PORTABLE LOW COST SOIL HEALTH MONITORING SYSTEM

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Abstract—Demographically agriculture accounts for the broadest economic sector and plays a key role in the overall socio-economic development of India. Despite attaining self-sufficiency in food staples, the productivity of Indian farms is below that of other nations. The low productivity is a result of inadequate use and adoption of modern agricultural practices and technologies, affected by negligence of such practices, high costs and impracticality in the case of small land holdings. However, excessive use of these fertilizers has been cited as a source of contamination of surface and groundwater. There are different stages in crop cultivation and each stage requires different nutrient levels. Therefore, a farmer has to spend a lot of time in monitoring the fields. With recent advancement in Wireless Sensor Network (WSN) technology, various techniques are available to measure soil nutrients. On the basis of knowledge of soil nutrients level, farmers can enhance the crop productivity because insufficient nutrient levels can adversely affect crop productivity while excess nutrient levels will either have a similar effect or simply be wasted. The ability to document and detail changes in parameters of interest has become increasingly valuable. Investigations were performed for a remote monitoring system using internet. These nodes send data wirelessly to a central server, which collects the data, stores it and allows it to be analyzed and displayed as needed.

Keywords— Wireless Networks nodes, Portable device, ARM Controllers, MBED platform, XBEE.

I. INTRODUCTION

In India, where the economy is mainly base on agriculture and the climatic conditions are isotropic and are not able to make full use of agricultural resources. When generating the idea for this project, the likely scenario considered was deployment in agricultural environments such as fields or greenhouses. The wireless sensor network investigates being a comparatively self-organizing system. It allows sensor nodes to connect to a network and have their data logged to a selected server. Sensor Networks provide wide variety of applications and awareness has increased with regards to implementing technology into an agricultural environment [1]. Manual collection of data for chosen factors can be sporadic and produce variations from incorrect measurement taking; this can cause complications in controlling any important factors. Wireless sensor nodes can reduce effort and time required for monitoring a particular environment. The logging of data allows for reduced likelihood of data being misplaced or lost. Sensor nodes could be placed in critical sites without the need to put personnel in hazardous situations. The utilization of technology would allow for remote measurement of factors such as temperature, humidity and moisture. There seems to be increased development aimed towards wireless solutions in comparison to wired-based systems [3]. One particular reason is sensor location can often require repositioning and traditional wire layouts could cost a significant deal of energy and time. The system aims to reduce the cost and effort of incorporating wiring and also to enhance the flexibility and mobility of sensing points. Storing data in the cloud is as easy as dragging and dropping into specific folders on your PC or Mac. This way, you can easily store data directly in the cloud without a hassle. The moment a file has been stored in the cloud, it remains secure irrespective of what happens to the physical storage

II. WORKING SCHEME

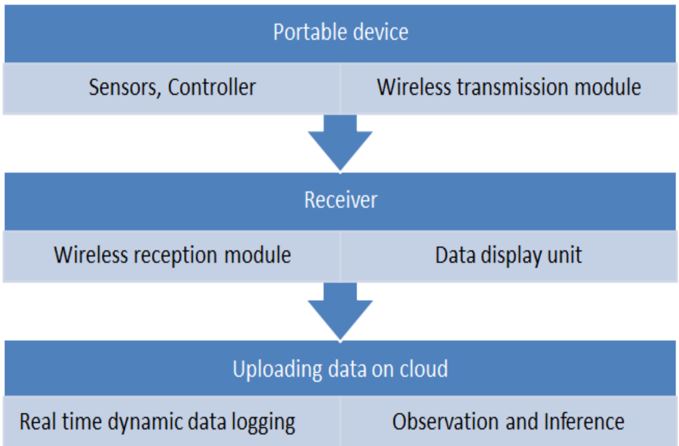

Fig.1. Working Scheme

The entire system working is segmented into three categories. First is the portable device which contains sensors and a controllers which transmits sensed parameters using transmitting module of zigbee. At the receivers, zigbee reception module receives the data and displays it on the monitor. This received data is also uploaded real time on the server [4].

III. NETWORK ARCHITECTURE

A. Transmission Section

The transmitting section is nothing but a portable device with sensors, ARM controllers and wireless transmitting module (Zigbee).

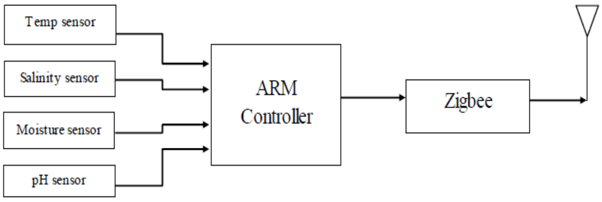

Fig.2. Transmission Section

B. Reception Section

The receiving section contains Receiving RF module, Controller and displaying unit.

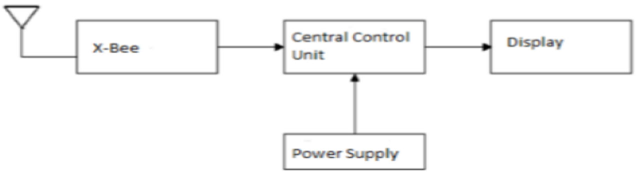

Fig.3. Reception Section

IV. HARDWARE DESCRIPTION

The component requirement for the system includes the following::

A. Sensors

The system uses multiple sensors interfaced individually to a controller to the general purpose input output pins of the controller to effectively draw information from them. There are in all three sensors used, which are listed below:

• LM35 is a sensor produced by Texas instruments for measurement of the temperature. It is a digital sensor used in this system for measuring soil temperature. The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature.

• Soil moisture sensor measures the volumetric water content in the soil. The sensor is digital in nature and is interfaced to the controller using berg wires.

• pH sensor is the third and final sensor used for monitoring the health of the soil sample. It uses a BNC interface to send data to the controller and transmit information to for analysis and interpretation.

• Salinity of the soil sample is Calculated from the following formula:

$$S = a_0 + a_1 R_t^{1/2} + a_2 R_t + a_3 R_t^{3/2} + a_4 R_t^2 + a_5 R_t^{5/2} + \Delta S$$

where ΔS is given by

$$\Delta S = \left[\frac{t - 15}{1 + 0.0162\,(t - 15)} \right] (b_0 + b_1 R_t^{1/2} + b_2 R_t + b_3 R_t^{3/2} + b_4 R_t^2 + b_5 R_t^{5/2})$$

Where
S: is the practical Salinity scale
R_t: Conductivity ratio
t: temperature of solution in Celsius degree (C)

Values a_0 to a_5 and b_0 to b_5 all are constants

Fig.4. Salinity Formulae[2]

B. Controlling device

• The system makes use of the FRDM KL25Z controller manufactured by Freescale semiconductors and enabled by the mbed platform

• The FRDM board makes use of a controller designed by ARM holdings and uses an online compiler to be coded and compiled.

• The controller has nearly 4 GPIO pins which enables interfacing with multiple sensors easily.

• Besides, it enables interfacing with the LCD device for displaying the data acquired from the sensors

C. Wireless Communication

For wireless communication we make use of the XBEE module. This module comprises of two units, one each for reception and transmission.
The transmission module is connected to the controller unit.
The XBEE modules communicate with each other at 2.4 GHz.
The reception module is connected to the computer where the data is published using a XBEE specific software. This data can be used to analyze and process the information transmitted.

D. Displaying Device

• In order to publish the data acquired from the sensors, we make use of two primary display units

O A 20X4 LCD display device is connected with the mbed board to directly display data at the location of data collection. The LCD display is connected to the controller using wires. The 80 pixels enables multiple sensor data to be displayed on the LCD.

O The secondary display unit is the serial monitoring software built in the computer itself. The data received by the XBEE module is displayed in the computer using a software specifically configured to receive from the XBEE.

V. RESULTS

As water is supplied to the soil sample, senor outputs are obtained and plotted as shown below:

A. Variation in moisture is plotted below

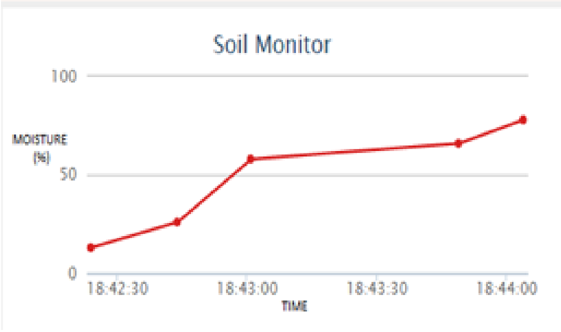

Fig.5. Moisture Variation

B. Variation in temperature (degree Celsius) is plotted with respect to time (seconds) below:

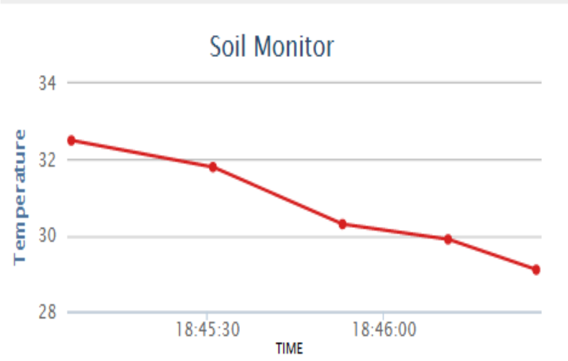

Fig.6. Temperature Variation

C. Variation in pH is plotted with respect to time (seconds) below:

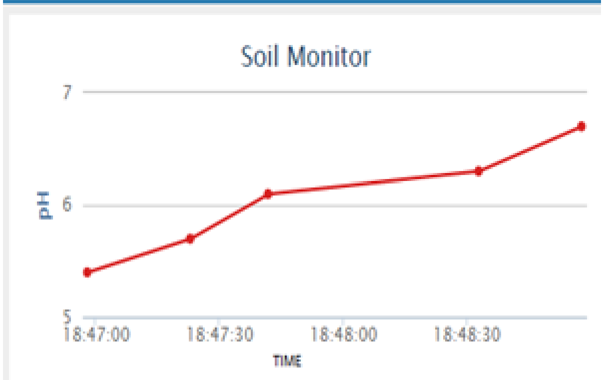

Fig.7. pH Variation

D. Variation in Salinity (gram/litre) is plotted with respect to time (seconds) below

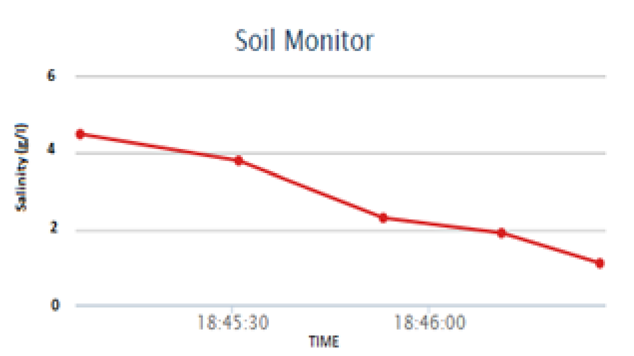

Fig.8. Salinity Variation

E. Observation and inferences:

From the observation recorded over a period of time, following inferences can be drawn.

Soil Parameters	Range		
Moisture	80% and above	50% to 80%	Below 50%
Temperature	28 C and below	28 C to 34 C	34 C and above
Salinity	0-3 g/l	3-6 g/l	6 and above g/l
pH	6 to 8	4- 6	Below 4
NPK absorption from soil (Prediction)	Good	Moderate	Low
Type of Crop	Grains, apple, mango, lemon, apricot , orange, almond etc	Pomegranate, fig, grape, olive etc	Date, other marine vegetation

Table 1. Observation and Inference

CONCLUSION

Growing concerns about environmental pollution by excessive use of fertilizers have led to increasing needs to monitor soil nutrients required for crop growth. The sensor network technology will help the farmers to know the soil requirements which will help them take better decisions and preventive measures at the right time. This will lead to tremendous improvement in the crop productivity. This, in turn, will save their time, labor, money and make effective use of resources. By uploading data on the cloud continuously over a period of time would enable the agriculture concerned authorities to take appropriate steps with regards to nutrient supply in the soil.

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