DESIGN AND DEVELOPMENT OF LOW COST SOIL MONITORING SYSTEM USING ARDUINO

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Abstract. The monitoring of the soil standard is a complex process as it has several laboratory testing methods and time consuming. To overcome this difficulty, a real time, portable monitoring of soil goodness by using Arduino has been proposed. Arduino together with the smart sensors measure the quality (Moisture, pH, and temperature) and effectiveness of soil. The controller accesses the information which is monitored by the use of sensors. The measured data will be displayed in the system. The experimental results verify that the proposed portable system can monitor soil quality in real time with an accuracy of 82%.

Keyword. Soil quality, Arduino, Sensors, Agriculture parameter

INTRODUCTION

The continuously increasing population in world demands for the rapid improvement in food production technology. Recent technologies like Big data, IoT (Internet of Things), smart systems are used in Agriculture domain also [1]. Soil degradation is a major threat in food production. Many laboratory methods were available for monitoring the soil parameters effecting on crop production. It provides facility to test the samples like water, soil etc. Farmers has to collect their samples there and get the test report after some days. Yet there is no any system available which can make available to farmers wherever they want and whenever they need results quickly.

In some of the developed countries farmers are using automated systems for knowing few agriculture parameters [2] and the field suitability also [6] and feeding the suitable inputs as well like water, fertilizer etc. [3], [4]. Most of these automated systems are suitable for large un-fragmented land and are not affordable for small/marginal scale farmers. Few precision agriculture systems are available for monitoring parameters but those are restricted with one or two parameters. One of the recent developed system in Philippines is for monitoring nutrients like pH, Nitrogen, Potassium, Phosphorus (N, P, K) and suggest fertilizers on its basis [5]. Crop suitability is dependent on not only soil nutrients but also some geographic and environmental parameters [6,7]. The objective of this work was to develop a low cost “open hardware” platform for the measurement and recording of data on soil moisture at different depths, pH and temperature.

MATERIALS AND METHODS

Soil monitoring system is gaining importance as there is need to use water resources efficiently and also to increase the field productivity [9]. The system is used for sensing, monitoring, and for controlling purpose. The system block diagram is shown in Fig.1. It consists of three sensors, a microcontroller and a LCD display. The pH, moisture and temperature sensors are inserted in the soil and the measured parameters are sent to the controller. All the sensors will record the value and give it to the microcontroller. Microcontroller then display this value on a LCD screen. The values will be displayed on the screen one by one at an interval of 10 seconds.

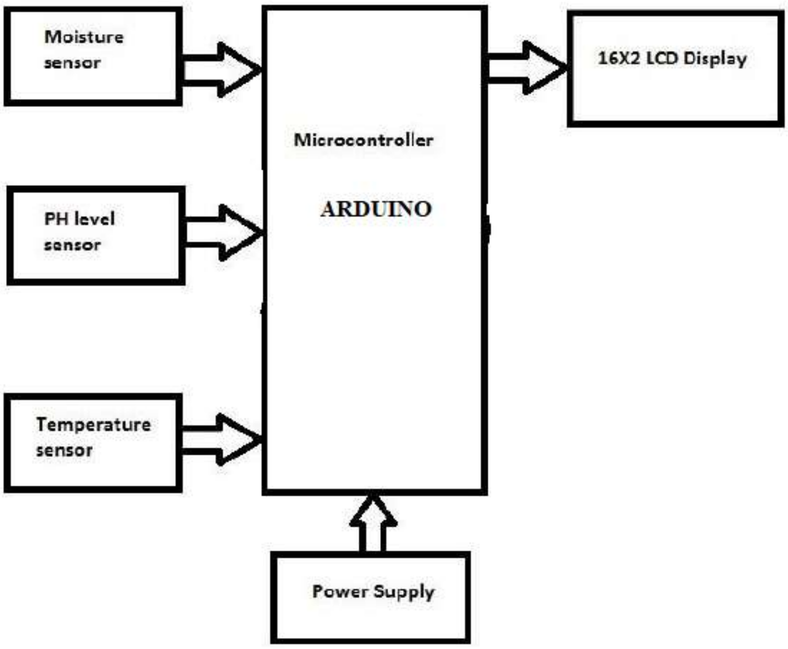

Figure 1. Block Diagram of the system

The description of various components which has been used in the circuit is given below-

Arduino Uno microcontroller

The Arduino Uno is an open source microcontroller board provides set of digital and analog input/output pins. It contains everything needed to support this IoT module. Using the board, it can simply connect to a computer and power source as well. The recommended range is 5v to 12v for Arduino Uno. Multiple calibrated sensors are directly connected to it for measuring the soil and environmental parameters.

Figure 2. Arduino Uno controller

Sensors

Some calibrated sensors are used to measure the soil and environmental parameters as listed below.

a) Soil moisture
b) Temperature
c) pH

All above sensors are selected as per their allowed range of values feasible with range of respective parameters in real time agriculture field. As an example circuit diagram connecting to a soil moisture sensor is shown below

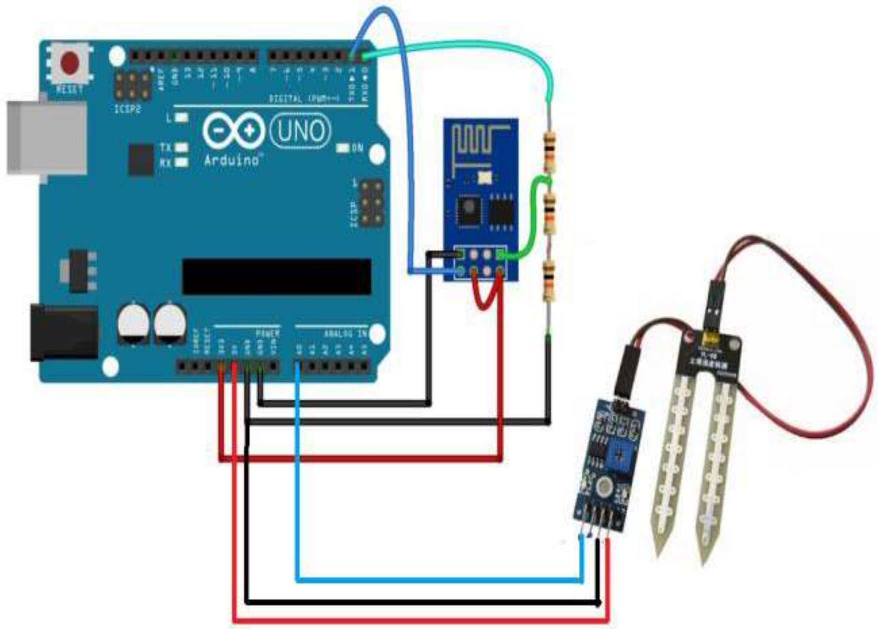

Figure 3. Interface of soil moisture sensor with Arduino

Similarly, all the sensors are connected appropriately as per their specifications. All the measured parameters are stored locally for specified interval and finally average values will be displayed in the LCD screen.

RESULTS AND DISCUSSION

Dedicated Arduino code is written for measuring the soil moisture, pH and temperature and imported to the micro controller. The flowchart for the program is shown Figure 4. Calibration of the sensors were made with reference to the data sheet and verified with the standard measurements. Figure 5 shows the experimental prototype of the system. In order to measure accurate parameters Arduino is powered by 5V from computer or a battery. If the magnitude of the voltage is reduced, the accuracy of the results will be affected. Arduino code measures multiple samples in the required time and displays the average values in LCD display. The different soil samples are collected for the measurement and the results are as shown in Table 1. These measurements were made on standard laboratories results and the accuracy level of around 82 % is achieved from the results. Sample pH measurement in LCD display is as shown in Figure 6.

Table 1. Recorded Data

Sample	Atmospheric Temperature	Soil moisture(%)	Soil temperature	Soil pH
Sample 1	29	32	28	6.12
Sample 2	30	31	29	6.5
Sample 3	32	29	30	6.2

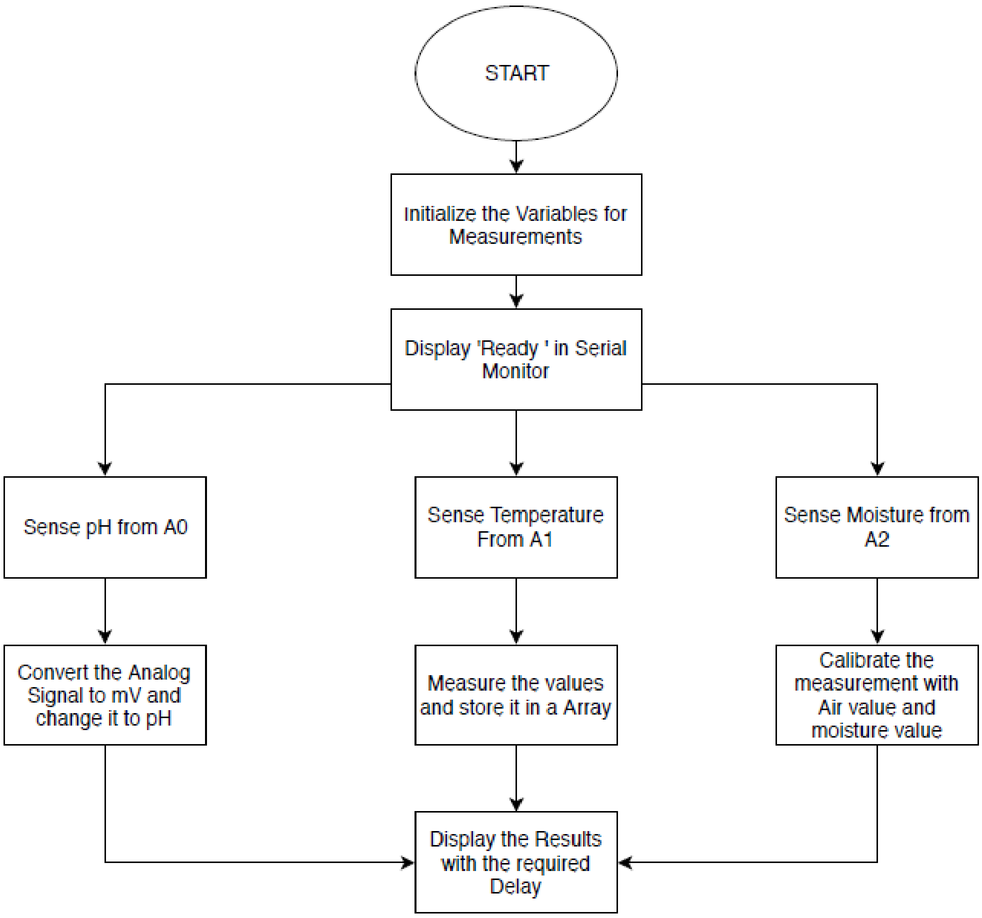

Figure 4. Flow Chart

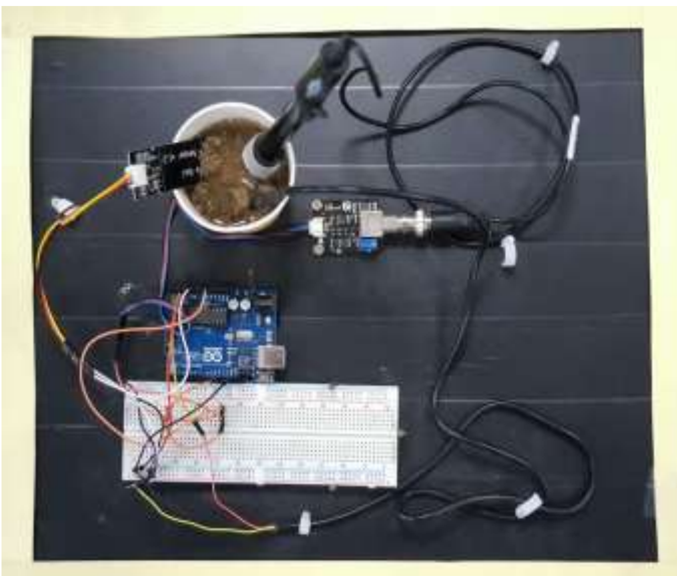

Figure 5. Experimental prototype of the system

Figure 5. pH Measurement

The results reveal that the hardware implementations have been successful and are reliable. The sensors that we are using are giving good results and performing to the expectations.

CONCLUSION

This project is a novel prototype module which can monitor multiple parameters simultaneously. Best part of this is it can be used by the farmers whenever and wherever they want. Simply we can say that this is an approachable real time field monitoring system. The microcontroller circuit has been developed with less number of components and is highly reliable. After verifying the data that was shown in got in display, assured about the success of the project.

Scope for further work on the system will include different activities. The main point of interest will be, to evaluate the recorded data and compare it with high accuracy systems. Focus can also be on the autonomy of system, which can be achieved by solar energy or batteries. This greatly improves flexibility and manageability of the system. Furthermore, it allows to control the system from a central point wirelessly, without the need of field work which can be dealt as a future work. Another important issue is to implement a temperature sensor to increase precision and calibration of the moisture sensor.

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