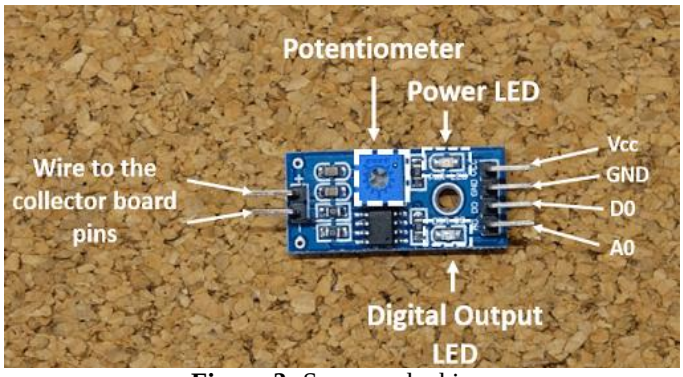

Figure 3: Sensor pcb chip

Sandy, Clay and Loamy soil samples with different moisture content are tested using YL69 sensor and corresponding moisture values are measured. Moisture measurement is the amount of water present in the soil. [3]

2.2 Processor

Moisture measurement from sensing unit is fed to the UNO Arduino processor. This processor is loaded with a program which is written in C-language. Set point value is fixed according to the requirement and loaded to the processor. The processor will control the water flow for different set points. [4]. Figure 4 shows UNO Arduino processor. It consists of 16 MHz crystal oscillator. ATMEGA 328 microcontroller IC. It has separate analog and digital I/O pins.

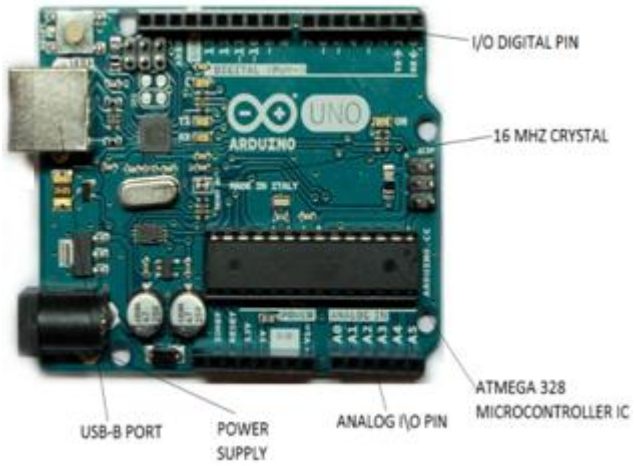

Figure 4: UNO Arduino

2.3 PID Controller

PID (Proportional Integral Derivative) controller technique is used to control the water flow. Figure 5 shows the control system for controlling the water flow into the irrigation system by using PID controller. The basic idea behind PID controller is to read the error (Measured – set point) and compute the desired actuator output by calculating Proportional Integral and Derivative (PID) response of error. The summation of the above three component actuates the Motor (M).

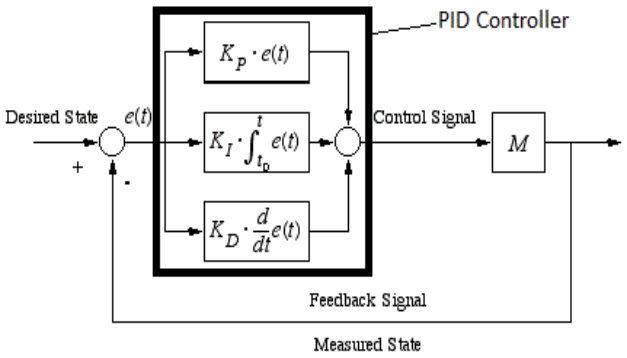

Figure 4: PID Block Diagram

After the tuning of PID is done by Kp, Ki and Kd controller, it determines which parameter is to be considered to obtain proper gain in order to actuate the motor.

2.4 Actuator

Tower pro SG90 servo motor with T-type valve are used as an actuator. It converts electrical energy into mechanical energy in turn the disc rotates in the clockwise direction. Its rotating range is between 0^0 to 180^0. Rotating servo motor is connected with the one end of T-type valve as shown in Figure 6. Servo motor rotates to control the flow of water. Input valve is connected with the water supply or water source (tank).This water flow made to pass through feed screw controller or barrier which is rotated by servo motor and generates the controlled output.

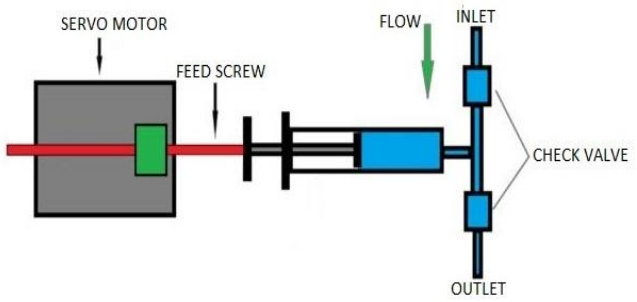

Figure 6: Working of T-type valve

Angle of motor is mapped according to the output of the PID controller. The output of PID controller varies from 1-5 volt which rotates the servo motor from 0^0 to 180^0 indicates the output voltage of controller. For each 1 volt change in PID output the shaft of servo motor rotates 36^0 i.e. for 1 volt angle is 36^0, for 2 volts angle is 72^0, for 3 volt angle is 108^0 , for 4volt angle is 144^0 and for 5 volt angle is 180^0.

Feed screw is tuned such that at 0^0 angle the feed screw is completely open and input is equal to output, and at 180^0 thefeed screw completely closes so that no water can transfer through the valve. Figure 7 shows the T-type valve connected with servo motor.

Figure 7: T-type valve with servo motor

GSM module is used for data communication. Arduino is interfaced with GSM shield. Shield is provided with a SIM slot which allow Arduino board to make phone call, send SMS and connect to internet shown in Figure 8. GSM shield transfers important information from system to farmer. [5]

Figure 8: GSM Shield

2.5 Set point estimation

Estimation of set point varies from place to place because of variable soil type and rainfall. Set point also depends on the type of crop in the field. Three major types of crops are Kharif, Rabi and Zaid. Season required for Kharif crop is hot and humid. Rabi require warm climate for generation of seed and cold climate for the growth. Zaid required warm dry weather for major growth correspondingly Sandy, Clay and Loamy soil also effects the set point range.

3. Results and Discussion

Three types of soil sample are analysed.
1) Measurement of moisture content in clay soil.
2) Measurement of moisture content in sandy soil.
3) Measurement of moisture content in loamy soil.

Different soil sample with different moisture content are analysed and respective moisture contents are absorbed to know the behavior of YL69 sensor.

Table 1: The variation of measured moisture content of the clay soil with actual moisture content present in the clay soil

Actual moisture content in soil	*Measured moisture content in soil*
0%	0%
12%	45%
13%	80%
19%	90%
28%	98%
30%	100%
40%	100%

Figure 9 represent the graph of moisture content in clay soil. Moisture content increases linearly with increase in water content and become constant after 30% water to soil ratio. For this type of soil suitable set point range for better crop yield should be taken between 15% to 18%. Set point range shows that clay soil retain high volume of water.

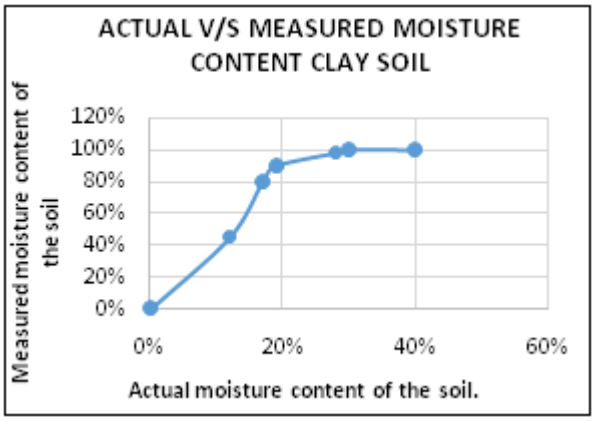

Figure 9: Graph for clay soil

Table 2: The variation of measured moisture content of the loamy soil with actual moisture content present in the soil

Actual moisture content in soil	*Measured moisture content in soil*
0%	0%
4%	16%
7%	40%
20%	70%
25%	100%
35%	100%
40%	100%

Figure 10 represent the moisture content in loamy soil. Measured moisture content increased linearly with increase in water content and become constant after 25% water to soil ratio.For this type of soil suitable set point range for better crop yield should be taken between 11% to 15%.

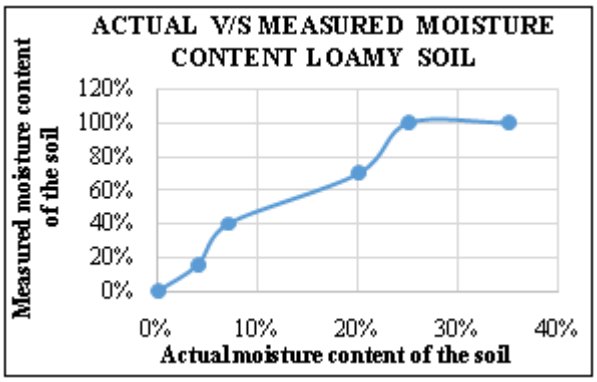

Figure 10: Graph for Loamy soil

Table 3: The variation of measured moisture content of the sandy soil with actual moisture content present in the sandy soil

Actual moisture content in soil	*Measured moisture content in soil*
0%	0%
5%	15%
7%	23%
12%	51%
16%	76%
20%	100%
25%	100%

Figure 11 represents the graph of measured moisture content in sandy soil. Moisture content increased linearly with increase in water content but it become constant after 20% water to soil ratio.For this type of soil suitable set point range for better crop yield should be taken between 7% to 11%. Set point range shows thatSandy soils retain less volume of water.

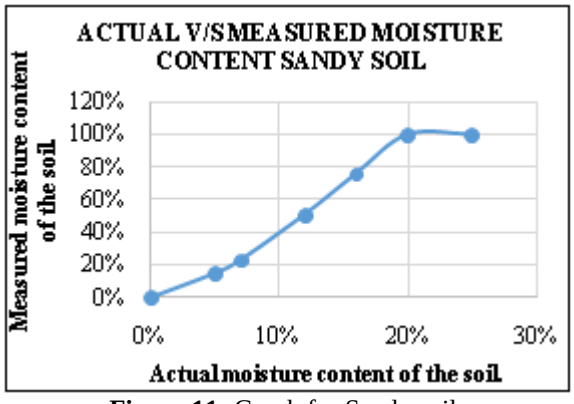

Figure 11: Graph for Sandy soil

4. Conclusion

In this study automated watering system is designed and behavior of moisture content in Clay, Loamy and Sandy soil are analysed to make the automated system more efficient. Measured moisture content in clay soil increases linearly from 0% to 30% and became constant. For loamy soil measured moisture content increases linearly from 0% to 25%and became constant. For sandy soil measure moisture content increases linearly from 0% to 20% and became constant. Experimental results demonstrate that clay soil retain high volume of water and sandy soil retain less volume of water.

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