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Automatic Irrigation System

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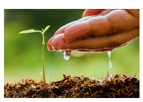
***Abstract*—The objective of our project is to detect soil moisture level in the fields and maintain it at an optimum level. Recently, there has been a sharp decrease in the availability of labour force in agricultural field and farmers are now heading towards automated systems. This project is an attempt in the direction to providing an easy and cost effective solution to automated irrigation. The data received from soil moisture sensors, coupled with information of water level in the tanks is used to trigger the operation of water pump(turning it on or off).**

I. Introduction



The agricultural sector is fighting against too many foes in the present world for its mere survival. Its time that technology, the prime deciding factor of the fate of virtually anything in todays world, extends its benefits to this crucial sector as well. Ours is a small effort directed for this cause.

We have designed an automatic irrigation system, that operates on the basis of data collection and processing of the soil moisture level and water availability.

Soil moisture sensors, plugged at points of interest, return quantitative data of the moisture level in the soil. This data is processed against a pre-fed data of optimum moisture level within an Arduino chip and the further course of action is determined based on the comparative results. This pre-fed data is based on optimum moisture levels for different crops in different conditions as recommended by the Indian Agricultural Research Institute. Parallelly, information regarding the availability of water is fetched via a float switch fixed to water tanks, which helps indicate the water level in these tanks. If the moisture content in the soil is below the required/optimum value, and water is available for irrigation, the Arduino switches the water pump on, and water is supplied to the required area. However, if the water level in the tanks is indicated to be low, no water will be pumped to the field, irrespective of the moisture content in the soil, thereby preventing any undue damage to the water pump. The soil moisture percentage, the water level and the pump status are very clearly indicated on a LCD screen that has been set-up alongside this entire system. Additionally, a Bluetooth module also sends this data to a specially calibrated android app on a mobile phone, and thus the data and process may be monitored by the user at all times and from anywhere. To add to these features, two LED lights, serving as simple indicators of the soil moisture level (red) and tank water level (blue) for the illiterate have been paired up with the system. Morover, the circuit checks moisture level during the time motor is on. If moisture level reaches optmum level, motor automatically turns off.

II. Details of devices and apparatus used:

A. Soil Moisture sensor module:

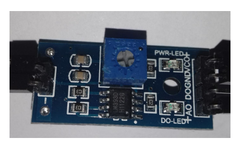


Fig. 1. LM393D comprator module

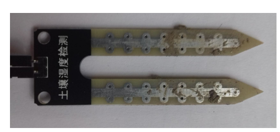


Fig. 2. Moisture Sensor Probes

Operating and principle

- The soil moisture sensor used in this project is LM393D comparator based moisture sensor. It senses volumetric moisture content of water present in the soil using resistance (and hence the potential difference) between its two probes.
- The voltage data is sent to comparator circuit where it is converted to return value in the range of 0 to 1023.
- This value is received at arduino pin number 1 for further processing.

B. LCD Module

Fig. 3. LCD Module

1) About device:

- A 16X2 JHD162A LCD(liquid crystal display) device was used.
- It has 16 pins. We used it in 4 bit operation mode to display the status of soil moisture, tank level and pump status.
- An already avaliable arduiono library LiquidCrystal.h was used to interface LCD with the main circuit.

C. Float switch water level detector

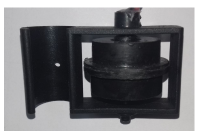


Fig. 4. Float Switch

1) About device:

- A magnetic conduction based float switch was used to monitor water level in the tank.
- It has a drum like floating part which when pushed upwards by water gets attached to upper bar conducts electricity and sends a HIGH signal and does not conduct when it is resting over the lower bar.
- When the switch conducts, HIGH signal is obtained, when it does not conduct, LOW signal is is obtained at arduino.

D. 9 V DC water pump circuit

Fig. 5. Submersible Pump

1) About device:

- A 9 V (volt) submersible pump was used to demonstrate water flow to the field. Along with it, a L293D moter driver IC and a (V battery were used as auxiliary components to drive it.
- A HIGH command to motor driver is used to run motor and LOW command is used to stop the m otor.

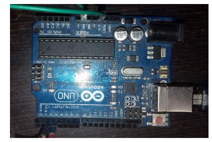


Fig. 6. Arduino

E. Arduino UNO R3 board

1) Operation:

- An arduino board was used in to control and give instructions to the components of the circuit. It makes use of ATmega328P to control commands. It has 14 digital and 6 analog input/output pins to connect it to other components of circuit.
- The programming language used to give instructions to it is in the form of C/C++. Pre generated libraries which contain function prototypes are available for it.

F. Bluetooth Module and android application:

Fig. 7. HC05 Bluetooth Module

1) About the device and app:

- A HC-05 Bluetooth modulewas used in the circuit to communicate between arduino and the android device to send data on soil moisture percetage, liquid level in the tank and pump status.
- Bluetooth module operates on the principle of radio waves to provide a wireless connection within the range of 30 meter. Android app used for receiving data is ArduTooth, which is available freely on Google PlayStore and can be easily modified to suit the requirements of the user.

III. Connection Procedure

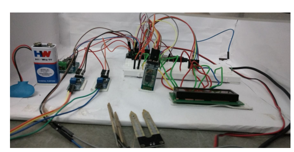


Fig. 8. Final System

A. Interfacing of the circuit

first of all, the soil moisture sensor was connected to the arduino. Then wires were soldered on pin numbers 1,2,3,4,5,6,11,12,13,14,15,16 of LCDE display module. Then pin numbers 1,3,5,16 (with a 330Ω resistor in series) to ground. Pins 2,15 were connected to Vcc (5 V), rest of pins

TABLE I
PINS OF ARDUINO USED TO CONNECT DIFFERENT COMPONENTS

Device	Pins used
Soil Moisture Sensor	A0
Float switch	A1
Motor Driver	A4,A5
LCD Module	pins8,9,10,11,12,13
Soil Status LED	4
Tank Status Led	5

were conected in series to pins 13,12,11,10,9,8 of arduino. For interfacing float switch with arduino, A1 pin was used to receive input and other terminal of float switch was grounded. Status indicator LED's were connected to pins 4 and 5 of the arduino with 330Ω resistors in series with them. Submersible pump was connected to the motor driver at motor 1 slot. pins A1 and A0 of motor driver were connected to A4 and A 5 of arduino. A 9 V battery is connected to motor driver to power the pump externally. Finally, the bluetooth module is connected to the arduino by connecting pin Tx to 1, Rx to 2, Vcc to 3.3V and GND to Ground.

For avoiding interference between the signals of soil moisture sensor and LCD module, a seperate ground is created for the pins of LCD.

B. Writing code and optimising bluetooth app

Fig. 9. A code snippet

For writing instruction code, arduino IDE (integrated development environment) software is used. The code is written using arduino programming language language and pre available arduino libraries LiquidCrystal.h and SoftwareSerial.h are used.

The android app contains a section for modifying it according to the format of output. Since we are displaying three output values and tha app is programmed to display 10 output values, we reduce the number of outputs to 3. The string display is also incorporated to show words 'HIGH' and 'LOW'.

IV. DATA ON OPTIMUM SOIL MOISTURE AND CALIBRATION OF THE SENSOR RETURN VALUE

This is most important part of this system. Since different crops need different levels of soil moisture for optimum growth, accurate calibration of moisture sensor according to different crops occupies paramount importance. The return value of moisture sensor is from 0 to 1023. map() function of aduino programming language is used to convert these values in the range of 0 to 100 percent. Data of volumetric moisture level requirement of some major crops for their growth period is collected. This data is divided by growing period to find the optimum moisture percentage required. Then, return value is taken and mapped according to required threshold moisture. This sets corresponding return value threshold. The table for reference is attached below:

TABLE II
OPTIMUM MOISTURE AND RETURN VALUES

Crop name	Percent Moisture	Return value
Rice	70	309
Wheat	40	610
Barley	38	620
Maize	56	450
Jute	60	410
Suger cane	5	
Coffee	30	718

V. WORKING OF THE CIRCUIT

The following flow diagram explains working of circuit in different situations:

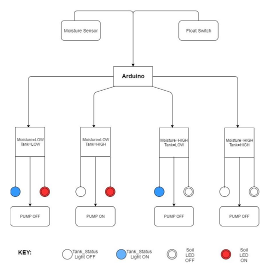


Fig. 10. Flowchart explaining working of circuit in different conditions

VI. IMPROVEMENTS WHICH CAN BE DONE

Due to limitation of pin inputs available on arduino, only one soil moisture sensor could be included. This limitation can be overcome by using any other micro controller which has provision of taking more inputs than arduino. By doing this, the precision of soil moisture monitoring will be greatly enhanced. Also, If solenoid valve is included in the circuit, the flows to different directions can be channeled (if a drip system is used) or different sprinkles could be turned on depending upon where moisture is less and where it is high.

VII. POTENTIAL AREAS OF APPLICATION

- This system can be very much useful for the farmers who grow only one crop for a particular season. The watering system can be automated fully by installing this system.
- This system can also be useful for the agricultural researchers who collect data on soil moisture levels in different soils and regions.
- Plantations like apple, almonds, cardamom, other spices, saffron, etc. can be automatically irrigated using this system. The problem with these type of plantations is that monitoring of each and every segment is done manually. This system, once installed will relieve this burden of doing monitoring manually.

VIII. DISTRIBUTION OF WORK AMONG GROUP MEMBERS

TABLE III
WORK DISTRIBUTION TABLE

Member Work done
Gaurav Meena Interfacing of Soil Moisture sensor, data collection on soil moisture, LCD connections, Code for final circuit, final circuit connections, demo box design, photos, electronics lab and report
Nishant Soil moisture sensor interfacing, protective case design, mechanical workshop operations, soldering of LCD, report
Aman Khandelwal Float switch ,motor interfacing, final circuit integration, mechanical workshop and report
Aj R Laddha Bluetooth module, android app optimisation, soil moisture sensor in digital mode and soil sample collection
Hemant Kumar LCD interfacing, Bluetooth module, android app optimisation, mechanical workshop, soil sample collection
Vinayak Kuthiala Report, Solenoid valve research, protective case designing, diagrams

IX. COST OF SYSTEM

The cost of whole system with the protective case is Rs. 1650.

REFERENCES

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[2] www.instructables.com For LCD conections and bluetooth module 3
[3] www.arduino.cc For map() function 4
[4] www.icar.org.in For Getting data on volumetric soil moisture content requirements for major Indian crops 5
[5] Dr. Srikant Srinivasan, IIT Mandi For providing information on soil moisture data collection