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A novel system for analysis of soil properties

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ABSTRACT

The paper describes a microcontroller based model to test a soil sample for five different parameters viz moisture, temperature, pH, resistivity, and conductivity built using ATMEGA32. The readings sensed are stored in an Excel sheet through a Visual Basic code. The saved readings will be read in MATLAB software and graphical representations will be done in MATLAB. Data is secured at the file level and also while accessing the folder through passwords so that there is no unwanted interference. Conditions are tested by using Fuzzy logic and desired conditions necessary for plant growth will be concluded. Also, the graphs can be viewed on an ANDROID operating mobile phone system where-in users can view the plots by using the application MATLAB mobile. GSM modem SIM900 is used to send the readings via SMS to the concerned person giving scope for communication. Through this project, we can study variations in soil properties, the concept of precision farming and sustainable agriculture, overcome the limitations in conventional techniques, analyze the plant growth conditions and include scope for communication.

Keywords: *Moisture, Temperature, Conductivity, Resistivity, ph, Precision Farming etc*

1. INTRODUCTION

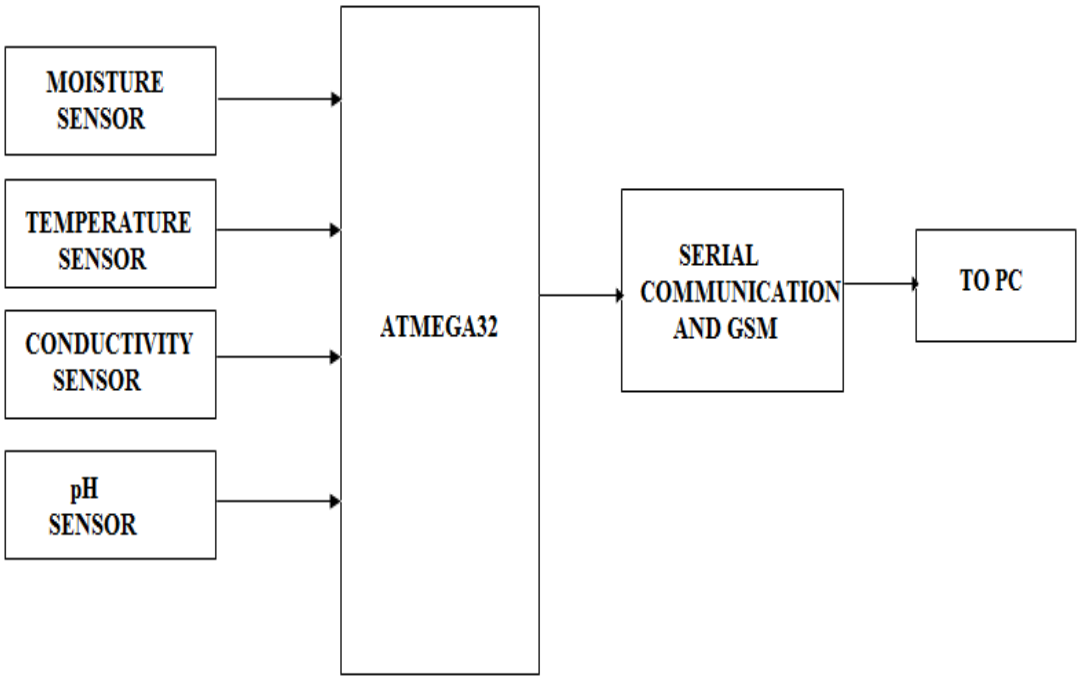
Nature has always been a wonderful gift to human beings from the creator and a helping hand in the major process. It is said that the three basic needs of human beings are the food, shelter, and clothing. Humans have been satisfying these needs with help of nature, but the recent trends in technology combined with these traditional practices can help in advancement in a wide variety of fields. One of these needs that is the food is obtained through agriculture where in crops are cultivated by the farmers and are either available to us directly or processed in the industry and provided to us. The major backbone of agriculture is the land with the vast extent of soil. Beside this, soil also provides livelihood through pottery, extraction of important minerals etc.

Soil present on the upper surface is basically the life supporting system of plants where in it is a source of essential nutrients. The soil is of various types ranging from very fine particles to the variety of granules which are present. The soil has s the properties of texture, color and other parameters like nutrient content, moisture, temperature, conductivity, resistivity, pH, humidity etc which are suitable for plant growth. Agriculture has been, one of the major occupations which have been practiced through the world from ancient times. But in modern times due to fast-growing population, the demand for food has been increasing which has caused extreme pressure on agriculture by means of increasing food production with higher a yield compared to that done previously.

We have the precision farming concept in which the crop production is done by careful observation and monitoring of the parameters which are required for plant growth, The higher increase in crop production should undertake the practice of sustainable agriculture, that is practicing agriculture in present keeping in mind the needs of the future generation by not allowing the resource to be degraded by interaction between the resource. We have the agriculture research Institutes where in research is done on a wide scale for latest techniques and improvements. In such centers soil analysis is carried out in which large chemicals are required and the process is time-consuming. Also, there is manual noting down of the reading which may result in errors. Also, the soil samples have to be brought to the lab and analysis has to be performed. There is also a lack of communication to a remote location. Today's youth have been diverting away from agriculture. Combining technology with agriculture in an efficient manner will attract youth towards this important occupation. In this project, we have designed a system in which we can practice the concept of precision farming and sustainable agriculture by monitoring the parameters. Also, we can overcome the limitation

of the conventional techniques practiced and attract youths towards agriculture practices and research by a combination of nature with technology.

2. PROPOSED METHODOLOGY



In this project we design a circuit to test the soil for five different parameters using following sensors:

1. Moisture sensor
2. Temperature sensor(LM 35)
3. Conductivity Sensor(MS CD 04)
4. pH sensor(pH 07)

All these sensors will be interfaced to the microcontroller using ATMEGA32. The readings which are sensed will be transferred to the computer by using Serial Communication interface RS232. The readings will be recorded via an Interface created using the Visual Basic code and will be saved in Excel sheet with corresponding time in HH:MM: SS format. There will be ten readings which will be a part of the record. We provide security through passwords both at file and folder level.

The parameters moisture and temperature will be sensed in dry soil condition at one time instant and Conductivity and pH will be sensed by mixing the soil with distilled water in ratio 5:15, this is done in order for the ions to be free. Resistivity will be determined through inverse relation with conductivity and formulations will be done in the Visual Basic code. Later graphical representations will be done by using MATLAB and a Simulink model is built using Simulink toolbox. A graphical user interface is also done for the plots.

Fuzzy logic will be built where in inputs will be fed and the desired output will be checked which are necessary for the plant. The readings can be sent to the concerned person using GSM module Sim900 giving scope for communication.

2.1. Hardware Design

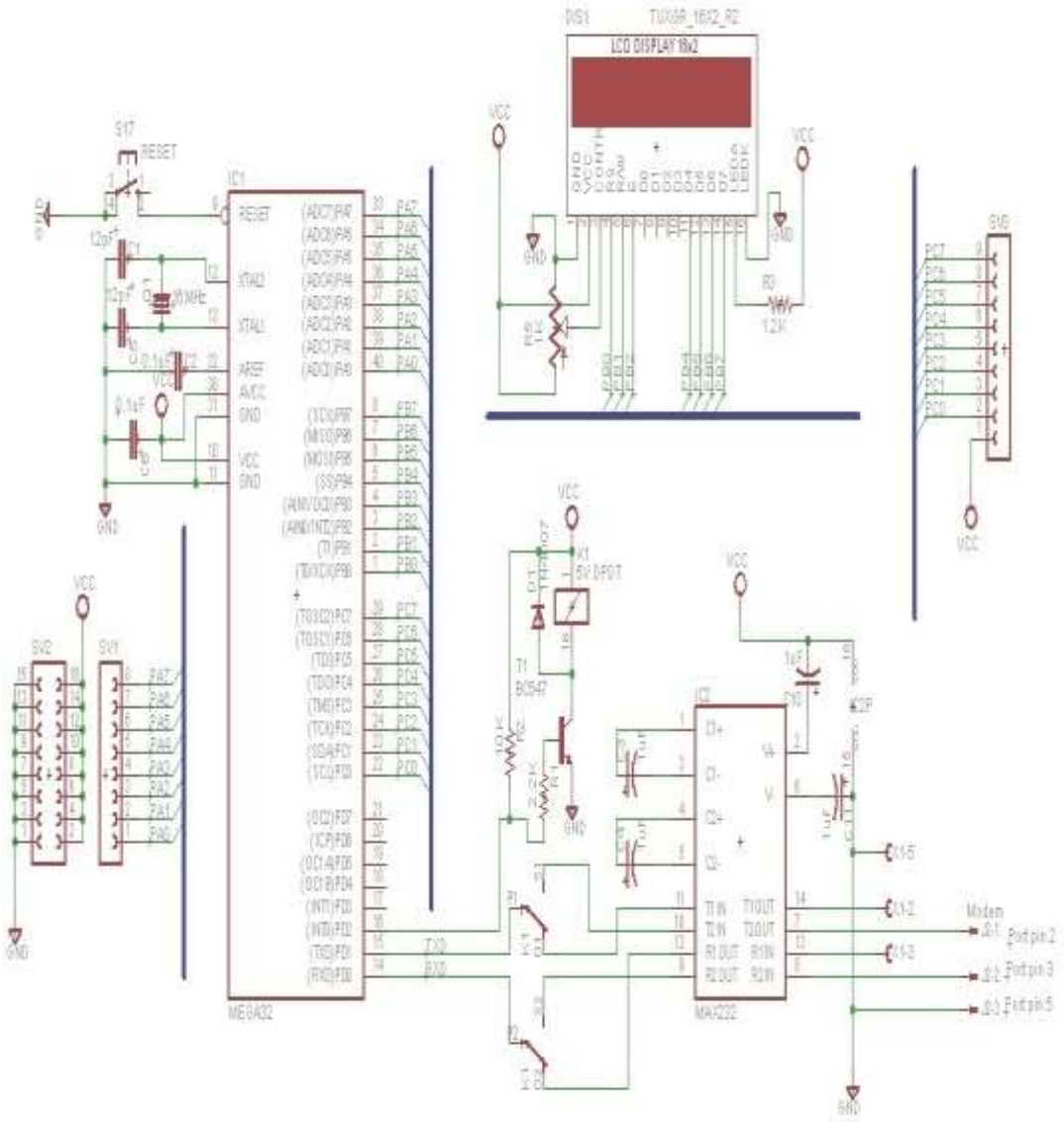


Fig 1. Project hardware description

ATMEGA32 microcontroller is being used in the circuit because it satisfies our needs of the project. Our sensors are analog and ATNEGA is digital input microcontroller, so we use the four ADC ports for the four sensors. ATMEGA has one UART pin for output. Since GSM was an add-on for the project so we share the single UART pin for RS232 and GSM modem by using an IC which gives double pole really double flow which has 6 pins, two normal close and two normal open and the two for coils unlike the 3 pins for normal IC. Since RS232 cannot be directly interfaced with ATMEGA so we have used an IC MAX 232 Because of the TTL logic of 1 and 5V and +3 and -3V.The capacitors used for the circuit is a needed circuitry for RS232.

2.1.1. Sensors

1) **Moisture sensor**: The moisture sensor is used to determine the moisture of the soil.The sensor will be dipped in the soil in dry condition and the values will be recorded.

Fig 2. Moisture sensor

Fig 3. Temperature Sensor

2) **Temperature sensor**: LM35 sensor series are temperature sensors (precision integrated), which gives output voltage which is linearly proportional to the Celsius (centigrade) temperature. It relies on a property of diodes that causes the breakdown

voltage of the diode to increase with temperature. The LM35 measures a temperature range of negative 55 to positive 150 degrees Celsius. It produces a signal which is analog and has a linear relationship to temperature. At room temperature, the LM35 has a typical accuracy of about 0.25°C. The temperature sensor requires a supply voltage of either five or ten volts. The LM35 draws only 60 µA of current from a single or bipolar power supply. If a single supply voltage is used, then the chip will measure temperatures from 0 to 150 degrees. The sensor is made up of 3 pins which are the supply voltage, output voltage, and the ground. This sensor will be dipped in the soil in dry condition and readings will be recorded.

3) **Conductivity sensor**: The conductivity sensor which we are using in our project is MS CD 04. The body is made up of CPVC and the electrode comprises of Platinum or Glass.The operating temperature for this sensor is 80 Degree Celsius. The soil sample will be mixed with distilled water in a ratio 5:15 and sensor will be dipped in the soil and readings will be noted

Fig 4. Conductivity Sensor

Fig 5. pH sensor

4) **pH sensor**: The pH sensor used is pH07. The body of the senor is made up of Glass and range is from 0 to 14. The temperature range for this sensor is 0 to 100 degree Celsius. The soil sample will be mixed with distilled water in a ratio 5:15 and sensor will be dipped in the soil and readings will be noted

2.1.2 ATMEGA 32

Atmega 32 is a member of Atmel AVR series Microcontroller family which has 40 pins. Pin 10 is used for providing 5V power supply and pin 11 is used for the ground connection. For oscillator, we have the pin 12 and 13 and three pins are used for providing a reference voltage and the power to the ADC. Pin 9 is used for Reset function .and rest 32 pins are divided into 4 port where each port comprises of 8 pins.

The ports and pins are as follows:

Port A (PA0 to PA7): used as analog input to the A/D convertor and can also be used as 8-bit bidirectional input and output when not used for A/D conversion purpose.
Port B(PB0 to PB7), Port C(PC0 to PC7), Port D(PD0 TO PD7): are basically used as I/O port which is 8 bit bidirectional.
Timers: Total 3 timers/ counters are present of which timer 0 and timer 2 are 8 bit and timer 2 is 16 bit.
Communication: Modes of communication which are available are USART, Serial Interface and two wire interface.
Interrupts: Capable of accepting three external interrupts which are configurable.
Memory: Has In-System Self-programmable Flash program memory, of 32 Kbytes, EEPROM of 1024 bytes, and internal SRAM memory of 2 Kbytes which are present.
Clock: Runs at a frequency from 1 to 16 MHz.Sources of frequency are an external quartz crystal, RC oscillator, and ceramic crystal.
Analog comparator: On-chip analog comparator is present. Interrupt assignment is done for different input results.

2.1.3. GSM MODULE SIM 900

GSM is the most widely used Cell phone technology. The GSM SIM 900 works on the frequency of 900/1800 MHz It has an internal TCP/IP protocol suite which allows you to connect to the GPRS and has a facility for SMS, voice and data transfer in M2M mode. The various pins of the module are ground, transmit, receive, line input, speaker positive and negative, Mic positive and negative, clear to send, request to send, data terminal ready.In our project, the GSM modem will be interfaced to the microcontroller and will bear a keypad and LCD display of 16X2. The desired number can be entered via the keypad to which the values are to be sent. The number will be displayed on the LCD screen. Thus using GSM we have scope for communication in our project to a distinct location.

2.1.4. RS232

For serial communication of data, we use RS232 which is a serial communication interface. The user has the freedom to choose as many as 20 signals as needed. Only three wires are needed that is Send, receive and ground. Voltage is bipolar that is 5 to 20 volts.RS232 is basically a 25 pin connector and the signaling work between DTE (data terminal equipment) and DCE(Data Communication equipment)is done by RS232.

2.2. Software Implementation

2.2.1. Database Creation

For saving of data, MS Excel sheet is used. The excel sheet will have each column which will store ten readings of each parameter with respect to time in HH:MM: SS . The time from HH:MM: SS will be converted to second's equivalent for plotting purpose. Since Moisture and temperature will be recorded at one time instant and Conductivity, Resistivity and pH at another time instant they will bear separate time interval. The color of each column will be a match to the plot output. The Excel sheet will also have average values, day, date and soil factor information like location, soil type and factor for which the soil is tested.

Security: Since data is important and any manipulation of data can provide misleading to the results, we provide security at file level as well as at the folder level so that any unwanted interference to the data can be avoided.

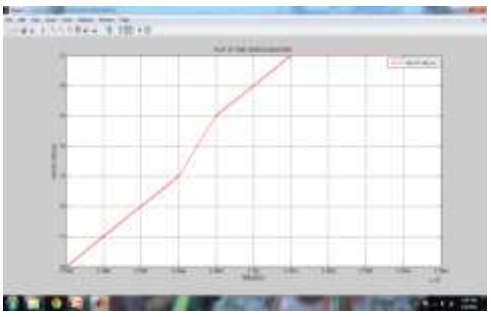
2.2.2. Visual basic code

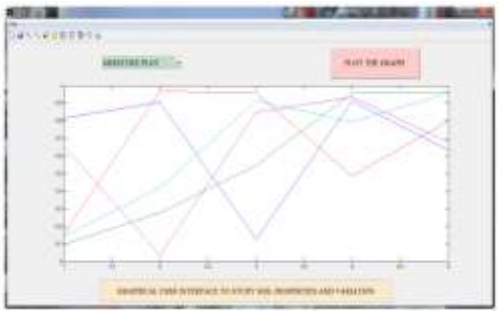
We create an interface using the visual basic 6, the interface is basically used to store the data for the duration of ten seconds.
Step 1: Upon connecting the circuit, the desired COMM port is to be selected.
Step 2: After this, the location will be selected where the desired readings will be saved. Then the button for importing Moisture and Temperature readings will be active. Upon clicking this button the ten-second duration step will run and the readings will be saved.

Similarly, the procedure is repeated for Conductivity and pH readings since these are imported at a separate time interval.

2.2.3. MATLAB Plots

The values saved in Excel file will be read in MATLAB workspace and the code to plot the graph will be run where in all the five plots for moisture, temperature, conductivity, resistivity, pH will be plotted. pH will be classified accordingly as acidic, basic or neutral depending on the values read. A bar graph representation of the average values is also done in MATLAB.





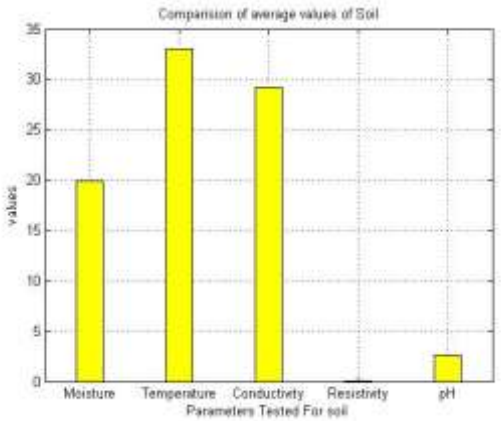


Fig. 6 MATLAB Plots

Fig 7. MATLAB Mobile app

2.2.4 MATLAB MOBILE CONNECTOR

MATLAB connector is a mobile application which helps to connect the mobile supporting Android/IOS Operating system to the MATLAB running on the computer. To connect to MATLAB mobile Computers need to install the MATLAB Connector Software. When the mobile app wants to access the data on the MATLAB running on the Computer first the command connector on should be typed on the computer. The IP address which is asked is the IP address of the Computer. Password will be asked, which can be any letter, number, underscore character with a minimum length of five and maximum length of thirty-two. The port number of the connector by default is set to 31415, however, this is subject to change upon proper selection. When the session is over connector off can type on the computers MATLAB and session can be ended. Using this application one can remotely work on MATLAB by typing commands, running the desired script and viewing the result as needed.

2.2.5. SIMULINK MODEL

Simulink software helps one to model, analyze simulate a system. In this project, we have used Simulink model to Graphs both in terms of analog and digital representation.
Time Scope displays signals in the time domain that are an analog representation of data and the scope is used for the representation of data in terms of digital representation.
One can view any factor and the desired representation by just clicking on the scope or the time scope of the desired parameter.

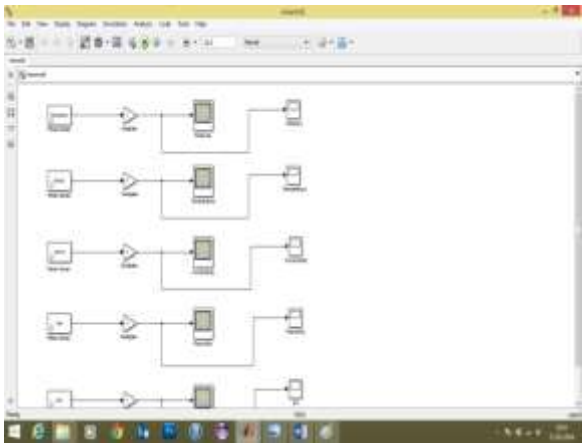


Fig 8. SIMULINK Model

2.2.6. IMPLEMENTATION USING FUZZY LOGIC

A fuzzy logic model will be built with inputs and the outputs with the desired membership functions defined appropriately with desired ranges. The fuzzy inference system used is Mamdani which will have all the rules which are formulated. Using the rule view the corresponding recorded readings will be set and the desired output will be checked accordingly

3. CONCLUSION

The implementation of hardware, testing and graphical representation of the data have been performed with which we found that there was a reduction in the time taken in testing these parameters with rare use of chemicals. Since the readings were recorded on a code-based system, there was no manual intervention and the data was free of human errors. This project also provided for on field observation with scope for communication to a remote location through SMS.

4. ACKNOWLEDGMENT

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