Arduino Based Real Time Instrumentation System for Remote Precision Farming

[1]K. Mahesh Babu, [2]R.Priyakanth, [3]T. Hamsa Priya, [4]K. Harini, [5]M. Harshitha, [6]S. M. Keerti Sree
[1,2,3,4,5,6]Dept. of ECE, BVRIT Hyderabad College of Engineering for Women, Hyderabad, India

Abstract
Precision agriculture is a farming management method based on observing, measuring and responding to inter and intra field variability in crops. Monitoring and recording of environmental conditions is necessary for precision farming. In this system, wireless sensors are used for monitoring soil parameters such as soil temperature, soil humidity, soil moisture and pH. This data is stored and analyzed based on which the decision about the suitable crop is made. This real time data is useful for efficient farming. A GSM module interfaced with Arduino is used for sending messages to a specific mobile device of a farmer with details about the suitable crop that can be grown in their respective fields. This method of soil testing in agriculture provides farmers with information about their crops. In this paper the estimation of different crop conditions are presented after a systematic study of relevant parameters involved in this estimation.

Keywords
Precision Farming; Arduino; GSM; Temperature; Relative Humidity

I. Introduction

Wireless sensor network consists of group of sensors for monitoring and recording physical conditions of environment [1]. Wireless sensors have been used in precision agriculture to assist in (1) Spatial data collection, (2)Precision irrigation, (3)Variable-rate technology and (4)Supplying data to farmers [3]. In the proposed system, wireless sensors are used for precision agriculture. The system consists of sensor nodes for sensing parameters like temperature, relative humidity, soil moisture, pH value and sending this data to base station for decision making. The real time data collected reduces labour cost and increases crop cultivation. This system is implemented for two different soils. The data from both the soils is useful for comparing different soil parameters.

II. Agricultural Field Monitoring

Precision agriculture using wireless sensor networks will ensure higher crop yields and lower labour costs by real time analysis and automatic monitoring of environmental and soil parameters using various sensors [1]. The analysis of this data helps to know which type of environmental and soil conditions are necessary for a better yield. This system is developed to modernize farming techniques by using Arduino controller, GSM and sensors. A GSM short message based interface is implemented for sending real time measurements of environmental parameters. Using this, farmers can remotely monitor crops without going into the fields.

Now-a-days the yield rate in agriculture has not been improving. So many agriculturists have developed different methods and have come up with various monitoring and analysis systems which could help the overall crop yield. The advancement in wireless sensor technology is used in monitoring various environmental parameters in agriculture and farming. With the evolution of miniature sensor devices coupled with wireless sensor technologies, it is possible to monitor environmental values such as soil moisture, soil temperature and soil humidity. Precision agriculture, using wireless sensor network will ensure higher crop yields and lower labour costs by real- time analysis and automatic monitoring of environmental and soil conditions using various sensors and also improving crop management, reduced waste and labour [2]. This project was implemented using tomato plant for trial to monitor real time parameters like soil moisture, humidity and temperature of soil using Wireless Sensor Network. To increase the productivity of the crop, optimum water for irrigation is useful in order to improve overall water management and output achieved shows increase in crop yield using this method [5]. This system is developed to modernize the farming techniques in agriculture by using Arduino controller and GSM and sensors. The information was given on user request in the form of SMS. The GSM, SIM900A was controlled with the help of standard set of AT commands [12]. These commands were used to control majority of the functions of the GSM modem [11]. A GSM-short-message based interface was implemented for sending real-time measurements of environmental parameters. Using this system the farmer can remotely monitor the crops.

III. Block Structure

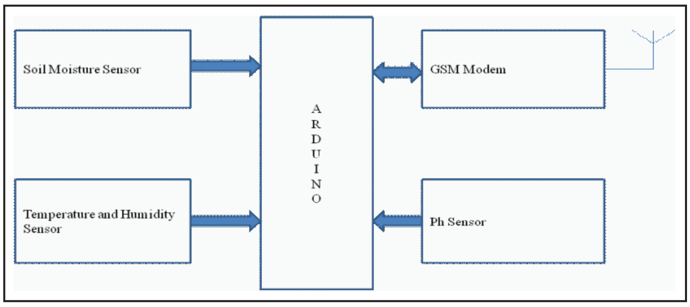

Fig. 1: Block Diagram of Proposed System

IV. Hardware Schematic

The Schematic of proposed system consists of following components:

1. Arduino UNO R3
2. SIM900A GSM Module
3. YL-69
4. DHT11 Sensor

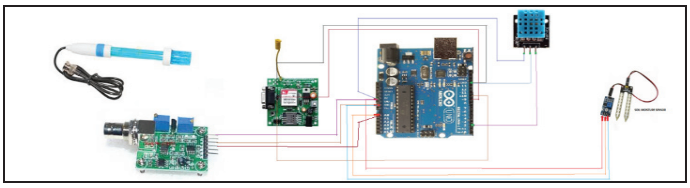

Fig. 2: Architecture of Proposed System

A. Arduino Uno R3

Arduino Uno is a microcontroller board based on the ATmega328P shown in fig. 2. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an

ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started [1].

B. Sim900a GSM Module

SIM900A Modem is built with Dual Band GSM/GPRS based SIM900A modem from SIMCOM shown in fig. 1. It works on frequencies 900/ 1800 GHz. SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS.

C. YL-69

This module sensor module package consists of has 2 parts- a Sensor part, and a PCB for output and sensitivity control. The sensitivity control PCB has 4 pins (Vcc, GND, D0, A0) on one side, and 2 pins on the other where the sensor will be connected. For following details, the potentiometer side of the PCB will be 'top side'. The Sensor (YL-69) has only 2 pins. The sensor side with 'YL-69' written on it will be considered 'top side'. When looking at both from the top side, the Sensor's right pin has to be connected to the PCB's left pin (marked with the GND symbol), and the Sensor's left pin, is connected to the PCB's right pin. When there is Soil water shortage, the module outputs a HIGH value. This sensor can be used with the DC Submersible Pump in gardening systems. When soil moisture is less than the set threshold, do outputs HIGH value. When soil moisture is more than the set threshold, module D0 outputs LOW value.

D. DHT11 Sensor

This sensor makes relay easy to add humidity and temperature data to your electronic projects. It's perfect for remote weather stations, home environmental control systems, and farm or garden monitoring systems.

V. Soil pH Tolerances of Vegetable Crops

Vegetables and other plants grow best when the soil pH is optimal for the plants being grown. It is important to match a plant to the soil pH or to adjust the soil pH to a plant's needs. Soil pH is the measure of the soil's acidity or alkalinity. Soil acidity and alkalinity is measured on a scale of 0 to 14, called the pH scale. Most plants grow between the pH range of 4.5 to 8.0; a soil pH of 5.0 has a high acid content; a soil pH of 7.5 has a high alkaline content; a soil pH of 7.0 is neutral. A soil pH test will determine a soil's pH. Soil pH is important because a soil's acidity or alkalinity determines what plant nutrients are available to plant roots. Nutrients in the soil—elements such as nitrogen, phosphorus, and potassium—become available to plants when they dissolve in water or soil moisture. Most plant nutrients will not dissolve when the soil is either too acidic or too alkaline. Knowing the soil pH in the planting beds in your garden will allow you to group plants by their pH needs. Grow together plants with like pH needs, similar temperature tolerances, and nutritional needs.

VI. Implementation

A. Soil pH Sensor

This sensor can measure soil ph content in the active root zone of crop The readings are taken on 12th, April 2017 from 9AM to14:00PM and shown in Table 2 & 3.

Table 1: PH Values of Some Plants

PLANT NAME	PH-VALUE
Peanut	5.0-7.5
Potato	4.5-6.0
Sweet potato	5.5-6.0
Carrot	5.5-7.0
Cauliflower	5.5-7.5
Corn	5.5-7.5.
Cucumber	5.5-7.0
Garlic	5.5-7.5
Melon	5.5-6.5
Pumpkin	6.0-6.5
Radish	6.0-7.0
Bean, pole	6.0-7.5
Mustard	6.0-7.5
Onion	6.0-7.0
Radish	6.0-7.0
Spinach	6.0-7.5
Sunflower	6.0-7.5
Watermelon	6.0-7.0
Pepper	5.5-7.0
Tomato	5.5-7.5

B. Temperature and Humidity Sensing

We used DHT11 Sensor for sensing soil temperature which is a precision integrated-circuit which has an output voltage linearly-proportional to that of Centigrade temperature. The readings are taken on 12 th, April 2017 from 9AM to14:00PM and shown results in fig. 6 & 7.

Fig. 3: PH Sensor

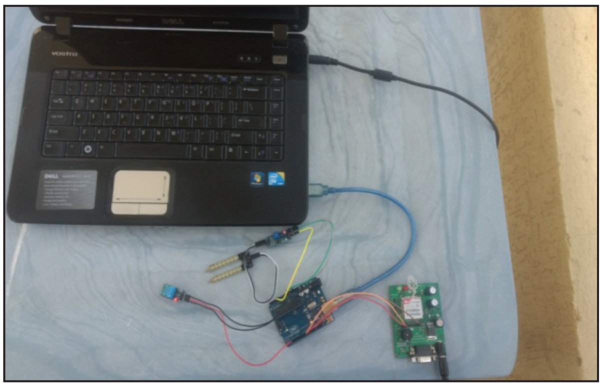

Fig. 4: Proposed System Hardware Setup

Table 2: Temp, RH & PH Values for Red Soil

RED SOIL		
Temperature(°C)	Humidity	PH
30	60	6.5
30	65	6.75
28	69	6.75
30	71	6.75
30	74	6.75
30	75	6.75
30	77	6.75
31	82	7.1
30	79	7.2
30	75	7.25
29	73	7.3

Table 3: Temp, RH & PH Values for Black Soil

BLACK SOIL		
Temperature	Humidity	PH
29	58	6.5
28	62	6.75
28	60	6.9
29	57	7.1
27	65	7.1
27	68	7.2
27	73	7.3
27	80	7.3
27	84	7.3
27	81	7.3
27	82	7.4

VII. Results

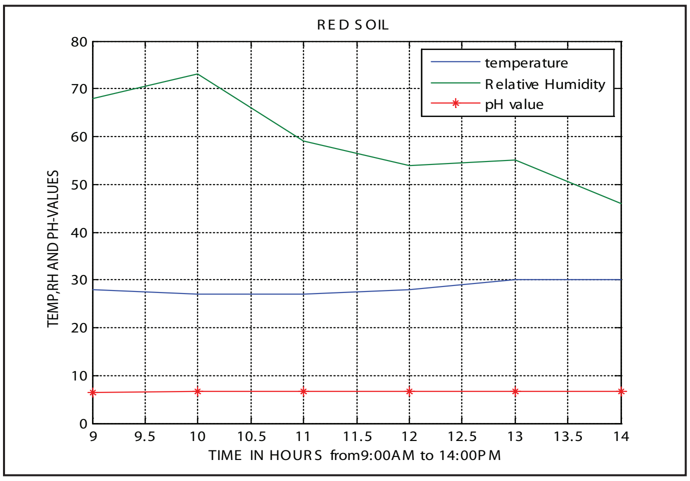

Fig. 5: Variation of RED Soil Parameters for a Period 9 AM to 14 PM On 12/04/2017.

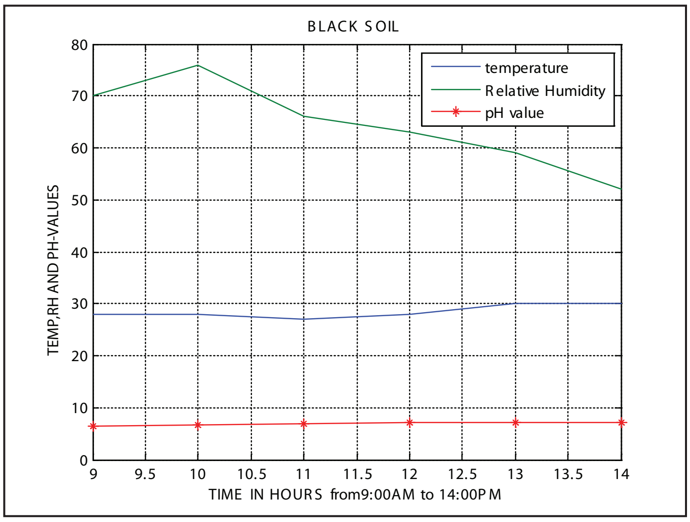

Fig. 6: Variation of BLACK Soil parameters for a period 9 AM to 14 PM On 12/04/2017

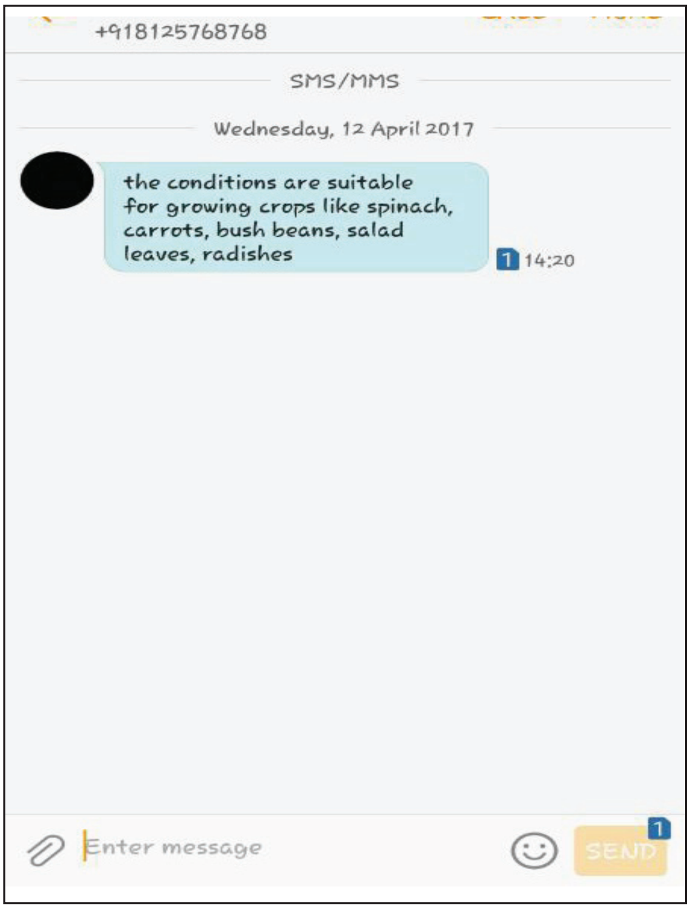

Fig. 7: Snap Sot of SMS Received on the Receiver's Mobile Phone

VIII. Conclusion

Precision farming is a farming management method based on observing, measuring and responding to the inter-field and intra-field variability in crops. Remote sensing helps in analyzing factors like air and soil temperature, soil moisture and pH necessary for crops. Use of remote sensing in agriculture provides farmers with information about their crops. In this paper, plant soil parameters are collected through sensors interfaced to a microcontroller and the data is uploaded to a GSM module. Wireless sensors are used for monitoring soil parameters like temperature, humidity, pH and moisture values for red soil and black soil. Based on this information, a message is sent to the farmer advising him about

the appropriate crop that can be grown according to the season and recordings are plotted for temperature, humidity and pH values with respect to time delay for a day.
The soil parameters required for a crop may also be suitable for other crops. This helps in growing multiple crops simultaneously. Multiple cropping makes an efficient use of nutrients and reduces the pressure on resources.

References

[1] Meeradevi, Monica R Mundada, Nikhita,"Real Time Monitoring of Environmental Parameters in Precision Agriculture using Wireless Sensor Network", Vol. 6, No. 8, August 2016 ISSN 2223-4985.
[2] J. Burrell et al.,"Vineyard computing: sensor networks in agricultural production", IEEE Pervasive Computing, 3(1), pp. 38–45, Jan-Mar 2004.
[3] Joaquin Gutierrez, Juan Francisco Villa-Medina, et. al.,"Automated Irrigation System Using a Wireless Sensor Network and GPRS Module", IEEE Transactions on Instrumentation and Measurement.
[4] Ning Wang, Naiqian Zhang, Maohua Wang, "Wireless sensors in agriculture and food industry—Recentdevelopment and future perspective", Vol. 50, Issue1, January 2006, pp. 1–14, Elsevier Publication.
[5] J. Thelen et al.,"Radio wave propagation in potato fields.In First workshop on Wireless Network Measurements", Riva del Garda, Italy, Apr. 2005.
[6] Aniket H. Hade, Dr. M.K. Sengupta,"Automatic Control Of Drip Irrigation System &Monitoring Of Soil By Wireless", (IOSR-JAVS) Vol. 7, Issue 4, Ver. III, pp. 57-61, Apr. 2014.
[7] Manish Giri, Pranoti Kulkarni, Anuja Doshi, Kanchan Yendhe, Sushma Raskar,"Agricultural Environmental Sensing Application Using Wireless Sensor Network" (IJARCET) Vol. 3 Issue 3, March 2014.
[8] Ms. Shweta S. Patil, Prof. Mrs. A. V. Malviya,"Review For arm Based Agricultural Field Monitoring System", International Journal Of Scientific And Research Publications, Vol. 4, Issue 2, February 2014.
[9] Griepentrog, H.W., Andersen, N.A., Andersen, J.C., Blacke,M., Heinemann, O., Madsen, T.E., Nielsen, J., Pedersen, S.M., Ravn, O., Wulfsohn, D.,"Safe and reliable: further development of a field robot". Proceedings of the 7th European Conference on Precision Agriculture. Wageningen, Netherlands, pp. 857-866, 2009.
[10] Raul Aquino-Santos, Apolinar Gonzalez-Potes, Arthur Edwards-Block and Raul Alejandro Virgen- Ortiz,"Developing a New Wireless Sensor Network Platform and Its Application in Precision Agriculture", Sensors 2011, 11, pp. 1192-1211.
[11] Purnima, S.R.N. Reddy, "Design of Remote Monitoring and Control System with Automatic Irrigation System using GSM-Bluetooth", Department of Electronics & Communication & Computer Science IGIT, GGSIP University, Delhi, India. International Journal of Computer Applications, Vol. 47, No. 12, June 2012.
[12] LIU Yumei, ZHANG Changli, ZHU Ping,"The temperature humidity monitoring system of soil based on wireless sensor networks".

Mahesh Babu Katta received B.Tech degree in Electronics & Communication Engineering from SRKR Engineering College Bhimavaram, A.P, India and M.Tech degree in Electronics and Communication Engineering from JNTUH, Hyderabad, Telangana, India in 2003 and 2012 respectively. Having 12 years of teaching experience currently he is working as Asst. Professor in the department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. His research interests include GPS.

R.Priyakanth received B.Tech degree in Electronics & Control Engineering from PVP Siddhartha Institute of Technology, Vijayawada, A.P, India and M.Tech degree in Communication and Radar Systems from K L University, Vaddeswaram, Guntur Dist., A.P, India in 2002 and 2005 respectively. Having 12 years of teaching experience currently he is working as Asst. Professor in the department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. He is currently pursuing his research under JNTUK, Kakinada in Multimodal Signal Processing. His other research interests include Biomedical Image Processing and IOT.

T.Hamsa Priya is a Final year student of department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. She is a member of ISTE and IETE. Her area of interest includes Communication.

K.Harini is a Final year student of department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. She is a member of ISTE and IETE. Her area of interest includes Embedded Systems.

M.Harshittha is a Final year student of department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. She is a member of ISTE and IETE. Her area of interest includes Communication.

S.M.Keerthi Sree is a Final year student of department of Electronics and Communication Engineering, BVRIT Hyderabad College of Engineering for Women, Hyderabad, Telangana, India. She is a member of ISTE and IETE. Her area of interest includes Communication.