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Research Paper

Wireless Sensors and Agriculture Parameter Monitoring: Experimental Investigation

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ABSTRACT: *In recent time, the wireless sensor network technology has found its implementation in precision agriculture as a result of the need for high productivity. Among the different technologies for crop monitoring, Wireless Sensor Networks (WSNs) are recognized as a powerful one to collect and process data in the agricultural domain with low-cost and low-energy consumption. Agriculture and farming is one of the industries which have recently diverted their attention to WSN, seeking this cost effective technology to improve its production and enhance agriculture yield standard. The proposed system is hardware as well as software based which will automatically control the parameters of the soil. The data will be transferred over the Internet using the Wi-Fi modem. Such a system contains pair of sensors like temperature, Gas and humidity will be monitored, the data from the sensors are collected by the microcontroller. The scope of the project can be extended to varied areas ranging from greenhouse environment, power plants, chemical industry, and medical production to home automation, but for the time being system is just implemented for the soil parameters management.*

Keywords: *Wireless sensor networks, Precision agriculture; Crop monitoring, Environment monitoring, Communication technologies*

I. INTRODUCTION

Applying wireless sensor networks for monitoring environmental parameters and combining this information with a user-customized web service may enable farmers to exploit their knowledge in an efficient way in order to extract the best results from their agricultural cultivation. In recent time, the wireless sensor network technology has found its implementation in precision agriculture as a result of the need for increasing production rate. The diversity of location and climatic effects upon agricultural cultivation, along with other environmental parameters over time makes the farmer's decision-making process more complicated and requires additional empirical knowledge. [1] - [3]. There is a considerable increasing growth in the field of Information and Communication Technology in Developing Countries. During the previous decade, environmental monitoring by using sensor networks has received considerable attention. The agriculture is in the transition from traditional agriculture to modern agriculture currently [1], [3]-[6]. Internet of things (IOT) for agriculture will play greater role for the promotion of agriculture informationize, including the construction of agriculture information network, the development of agricultural information technology and the agricultural use of information resources.

II. LITERATURE REVIEW

A wireless sensor network was introduced by the Defense Advanced Research Projects Agency (DARPA) in the early 1980's [2], [8]. It was called the Distributed Sensor Networks (DSN) program where many low-cost sensing nodes were spatially distributed and they processed data collaboratively [5], [7]. A wireless sensor network **(**WSN**)** consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to cooperatively pass their data through the network to a main location. A wireless sensor network (WSN) is a network formed by a large number of sensor nodes where each node is equipped with a sensor to detect physical phenomena such as light, heat, pressure, etc. [8]-[11].

2.1Use of WSN in Agriculture

Wireless Sensor networks can be used for monitoring spatio-temporal changes in climate, hydrology, pressure, motion, soil moisture, plant eco-physiology, pests and reporting best options to the agriculturist. Having such information at regularly would be a big boon for him. In order to ward of the adverse conditions which challenge the agriculturists, automatic actuated devices can be used to control irrigation, fertigation and pest control. Irrigation management is also one of the important activities in precision agriculture [7], [12], [13]. Microplitis Croceipes, a tiny parasitoid wasp, locates caterpillars attacking cotton plants by keying on a complex volatile organic cocktail emitted from the plant when attacked. Thus sensors capable of detecting this cocktail would result in early detection and mitigation of these attacks by highly selective pesticide applications or wasp introductions [5], [13]-Wireless Sensors and Agriculture Parameter Monitoring: Experimental

I. INVESTIGATION

[16].However, WSNs are still under a developmental stage; as such, they are at times unreliable, fragile, and power hungry and can easily lose communication especially when deployed in a harsh environment like an agricultural field [13], [17], [18]. The effectiveness of precision agriculture is based on the analysis of accurate sets of measurements in soft real-time. Parameters such as the soil condition and humidity are aggregated and analyzed, in order to extract useful information that a farmer can use as a recommendation or guidance; or even to apply fully automated procedures to the crop cultivation process chain [1]-[3], [17], [18].In Precision-Agriculture field variations are monitored, stored for managing and maintaining the precious resources using technologies to manage and improve production or yield. This can be the tool at the hands of agriculturists for management with goal of optimizing return on investments while preserving natural resources. Precision Agriculture deals and takes care of viz. three branches of science [13], [18], [21].
1. Crop Science: Understanding needs of crops according to weather and managing resources like fertilizers.
2. Environmental Protection: Precision agriculture helps to reduce Carbon, Nitrogen and Methane emissions.
3. Using WSN in agriculture can help reduce wastage, preserve resources, and utilize them effectively resulting in improved efficiency, reduced efforts and boost economy [13], [18].

2.2 Environmental Monitoring (EM)

Environmental monitoring describes the processes and activities that need to take place to characterize and monitor the quality of the environment. The foundation of EM is the collection of data, which enables a better understanding of our natural surroundings to be gained by means of observation. Environmental Monitoring is not limited to the understanding of environments, but also includes monitoring for preservation reasons. The environmental parameters, such as temperature, humidity, water seepage of ground, etc. are the key factors of substations in electric networks [1]-[3], [11], [18]. The manual inspection is still used in many substations in India. Such traditional method exposes evident disadvantages:
1) Time-consuming since the wide distribution of substations; 2) No timeliness of failure discovery; 3) Carelessness of inspectors;
Obviously, it is significant to establish a remote environmental parameters monitoring system in the substations. The substation environmental parameters of temperature, humidity, water seepage of ground and smoke are main monitoring objects of the system [1] –[3], [13], [18]. The environmental monitoring system desired is a complete, real-time monitoring and data recording system. It automatically measures and records air quality and environmental parameters. The environmental monitoring system comprises three main components - namely, a Standard Transducer Interface Module (STIM), Graphical User Interface (GUI), and Transducer Independent Interface (TII). The STIM module is intensively used for measuring and storing data whereas the GUI is used to read and save data in text files, interpret, and display the results in digital and graphical wave forms, and the TII is used for communication between STIM and the Network Capable Application Processor (NCAP). The monitoring system is a complete data acquisition system with sensor array(s) coupled to a data storage device. An environmental monitoring system is shown in Fig.1 [13], [18].

II. METHODOLOGY

It deals with hardware and software implementation followed by block diagrams and procedure of experimentation

3.1. Hardware And Software Implementation

Minimum hardware and software needed to implement the specified requirements are power supply, temperature sensor, soil sensor, gas sensor, rpi board, relay driver, Wi-Fi modem and pc. Components required for interfacing are DS18B20 (temperature sensor) , 4.7kQ resistor (Pull Up), breadboard (Half Size) and connecting wires, Solder and a soldering iron, raspberry Pi board. Software required are Linux, Debian, Raspbian, Python and Putty. Linux is basically a kernel. It is the basic software which gives low-level access to equipment. With help of this we can perform errands likewise transferring of information over the system, displaying graphical images, sound yields, beginning & halting programs, perusing & composing records and so on. Debian is a free working framework (OS) for your PC and incorporates the fundamental arrangement of projects and utilities that make your PC keep running alongside numerous a huge numbers of different bundles.

Raspbian is informal port of Debian wheezy armhf with arrangement settings altered to generate a code that utilizes "hardware floating point", the "hard float" ABI and work on the RPi. The port is important on the grounds that the authority Debian wheezy armhf release is good just with **Wireless Sensors and Agriculture**

Parameter Monitoring: Experimental Investigation

forms of the ARM architecture later than the one utilizes on the Raspberry Pi. Putty is utilized to enter into Raspberry Pi module. It is a free and open-source terminal emulator, serial console and files exchange trade application. It reinforces a few framework traditions, including SCP, SSH, Telnet, rlogin, and crude attachment affiliation. It can in like manner interface with a serial port. Python is an intelligent translator and object oriented programming language. It joins modules, exemptions, dynamic writing, high end dynamic information sorts, and classes. Python is a strong language which also provides clear linguistic structure. It has interfaces to numerous framework calls and libraries, different window frameworks, and is extensible in C or C++.

3.2. Procedure Of Setup

First connect pin no 1 of the DS18B20 to the ground GPIO pin. Secondly connect pin no 2 of the DS18B20 to the GPIO pin 4,then connect pin no 3 of the DS18B20 to the 3.3V GPIO pin, now connect resistor of 4.7kQ in-between pin no 2 and pin no 3 of the DS18B20.Now turn on the Pi. If by mistake anything goes wrong while wiring then u can come to know about it just by touching the sensor. With wrong wiring sensor gets heats up in 1-2 seconds. In such case switch off the Pi and let the Sensor cool down for some time and once it is chilled off then re interface it with the Pi. After Setup following are the steps to be performed.

- Connect system with WIFI
- Provide Power supply to Raspberry-Pi
- Identifying the IP address of Raspberry-Pi (Command Line/Fing App)
- Open the Putty Software
- Enter the IP address of the Raspberry-Pi
- Open Command Line Window
- Enter the user name and password
- Change the access permission
- Open the Nano File
- Access the data through Web by opening Google Chrome
- Enter the IP address in tab
- Enter the user name and password
- Final Output will be displayed
- Open the Command line and enter power off
- System will shut-down

Respective block diagrams of sensors used are shown below. The one wire Digital Temperature Sensor - DS18B20 from Maxim (in the past Dallas) is an incredible chip for measuring temperature in your undertakings. This sensor utilizes One Wire convention. You require just a Raspberry-Pi board, a DS18B20 with a 4.7KOhm resistor. The DS18B20 can be controlled by somewhere around 3.0V and 5.5 V so you can just interface its GND pin to 0V and the VDD pin to +5V from the Raspberry Pi. However, the DS18B20 can sink its required energy from the data line which implies we just successfully require two wires to associate it up. This makes it awesome for use as an external sensor. The moisture sensor board features both analogue and digital outputs. The analogue output gives a variable voltage reading that allows you to estimate the moisture content of the soil. The digital output gives you a simple "on" or "off" when the soil moisture content is above a certain value. The value can be set or calibrated using the adjustable on board potentiometer.

A gas sensor recognizes the existence of gasses in a particular zone, regularly for security purpose. It is utilized to identify a gas leak and inform the same to the controlling device so that the system can be shut down immediately. This gas sensor can also send the signal to alarm causing it to ring in the territory where the leakage is taking place. It gives the workers a chance to leave the premises before getting adversely affected by the dangerous gasses. This sensor is vital as it can save many lives of human beings as well as animals because there are many gases that can be destructive.

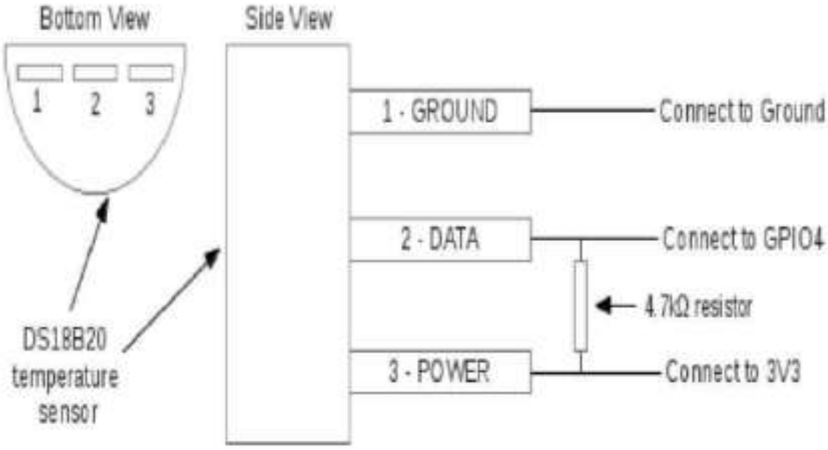


Fig.1 Block diagram of temperature sensor

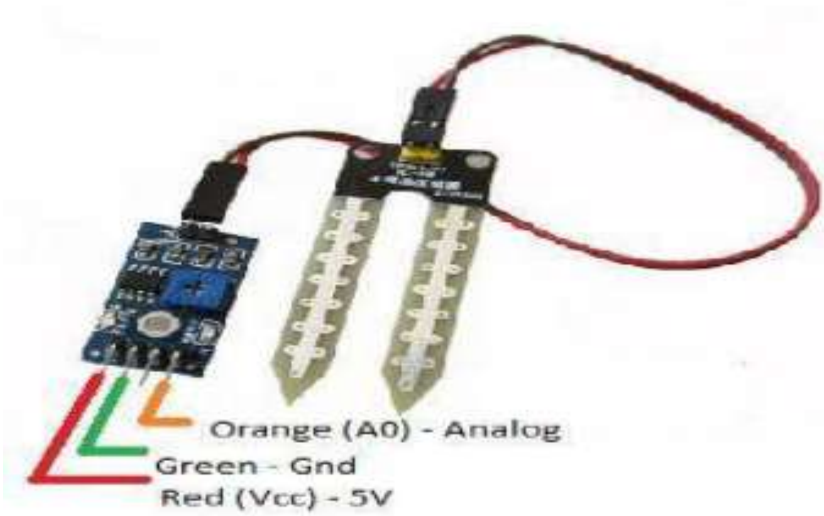


Fig. 2 Soil sensor

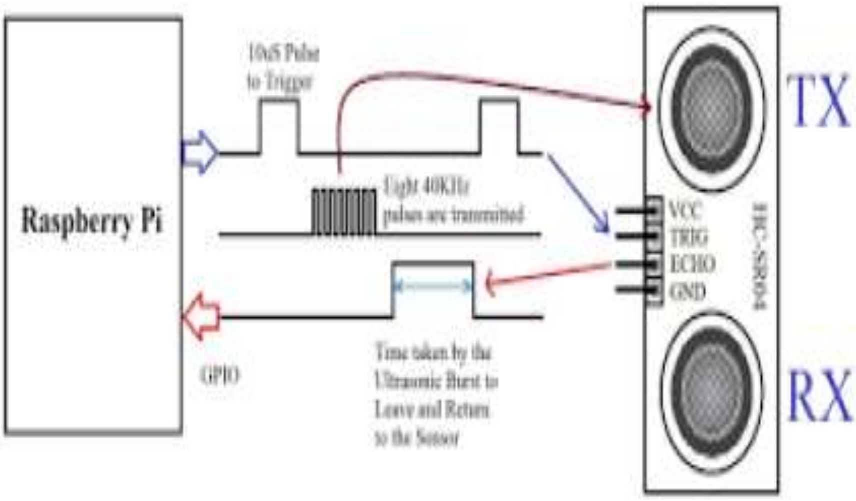


Fig. 3 Soil sensor with raspberry pi

Fig. 4 MQ2 gas sensor

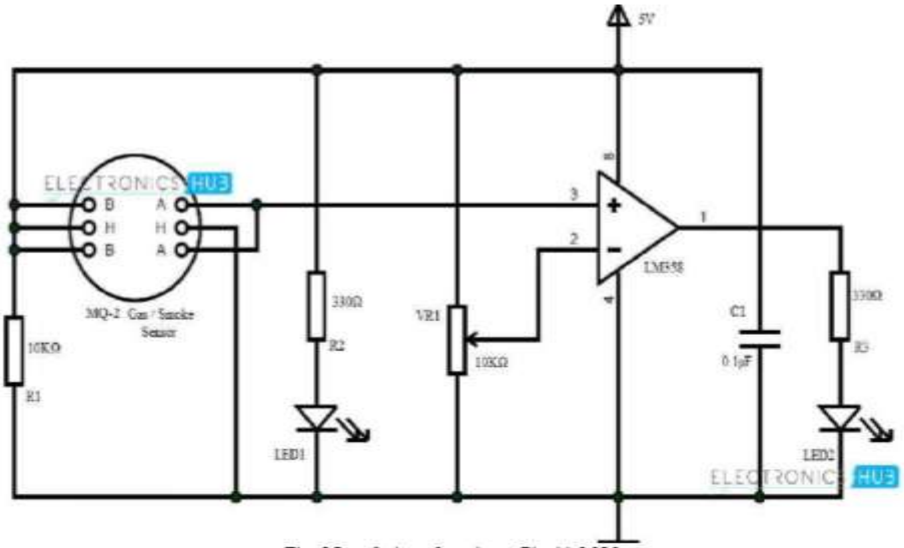


Fig. 5 Interfacing of raspberry Pi with MQ2

The output of the sensor goes to the analog to digital converter. This converter changes this analog signal from the gas sensor into a digital signal, which is the main sort of signal that the Raspberry pi can decipher

3.3. Block Diagram

The Block diagram shows the activity performed during the course of the project. The activity performed in the project starts with monitoring of the soil and environment parameters such as Soil Ph, Temperature and Gas. The monitored value in digital format is given to RPI. If temperature, soil Ph and Gas increases or decreases with respect to the threshold value, the system will perform controlling operation directly. If they are equal to the threshold value it will simply just transfer the environmental values over the Web and message will be displayed.

As the acidity of the H+ in the soil increase the soil PH value decrease, Soils with PH value below 7 are referred to as "acidic" and those with PH values above 7 as "alkaline", the system will perform controlling operation directly such as water sprinkler will start to increase or decrease PH level of soil. If Temperature of the environment is above room temperature then Fan will turn ON else it will be OFF. If more oxygen level of gas gets sensed then buzzer will turn ON and message will displayed as "Aerobic soil environment". Similarly if less oxygen level of gas gets sensed then buzzer will turn OFF and message will displayed as "Anaerobic soil environment.

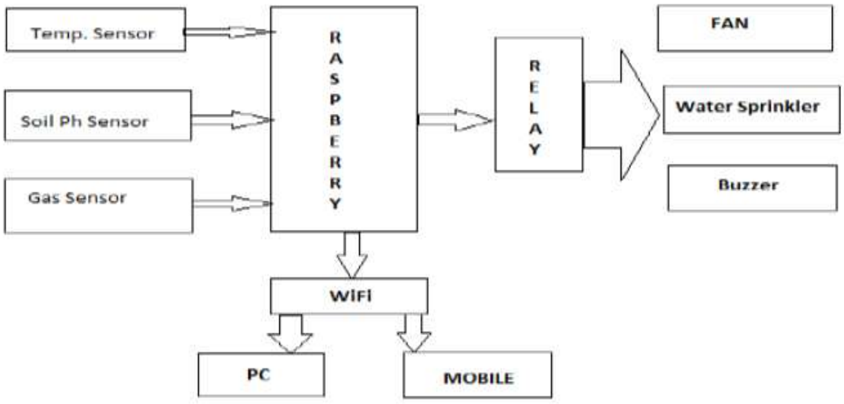


Fig. 6 Block diagram of data acquisition system for remote monitoring and controlling of soil environmental parameters.

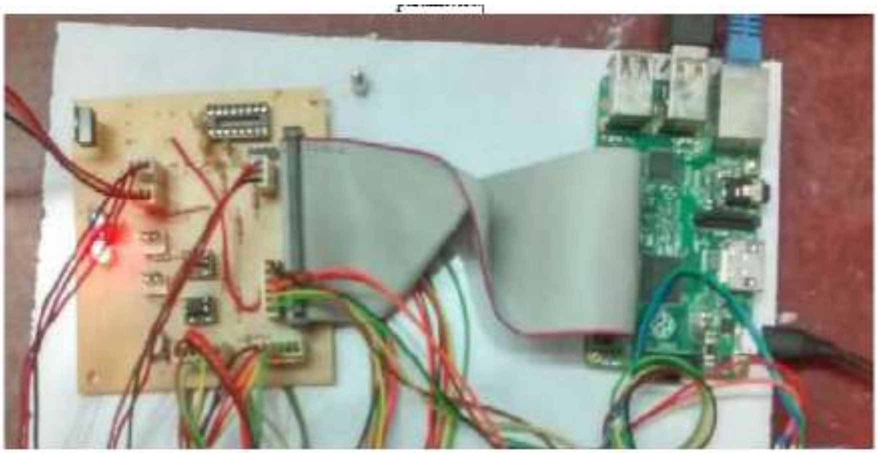


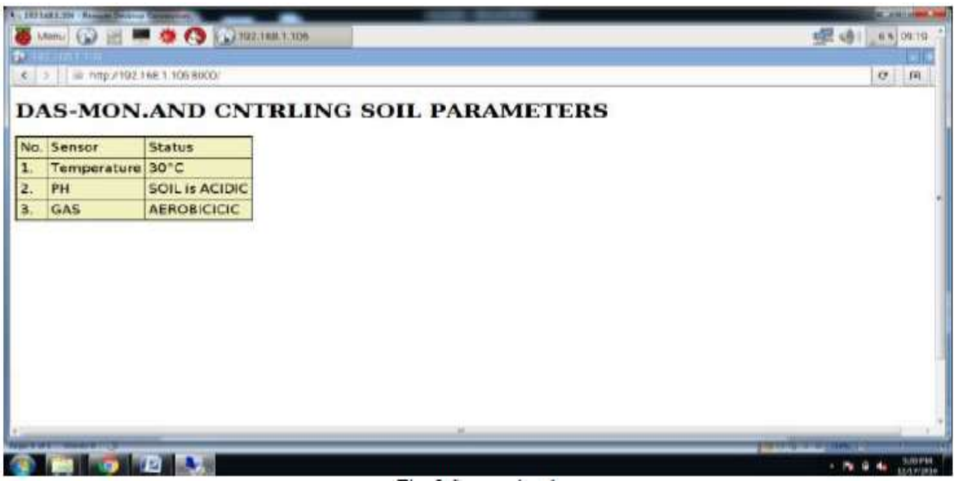
Fig. 7 Hardware design

V. RESULTS

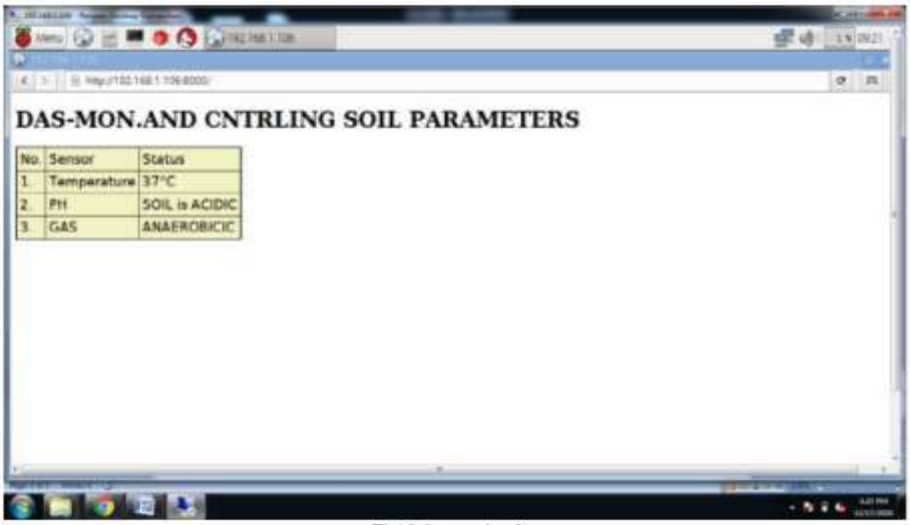
Results are shown below with respect to web page display

4.1. Web page Display

When temperature is below room temperature, Soil pH is less than threshold value (i.e. below 7) then soil is acidic and more oxygen get sensed, soil is aerobic.



When temperature is above room temperature, Soil pH is greater than threshold value (i.e. above 7) then soil is alkaline and less oxygen get sensed, soil is anaerobic.



III. CONCLUSIONS & DISCUSSION

A sensor network is an emerging field with increasing applications day by day. This paper presents a crop monitoring system based on wireless sensor network. IOT has important significance in promoting agricultural informationization. Wireless monitoring of field not only allows user to reduce the human power, but it also allows user to see accurate changes in it. Embedded Web Server" is new technology which can be used for monitoring and controlling parameters. This technology facilitates the monitoring and controlling of parameters remotely with the help of raspberry pi and IOT. This system is inexpensive, scalable, and highly efficient and it also provides fast response. As it uses a low powered raspberry pi board and different low powered sensors, it helps to atomize the industry in less cost and less energy which decreases overall cost of the atomization. Use of is increasing day by day because of the development in WSN technology and its adaption by agriculture technology. In this situation, the wireless sensor network with additional hardware and software is an efficient solution for Precision Agriculture.

VI. FUTURE SCOPE

From the literature studied, scope for future study will be

- Study of how to use alarming system in a Wireless Farming System can be investigated. Including such
- system involves sending a warning or alarm to a farmer's phone when a certain condition occurs
- To conduct a study of designing and Expert System this supports decision making by associating sensor readings with professional information.

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