International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 9, September- 2014

Acquisition of Soil pH Parameter and Data Logging using PIC Microcontroller

Gaganpreet Kaur Marwah
Assistant Professor
Lovely Professional University
Phagwara,India

***Abstract*— Soil pH play an important role in the growth of plant, it acts as an indicator of microorganism and bacteria population in root zones. The analysis of pH gradient can also be used to determine management strategies for root development and soil quality without adding extra fertilizer. The accurate measurements and analysis of pH data is crucial for a multitude of applications ranging from agriculture sector to the clinical laboratories, generally an inexpensive hand held unit is required for these applications. This paper describe the measurement of soil pH and the value is sent to the base station and in turn base station intimates the farmer about the soil pH via SMS using GSM modem. After getting the soil pH value in his mobile, the farmer selects the necessary fertilizer and crop for his next season.**

Keywords*— Embedded System,Data Acquisition, Soil pH,Data logging,PIC Microcontroller,pH Meter.

I. INTRODUCTION

The pH of the soil solution is very important because the soil solution carries with it nutrients such as Nitrogen (N), Potassium (K) and Phosphorous (P) that plants need in specific amounts to grow, thrive and fight off diseases. If the level of pH of soil more than 5.5, it raises the nitrogen content in it. When soil pH is between 6.0 and 7.0 then phosphorous is also available to the plants. Certain bacteria convert atmospheric nitrogen into a form that can be used by plants for its growth. Plants cannot utilize N, P, K and other nutrients, if soil solution is too acidic. In acidic soils, plants are more likely to take up toxic metals and some plants eventually die of toxicity (poisoning)
[1].

A. Nutrition

Nutrient availability in any soil can determine by only its pH value. According to the level of pH, soil can retain its nutrients content. Some nutrients are fixed and are made available by determining the exact soil pH. For example, if soil is too acidic, it leads to deficiencies of phosphorus, calcium, magnesium and molybdenum as well as toxic levels of manganese and Aluminium. If soil is alkaline that may leads to deficiencies of iron, manganese, boron, copper and Zinc. Some plants prefer neutral soil and other prefer different level of pH content.

B. Pets, Diseases and Soil pH

For a strong and healthy plant required sufficient amount of water, sunlight and nutrition's that build up a natural resistance in a plants against pests and diseases. Therefore it's very important to maintain the neutral level of pH soil, to avoid certain nutrient deficiencies which will weaker the plants and make them more vulnerable to pest and disease attacks.

C. pH

The value of pH of any solution acts as a function of hydrogen concentration in it. By measuring the pH value, we able to know the important property of any solution like acidity and extent of reaction. The pH scale range from 0 to 14 and with pH 7 act as acidic, pH 0 act as neutral and pH 14 act as highly basic.

II. SYSTEM OVERVIEW

A. System Overview

This system provides a small and inexpensive method for measuring the pH data with the data logging facility. Figure 1 shows the components and functionality of the designed system. The pH sensor measures the solution and gives the output in miliVolt.

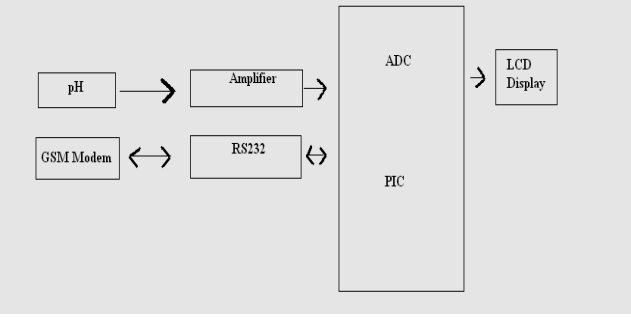

Figure.1. Block Diagram

This pH sensor gives the positive voltage value for pH above 7 and negative voltage value for below 7.The range of voltage
Varies from +400mV to -400mV. After obtaining the voltage value from the pH sensor is fed to the signal conditioning circuit that handle both the positive and negative voltage

value and amplified the input voltage up to 5 volts. Then after it sends to the ADC of the PIC controller and converted into the digital value. By using the mikroC program this digital value display on the LCD for the user and also logged into the micro SD cards. The information about the soil pH is sent to the farmer via SMS using Global System for Mobile Communication (GSM) modem.

B. Hardware

The proposed system consists of pH sensor, LCD display and Amplifier section, PIC microcontroller and power supply unit.

1. Power Supply Unit

The main component of the power supply unit is transformer, which isolate the power supply unit from the power line. The transformer steps up or steps down the input line voltage. The step down alternating current input signal converted to a pulsating direct current by using the rectifier. By using filter section pulsating dc current change into a pure form of dc voltage. The final section, the regulator that maintain the output of the power supply at a constant level in spite of large changes in load current or input line voltages.

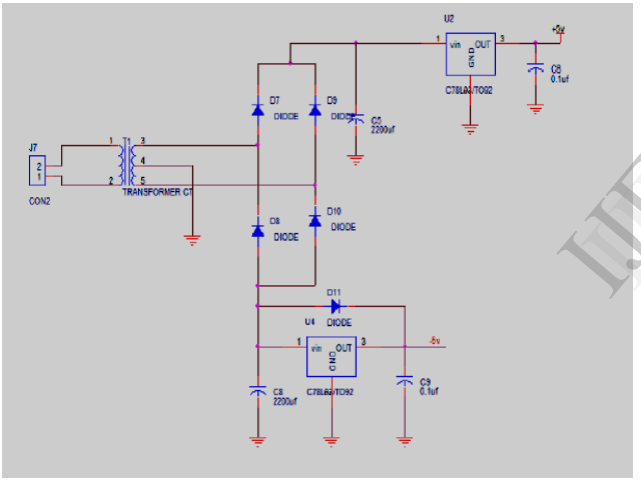

Figure.2. Power Supply Unit

2. pH Sensor

Hydrogen ion concentration of any solution can be measure by its pH value. The range of pH varies from 0 to 14, if any solution having pH value close to 0 it treated as a highly acidic, where as its value close to 14 it consider as a highly alkaline. A special selective hydrogen ion electrode (pH probe) is also immersed in the solution for electrically measurement of the pH value. This electrode gives an output voltage that changes its value according to the concentration ratio of Hydrogen ions inside the electrode as comparison to those which are outside the electrode. The output of the reference electrode does not depend on the concentration of ion ratio. After measuring the voltage between these 2 electrodes i.e. between reference and a special electrode, the pH of the solution can be determined.

3. pH Amplifier

In order to measure pH and get accurate results, several challenges must be taken into account.
These are:
1. The voltage obtained by the standard pH sensor varies from +400 mV to -400 m, where as pH range varies from 0 to 14 at room temperature.
2. The impedance of the pH electrode is very high that act as a second major issue. Due to this high impedance the current that passed to the measuring circuit by the electrode is very small.
3. Temperature also effect on the pH measurement. The effect of temperature becomes critical as we move away from a pH value of 7 and as the temperature moves away from 45 °C. For example, at a pH of 4 and temperature of 95 °C the error could be as much as 0.7 pH.

In order to overcome all these challenges, a circuitry has been designed with Adjustable gain and offset. In order to normalize (Zero for 7pH) we will need to add an adjustable offset control. Since the pH probe should produce 0v at pH7 the gain portion of the circuit will not affect this reading, which is why we adjust it in the offset portion. When combined with gain adjustments we can make a simple circuit that is able to be calibrated much like most commercial pH units. Below is the simple schematic which incorporates the trimmer pots that will let us adjust for calibration and normalization.

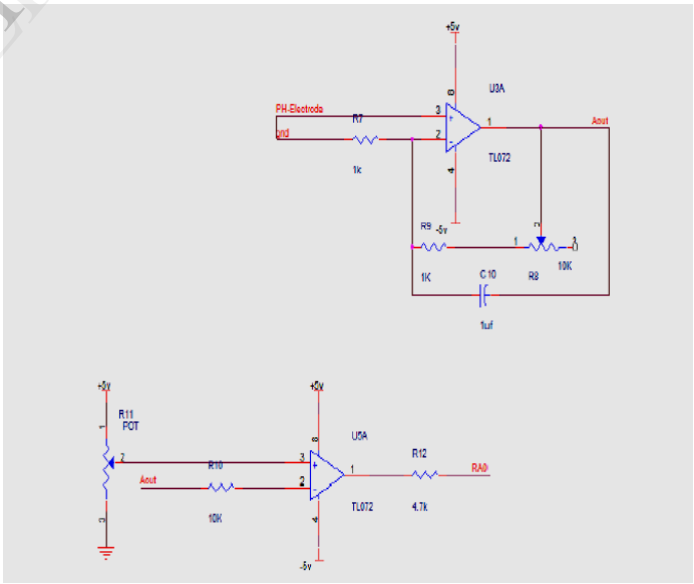

Figure.3. pH Amplifie Circuit

4. PIC Microcontroller (PIC18F4550)

In this project we used the PIC microcontroller 18F4550 which belong to the family of Harvard architecture made by Microchip Technology and it referred as Peripheral Interface Controller. Originally it derived from the PIC1650 that developed by General Instrument's Microelectronics Division. This controller is popular among the industry and hobbyists requirement due to its

high feature like low cost, wide range of availability, serial programming (and re-programming with flash memory) capability. This controller in built with 10 channel of ADC that makes it more superior compare to other controller.

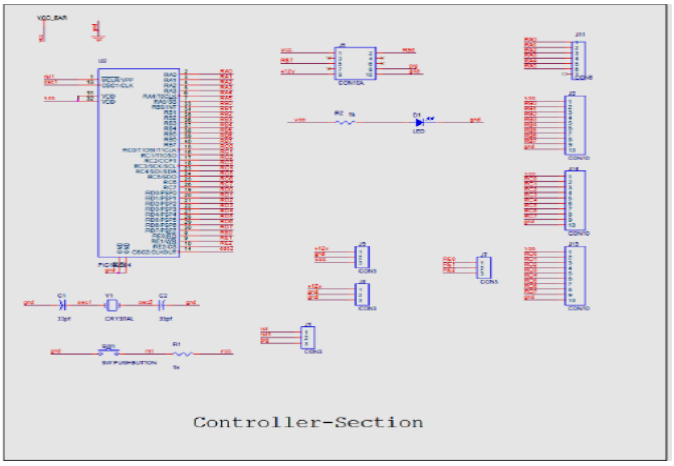

Figure.4. PIC Microcontroller Section

5. *Liquid Crystal Display Section*

In this project we used the 16*2 Liquid crystal display that is a thin and flat display device. LCD required small amount of power that make it more useful for battery based project. LCD contain large number of a pixel, each pixel consists of a column of liquid crystal molecules which suspended between two transparent electrodes, and two polarizing filter. When there is no liquid crystal between them, light passing through it, would be blocked by the other. The main phenomenon used in the LCD is polarization of light. Due to this polarization of light it get twist while entering from one filter and through which it enter to other filter [2].

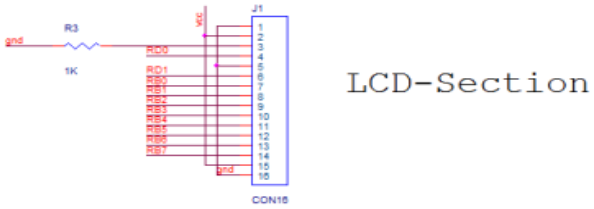

Figure 5. LCD Display

6. *Data Logging*

Data logging is a traditional method for recording the physical and electrical parameter like temperature, pressure and voltage over a period of time. In this system we the logged pH data and can send by using GSM module to the farmer so that at right time correct action taken by the farmer. For storing the pH data, we used the micro SD card, that less costly as compare to other storing elements and also we used the GSM modem that interfaced with RS 232 so we can father send the pH data to the remote location.

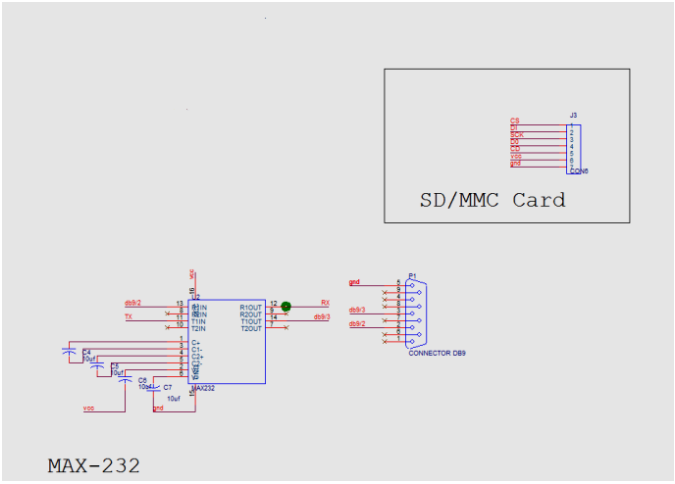

Figure 6. Data logging Section.

7. *Flow Chart*

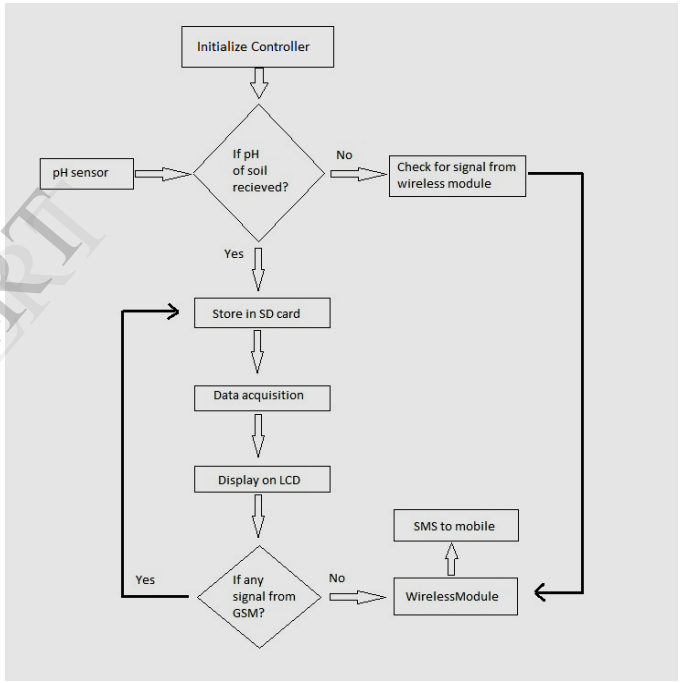

Figure.7. Flow Chart of the System developed

III. RESULTS AND DISCUSSION

In the present work, pH of soil is measured. Different samples of soil are collected and tested. A pH test on soil measures soil acidity. If the pH of soil is 7.0 it considered as a neutral. For a acid soil pH value should be below 7.0 and if pH above 7.0 it act as an alkaline. Four different samples of soil are tested and their pH values are measured, displayed on LCD and the values are logged in SD card.

TABLE 1. RESULT

Sample No	Actual pH Value	Measure pH Value	Type Of Soil	Effects	Action
1	4.98	5.03	Very Acid Soil	Calcium, Potassium ,Copper and magnesium get more soluble	Added lime water
2	6.01	6.05	Acid Soil	Ideal condition for some[plants	If required add only lime water
3	7	7.5	Moderately acid soil.	Only Lime – hating plant cannot grow where as other plants can grow in better way	No addition required
4	8.02	8.07	Alkaline soil.	The percentage of phosphorus amount decreases in the soil	Added sulphur and iron sulphate in the soil.

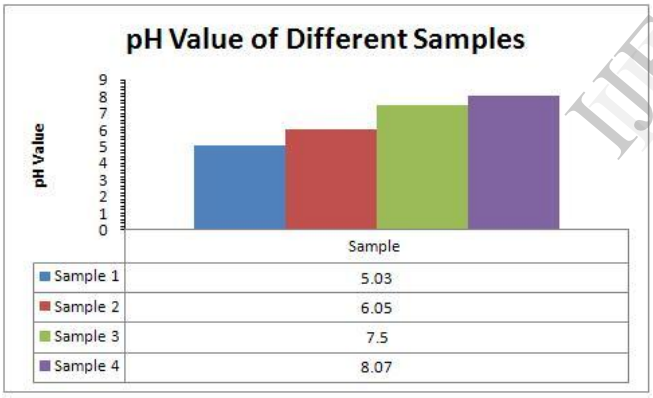

Figure.8. pH Value for Different Sample

IV. CONCLUSIONS

In this paper we presented the new approach by using PIC micro controller for implementation of a data acquisition technique .This hardware device act as inexpensive method for making a better management decisions related to the improvement of soil fertility by doing analysis on its pH value. From the base station result can be send to the farmer by using GSM module so that farmer can take correcting method to improve soil fertility.

V. FUTURE SCOPE

This project can be further extend by connected a temperature sensor. The most common cause of error in pH measurements is temperature. So temperature sensor can be incorporated in the system in order to get the exact value of the solution. The system can also be used for measuring the electrical conductivity (EC) properties of the soil by incorporating more sensors like contact or non-contact type EC sensors in the system. With this more precise information about the soil can be obtained to aid farmer in farming.

REFERENCES

[1] G.D. Agrahari, D.S. Dhote and S.G. Shende, ―Acquisition of soil parameters and data logging using Advance microcontroller‖, International Journal of Basic and Applied Research, 12012 Page(s): 158-163

[2] Introduction to LCD programming tutorial by Craig Steiner Copyright 1997 -2005 by Vault information services LLC.

[3] Ali Ziya Alkar, Member, IEEE, and Mehmet Atif Karaca ―An Internet-Based Interactive Embedded Data-Acquisition System for Real-Time Applications‖ IEEE transactions on instrumentation and measurement, VOL. 58, NO.3, March 2009.

[4] Andrew J Thompson, John L Bahr and Neil R Thomson, ―Low power data logger, proceedings of conference department of physics, university of Otago, Dunedin.

[5] Anshul Mittal, Aseem Singh, ―Microcontroller based pest management system‖, IEEE: Second International Conference on Systems, 2007.

[6] Anuj Kumar, I. P. Singh, and S. K. Sud, ―Design and Development of Multi-Channel Data Logger for Built Environment‖, proceedings of International Multiconference of Engineers and Computer Scientists 2010, Vol II, IMECS, March 17-19, 2010, Hong Kong.

[7] B. Nkom, H. Musa, ―Development of a Novel Microcontroller-base Data Logger‖, IEEE : 2nd International Conference on Adaptive Science & Technology, 2009, Page(s): 314-324.

[8] Bo He, Ke Yao, Bingsen Li, Chunyun Ren, Jing luo, ―Design and Reliability analysis of Data Logging and Management system for AUV‖, IEEE International Conference on Information Engineering, 2009, Page(s): 75-78.

[9] Byung Hwan Chu, B. S. Kang, C. Y. Chang, Fan Ren, Fellow, IEEE, Aik Goh, Andrew Sciullo,Wenhsing Wu, Jenshan Lin, Fellow, IEEE, B. P. Gila, Steve J. Pearton, Fellow, IEEE, J.W. Johnson, E. L. Piner, and Kevin J. Linthicum ―Wireless Detection System for Glucose and pH Sensing in Exhaled Breath Condensate Using AlGaN/GaN High Electron Mobility Transistors‖ 2009 IEEE Transactions.

[10] Chaitanya S. Misal, James M. Conrad, ―Designing a pH Data Acquisition and Logging Device using an Inexpensive Microcontroller‖, Proceedings of IEEE Southeast Conference, 2007 , Page(s): 217 – 220.

[11] Fanliang Kong; Gui-Tang Pan; Zhiwei Xia; Hongjun Chai; Sanran Lin; Xueming Huang, The development of long-term ambulatory pH monitoring system and its clinical application‖,Proceedings of IEEE, 2002, Volume: 4, page(s): 1914 – 1916.

[12] G.D. Agrahari, D.S. Dhote and S.G. Shende, ―Acquisition of soil parameters and data logging using Advance microcontroller‖, International Journal of Basic and Applied Research, 2012 Page(s): 158-163.

[13] Gordon. D, Witt. F, Schmidtke. H, Beigal .M, ―A Long-term Sensory logging device for Subject Monitoring‖, IEEE International Conference on Pervasive Computing Technologies for healthcare, 2010, Page(s): 1-4.