Smart Bi-directional Soil Parameter Monitoring using GSM Based Multi-Level Alarming

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Dinesh Sharma[1], G. S Tomar[2]

Abstract

The higher productivity from soil can we achieve through Wireless Sensor Networks (WSNs) technology due to this reason implementation of WSN in precision agriculture is increasing day by day. Among the different technologies for crop monitoring (WSNs) are recognized as a powerful one to collect and process data in the agricultural domain, with low-cost and low-energy consumption. The proposed system will use Global System for Mobile (GSM) technology for automatically monitor the parameter of soil. It transfer the soil data over the mobile network using the GSM modem. Under the hardware part sensors node units were developed. Which is used for fetching and loading data through the energy efficient GSM and this Bi-directional multi-level text messaging option to improve the efficiency of alarming system. The system contains pair of sensor like ph and humidity used to monitor collected soil data from sensors by the microcontroller. This paper focus different challenges and uses encounter and also discuss different results obtain by monitoring the various soil parameters in the real time Agriculture environment.

Keywords

Wireless Sensor Networks, Precision Agriculture, GSM, Soil Parameter Monitoring, Soil PH, Multi-level Alarming

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[1]Amity University Madhya Pradesh, Gwalior, India
[2]Machine Intelligence Research Labs, Gwalior 474011, India

Corresponding author:
Email: Sharma.dineshme@gmail.com, gstomar@ieee.org

Introduction

The productivity of the soil is required to increase using the continuous parameter monitoring. Wireless Sensors Network (WSN) is usually deployed for soil monitoring for increasing the production rate of the precision agricultural. The wireless connectivity of the sensors with the end users (which are formers in this case) is the major issue to address. Deploying WSN for monitoring environmental parameters and using GSM[1], for combining acquired data with a real time management system may solve the connectivity issue form former side. Using such smart precision agricultural may enable farmers to exploit their knowledge timely and efficiently to produce best results from their agricultural cultivation.

Increasing demand of food due to increasing rate of population also motivated many researchers to develop smart agriculture systems. During the previous decade, environmental monitoring by using sensor networks has received considerable attention. There is a considerable increasing growth in the field of Information and Communication Technology (ICT) in the developing countries. It is also observed that after the one crop season the alkanets of the soil are significantly changed due to use of the pesticides The assorted variety of area and climatic impacts upon horticultural development, alongside other natural parameters after some time settles on the rancher's basic leadership process increasingly convoluted and requires extra experimental learning.

The acidification of the soil is the natural process during the agriculture. The prime reasons of acidification are:

1. It is due to the increased concentration of the hydrogen ions, inefficiently using the nitrogen and excessive use of fertilizers during cultivation.
2. The excessive irrigation or rainfall may cause soil o loose the calcium (Ca) causing lower pH value and therefore soil may tends to acidic.
3. Using the fertilizers like ammonium nitrate, ammonium sulfate and urea may oxidize the soil due to presence of ammonia to cause acidification. Therefore it is required to analyze the soil pH value and parameters like humidity and temperature for more productivity.

The acidity of the soil can be controlled by increasing the soil pH value. The nature of the soil and its comical composition can be correlated with the pH value range of the soil samples. There were many test methods and approaches designed for monitoring the soil pH values. The soil samples can be acidic or alkaline based on the range of the pH values.

For the ideal crop soil the pH range is around 7 as shown in the soil samples pH range in the Figure 1. Therefore it is required to analyze the pH performance for the soli quality. It is of importance to identify the acidity or alkalify of the soil samples as mentioned in the Figure 1.

The paper is therefore focused to test the pH performance over the soil samples of Madhya Pradesh state of India. The acidity present in the soil indicates the availability of nutrients within it. The measure of the acidity is referred as pH of the soil, though more strictly it refers to the pH of the soil solution. The pH is chemical property of the soil. In addition amount of Magnesium, and Nitrous Oxide (N_2O), Phosphates are the additional chemical properties to measure. Paper focuses on the measurement of these properties using sensors.

1.1 Background of Wireless Sensor Networks

The WSN has emerged from advancements in the areas of micro-electromechanical system (MEMS) technology, wireless communication, and digital electronics. An example of the basic hardware

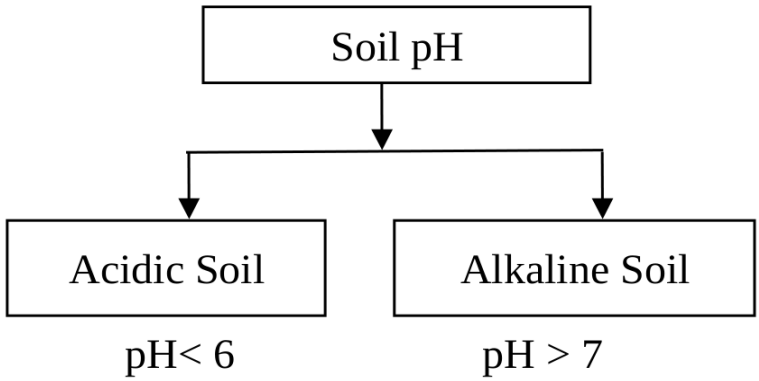

Figure 1. Soil pH and its nature

architecture of the WSN for soil parameter monitoring is given in the Figure 2. It is clear from the Figure 2 that the life of sensor node depends on the life of the battery, Thus WSNs devices are small in size, low cost, and require low power to work. The basic structure of WSN sensor nodes is shown in the Figure 2 below .There are four main components that makes up a sensor node. The parts are namely: a sensing unit, a processing unit, a transmission unit and a power unit. In this paper designing of the sensor unit with low cost is proposed and for the communication and connectivity GSM is proposed to used. The Arduino based controller boards are used for the sensor interfacing and processing. The board is having its own inbuilt ADC module used for the analog sensor read.

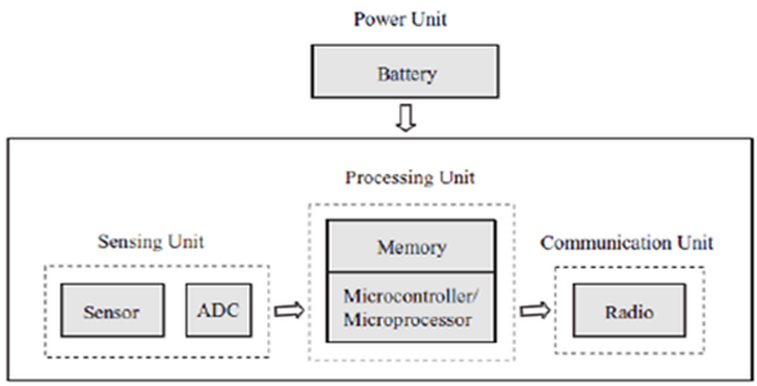

Figure 2. General Board Structure of WSN Sensor unit

Depending upon the type of application a sensor node may have additional parts. Sensing unit usually takes the burden of sensing and gathering sensor data and then passes the data to the processing unit. The processing unit receives the sensed data and processes it according to a set procedure or program. A transmission unit connects sensor not with a network. Power unit supplies power required to run the sensor nodes.

Table 2. Hardware Platforms Boards

Hardwires Boards	**There Descriptions**
Aurdino	Used for ZigBEE, GSM and is Less Costlier
Resbery pi	Slightly Costlier but more efficient WSN
IOT based	Costliest and need WiFi connectivity but used for Lage scale Integration of data.

Based on the different applications of the hardware boards availability many sensor modules were designed the basic description of the available hardware boards are given in t eh Table 2. It is clear from the Table 2 that Aurdino boards are less costly easily available and are also compatible with GSM thus are selected as the choice for the current paper to work.

Classification of the WSN Systems

WSN systems are classified as shown in the Figure 3. This classification is based on technologies supported by the Arduino boards. The WSN can be designed using any of these combinations. As already discussed that due to simplicity and size the Arudino board is proposed to use the sensor interfacing unit as shown in the Figure 3.

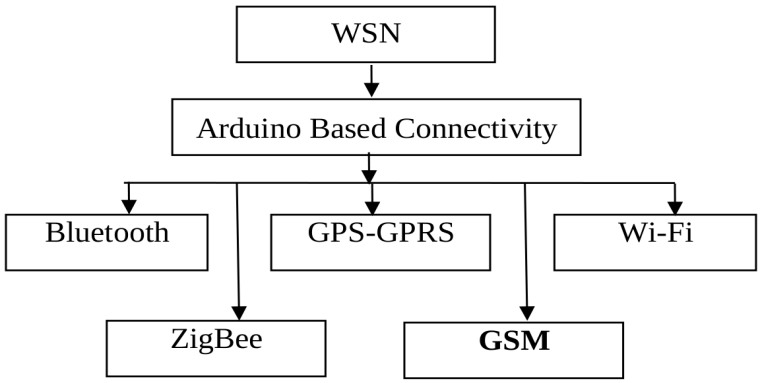

Figure 3. Classification of Aurdino based WSN

Literature Survey

Saravanan Ragavan et al[1], have discussed GSM Based Low Cost Smart Irrigation System with Wireless Valve Control. In this paper they discussed about IoT is brought forwards to use in automatic irrigation, Any cell phone can send command to the controllers or collect information from the controller. Only

during day time a valves can be controlled because of solar photovoltaic. GSM and radio frequency provides credible communication for the devices. Aishwarya T et al[2], have discussed about Arduino Based Automated Irrigation System in 2017. In this paper they focus about system, which can save manpower, water to improve production and ultimately increase profit, The automated irrigation system is feasible and cost effective for optimizing water resources for agricultural production, The system would provide feedback control system which will monitor and control all the activities of irrigation system efficiently

G. Ravi Kumar, et al[3], have discussed Smart Irrigation System, In this paper they discussed a contemporary design technique of monitoring and controlling the moisture level of soil using Lab VIEW. The project also includes rain sensor. R. A. Pagare et al[4], have discussed about GSM based Automated Water Deployment System for Irrigation using Wireless Sensor Network & Android mobile. In this paper they discussed about GSM module (mobile), Android, SMS Wireless Sensor Network, automatic irrigation, Zigbee, sensors, microcontroller, regulated power supply. The primary drawback is that this proposed system will mostly applicable for only large size farms. It will require frequent maintenance for efficient operation. Sometimes this system will have limited life due to deterioration of the component in a hot, arid climate when exposed to ultraviolet light. WSN networking stacks employ techniques to coordinate the nodes sleep schedules and maintain states at each of the network's motes (e.g., routing entries, link quality information, etc.)[3]. In turn, implementing these techniques leads to networking software with increased complexity running on resource constrained motes. This complexity coupled with the unexpected and untested environment in which the network is deployed can lead to failures[4].

Pavithra D. S et al[5], discussed about GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile. In this paper they discussed about GSM module (mobile), Android, SMS, automatic irrigation, microcontroller, Temperature sensor, soil moisture sensor, regulated power supply.

Qiang et al[6] presented hierarchical based WSN for soil parameters measurement Viz. humidity and Soil Water Temperature (SWT). They have designed sensor nodes which are placed in fully underground condition to collect the soil parameter measurements. These wireless nodes deliver the collected data wirelessly to the relay nodes placed above the ground. Relay node forwards the data to base node. They have used the probabilistic protocol architecture.

Roopa Mahadev et al[7] discussed about Arduino Automatic Plant Irrigation using Message Alert Based, they discussed some important points like Soil moisture sensor, Arduino, Relay, GSM this project serves as a motivation for farmers who are declining in number day by day due to lack of technology and sophistication. This system provides several benefits and can be operated with less manpower. Rohit Somvanshi et al[8] discussed about Smart Irrigation System Using Mobile Phone, in this paper they discussed about some important topic like Smart irrigation, Soil moisture, GSM, Laser fencing, Zigbee. By implementing the proposed system there are various benefits for the government and farmers. For the government a solution for energy crisis is proposed. By using the automatic irrigation system It optimizes the usage of water by reducing wastage and reduce the human intervention for farmers. This Technology in future will enable the farmer to control and view farming direction from home through various methods like internet, mobile.

Aprajita Anand et al[9] have discussed about GSM based agriculture monitoring systems. In this paper they discussed some important points like GSM, agriculture, soil moisture sensor, temperature sensor, monitoring, Arduino. The progress in electronics and telecommunication engineering, paved way for new

inventions and technologies. As we are moving towards miniaturization, handy components are needed which has better accuracy and reliability. Here we are developing an embedded system which will help in agricultural field to monitoring field. Matenge GR et al[10] have discussed about Soil Moisture Based Irrigation Test in a Remotely Monitored Automated System. They explain some important topic like Soil moisture sensor; Solar system; Microcontroller; GSM modem; Automated irrigation system. More efficient technologies are beneficial in lowering the cost of production due to reduced pumping cost and leaching of nutrients. Fertigation allows easy manipulation of nutrients to meet plant needs.

V. Rodoplu, et al[11] have designed a position based distributed network WSN protocol designed for energy consumption minimization for mobile based networks which was designed to impairment the peer to peer WSN system.

R. Yan et al[12] have presented a sensor node design an approach based on energy awareness for application in wireless sensor network design. They present the design and implementation of energy aware sensor node, which can help in constructing energy efficient WSNs by calculating distance between nodes, periodic sleep/wake up scheme for data transmission. Hence, they talked energy saving can be achieved by unique network configuration and choosing the most energy efficient one[12].

Bin, èt al.[13] presented an energy optimization technique for the wireless sensor Network. They have shown how the energy can be optimized in the WSNs. They utilized the Dijkstra shortage path algorithm to calculate the optimal order of transmission distance from source node and sink node. But the method seems to be bit slow and conventional[13].

Pavithra D. S et al[14] have discussed about GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile, in this paper they explain some important topic like GSM module (mobile), Android, SMS, automatic irrigation, microcontroller, Temperature sensor, soil moisture sensor, regulated power supply. Irrigation has been the backbone of human civilization since man has started agriculture. As the generation evolved, man developed many methods of irrigation to supply water to the land. In the present scenario on conservation of water is of high importance. Present work is attempts to save the natural resources available for human kind. By continuously monitoring the status of the soil, we can control the flow of water and thereby reduce the wastage.

Stephan et al[15] have proposed a technique to localize a scheme for wireless sensor network utilizing artificial Neural Network and Genetic Algorithms. They invented a WSNs using artificial neural network as the machine learning algorithm and genetic algorithms to select the best ANN structure[16] but the technique was too lengthy and was not accesible for real time applications like soil monitoring. N. Javaid, et al.[17] invented an energy-efficient enhanced distributed developed clustering for designing a heterogeneous WSN network. In this paper, they invented a novel clustering based routing method for heterogeneous WSNs. Method was based on dynamically changing with maximum efficiency CH election probability[18].

R. Bulli Babu et al[19,20] have proposed a GSM based system for monitoring the agricultural based systems. They have designed a sensor for controlling the temperature and water level in the field. For communication GSM was used. The automation system was designed using the microcontroller based system. System was designed for alerting the farmers in case of emergency. Jayshive et al[21,22] have recently perfrom the experiment for measument of phosphorous in central India soil. They have used the chemical test approach and the pH value is measured using the pH meter for analysis of the soil phosphorous. Over all from the literature review it can be concluded that existing GSM based systems

works uni-directional communication and there efficiency is also less. Thus this paper is focused to improve the efficiency and the reliability of the GSM based system using Bi-directional mode.

Components of Soil Parameter Monitoring

For increasing the accuracy of precision agriculture continuous soil parameter monitoring is essential. The soil parameter monitoring enables us to develop site specific crop field management (SSM) systems for automatically fulfill the requirements of the soil and crop as they grow. Careful soil monitoring may help to develop the sustainable ag the high climate changes. Antonio Delgado et.al (2016) have classified the soil properties as Physical, chemical and biological properties.

Harvest field checking is a urgent practice in agribusiness to decrease asset squander and to expand yield in exercises like water system and treatment, since it enables ranchers to access to strong data on the ecological, soil, and plant conditions and varieties of their harvests and settle on choices from that point. In spite of the fact that yield field checking have been made generally with HR, single-point agro meteorological stations, and sensor wired systems, this theme inundate in exactness horticulture request a high thickness and adaptable sending of instrumentations to gather information progressively. WSNs have risen to offer minimal effort, adaptable, simple arrangement, and high-precision points of interest for harvest field soil observing progressively.

In this paper the various effects of variations in the soil properties and their impact on the agricultural production are addressed. Paper also addresses the methodologies to measure the soil parameters using the sensors. There are various physical properties of the soil such as conductivity and humidity which are very important for crop field monitoring. The various components including the sensors and the supporting accessories to test properties of the soil are monitored in the Table 3 below.

Table 3. Different soil parameter sensors and accessories used for the proposed WSN

Accessory	**Properties**
Arudino UNO	2560 processor. A board with internal ADC with 6 analog read channels works at the 5 V supply.
LM 35	up to 50 °C Sense temperature
FC-28 or YL 69	Humidity Sensor: Used to monitor the moisture content within the soil
GSM Modem	900 MHz band Used for the communication
pH Sensor / pH meter	Campbell measures the soil pH
weight machine	Soil measure for the weight calculation

As the productivity directly depends upon the nature of the soil and its properties. For example different crops need different soil moisture and humidity contents. Continuous agricultural usages may have probability to change the pH value of soil which may significantly affect production of crop. The sensors mentioned in the Table 3 include moisture measurement and the soil pH measurement. DAM is used for the communication device works at the 900 MHz band. The goal of work is to provide two way Bi-directional communication between field and the users. The pH values are tested and verified by calibrating the pH meters in pharmacy lab and is checked by the Campbell's pH value sensors interfaced using the arudino board in real time also.

Proposed Network Architecture

Out of various different possible approaches for Wireless Sensors Network in this work it is proposed to use the GSM based networks since it may gives the long range coverage and can be easy to use by users. Although many systems have been designed using the GSM for soil monitoring. But major challenge is the bidirectional connectivity and security is missing. In this paper the GSM based Agricultural system is proposed using the Bi-directionall communication with multi level alarming system.

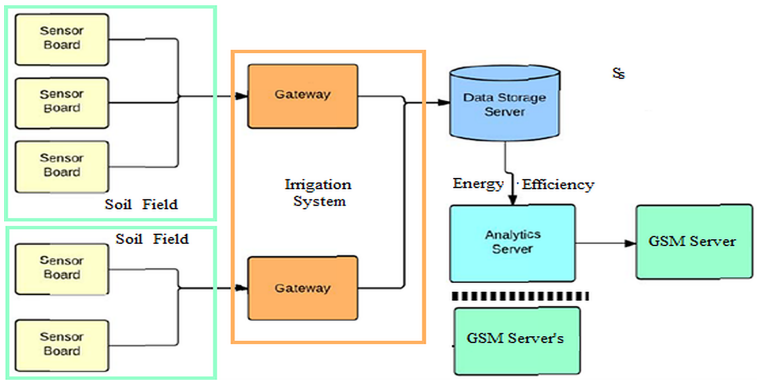

Figure 6. Proposed block diagram of the soil monitoring on the field using GSM based sensors network implementation

The basic block diagram of the proposed GSM based system is shown in Figure 6. It can be observed from the Figure 6 that the irrigation soil field is divided into sensors grids. The data collected from the sensors are stored on the local server called data storage server. The field sensors are connected to the GSM network through GSM modem. The proposed work is elaborated further in two phases as;

1. In phase one basic Irrigation or Agricultural system is implemented using the sensor based hardware unit.
2. In Second pass the Bi-directional secured communication is proposed to establish for increasing the reliability of the architecture WSN. The yield from the sensor is a simple yield that can be associated with one of the simple to advanced port (ADC) accessible on the microcontroller board.

The yield from the sensor is a simple yield that can be associated with one of the simple to advanced port (ADC) accessible and available inbuilt on the microcontroller board such as Arudino board.

5.1 Proposed Bi-directional Soil Moisture Monitoring Using GSM

The proposed soil sensor is soil moisture sensor FC-28 or YL 69 accompanies a couple of tech text probes which can be placed within the soil as shown in the Figure 7 a). These sensors have flat rectangular tapered end electrodes. A little current is produced between the probes electrodes under the presence of the moisture and the degree of resistive opposition will be estimated. It is observed that soil resistance increases when soil gets dryer. These sensors are considered to measure the moisture using electrical properties of the soil.

Soil moisture sensors are utilized for testing the amount of moisture present in the soil on the field, when the soil is having the lack of water, the sensors analog output reads the high level, else the output of sensor is at the low level. Soil moisture sensor can be use in the smart water irrigation system blossoms just as harvests or some other plants requiring programmed watering methods.

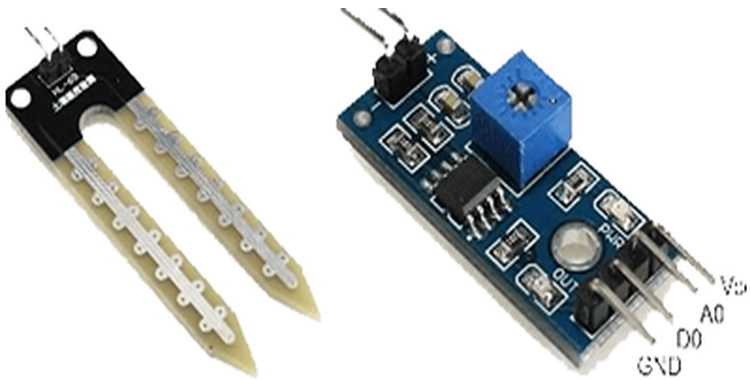

Figure 7. Basic capacitive Soil Moisture measuring sensor a) YL-69 Sensor probes or electrodes b) the Shield for interface

Soil moisture sensor probe module contains the 2 pins as Vcc and ground, as shown in the Figure 7. Which are associated with its shield so that it may be compatible to any sort of microcontroller gadget like the Arduino boards? It usually works on the concept of the analog data acquisition technique. The soil moisture sensor gets the data from the moisture of the soil and generates a small amount of voltage signal to the analog pin. This pin reads the coming soil sensor signal and the Arduino microcontroller gives the output according to the read data. Since the read signal will be in the analog form therefore, it has to be converted into the percentage moisture value. The formula for calculation of percentage moisture is defined as;

$$\text{Percentage moisture} = 100 - \frac{\text{analog value}}{Q} \times 100 \tag{1}$$

Where the maximum quantized value Q for the digital resolution for the 10 bit ADC on the Arduino board will be

$$Q = 2^{10} - 1 = 1023 \tag{2}$$

In order to maintain the real-time working the maximum threshold of Q is set to marginal in terms of percentage. That means the upper limit of moisture is set as 80-90 percentage for cutting off the water supply using SMS through GMS module.

The major benefit of using the FC-28 / YL-69 sensor as the moisture sensor is that it has capability to adjust the sensitivity. Therefore, soil moisture sensor modules were calibrated to perform the accurate sensing operations. A sensor pot with potting soil was taken and the levels of moisture are regularly changed during calibration. The pot was exposed to hot sun in order to get rid of the moisture. This

allowed us to simulate the dry soil environment although this is verified by the pot testing under dray soil further. Another benefit of YL-69 is that it has the configurable moisture threshold level capability. Threshold can be set by analog value basis based on the soil environment and properties.

The circuit description of the soil sensor interfacing with Arduino board is presented in the Figure 8. The sensor probe is connected to Arduino analog read through the shield pot. The shield has four pins output as Ground (GND), D0 (digital read), A0 (analog read), and Vd as the supply pin. The threshold of the soil analog value is set through the coding experimentally.

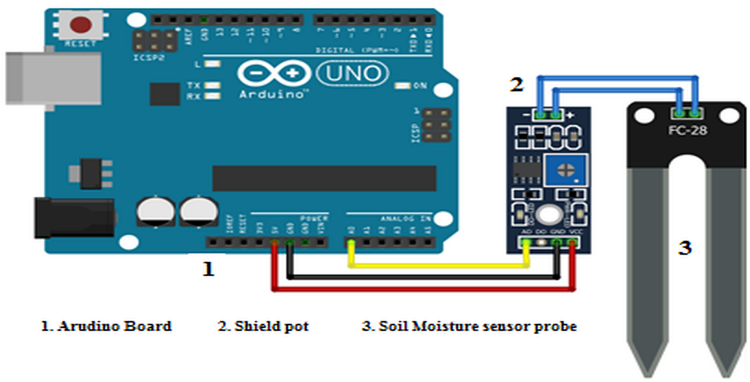

Figure 8. Connections for the Arduino based Soil Moisture sensor Interfacing Unit using YL-69 sensor probe (electrode).

The pin description for LCD-Arduino interfacing is given in the Figure 9.

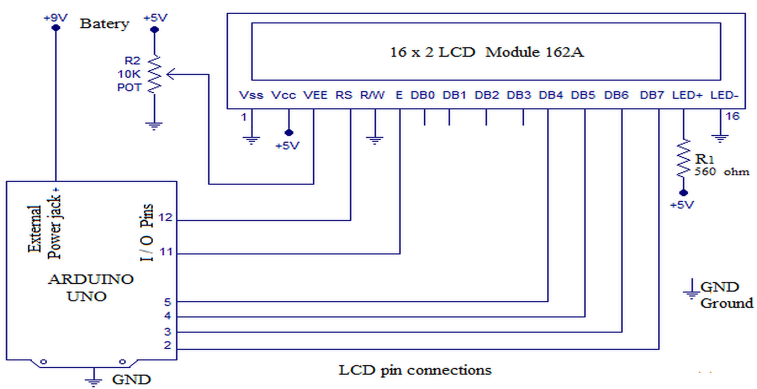

Figure 9. Circuit Layout descriptions for Arduino interfacing with LCD display [14]

Connection between the sensor probe and the Arduino board is shown in the circuit in Figure 8 and are achieved with the following sequential hardware pin descriptions as shown in Table 4.

Table 4. Hardware Pin abbreviations and Descriptions

Pins	Descriptions
Vcc	Is connected to the pin having +5 V supply on the board or shield
GND	is connected to the Pin GND and is meant to common Ground
A0	is the output pin on the shield is connected to the analog read pin of the Arduino board.

5.2 Methodology

Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. One common type of soil moisture sensors in commercial use is a Frequency domain sensor such as a capacitance sensor. Another sensor, the neutron moisture gauge, utilizes the moderator properties of water for neutrons. Soil moisture content may be determined via its effect on dielectric constant by measuring the capacitance between two electrodes implanted in the soil. Where soil moisture is predominantly in the form of free water (e.g., in sandy soils), the dielectric constant is directly proportional to the moisture content. The probe is normally given a frequency excitation to permit measurement of the dielectric constant. The readout from the probe is not linear with water content and is influenced by soil type and soil temperature. Therefore, careful calibration is required and long-term stability of the calibration is questionable.

- In This sensor We are using 2 Probes to be dipped into the Soil
- As per Moisture We will get Analog Output variations from 0.60volts – 5 volts Input Voltage 5V DC

Results and Discussion

This section presents the sequential procedure and the results of the proposed Bi-directional GSM based Soil monitoring system. The paper presents the result s of soil moisture sensing and also the pH value analyses of the test soil samples are presented. The sequential steps of the entire WSN designing with the GSM is presented in the Figure 10 with three stages as 1) Device and parameter initialization, 2) moisture analog value reading, 3) Message communication and interfacing using GSM modem. Our major contribution is at the 3rd stage where multilevel alarming and security system is designed for better user repose.

Steps of Clustering based WSN

6.1 Results of Sensing Soil

The sensor unit or probe device continuously takes the moisture data from the soil samples under test and if the percentage moisture present in the soil gets lower or greeter then the set limits of thresholds then GSM module gets active and it provides user former a warning message as text through the SMS that

Humidity level is low please turn on motor

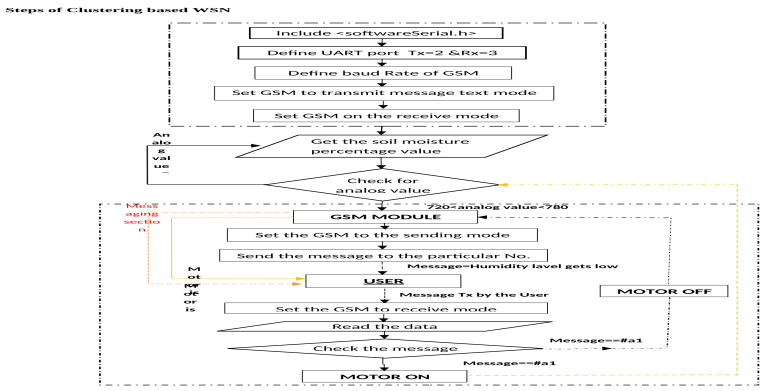

Figure 10. Flow Char of proposed Bi-directional Alerting and GSM based soil monitoring system

The examples of the text message sent to the users mobile phone mobiles as multi level alarming are shown in the Figure 11.

Figure 11. Result example of the percentage moisture based sent SMS sequence as mufti level GSM based text alarming system schemes.

6.1.1 Flow Chart of Moisture Sensing

The design flow for the soil moisture sensor reading is shown in the Figure 12. First the analog value read from sensor is converted to the percentage moisture. The analog value is compared to threshold. The text message is sent using AT command through GSM modem accordingly.

6.2 pH Value Analyses

Farmers frequently ask, .What effect does pH have on availability of nutrients in the soil?. There is no simple answer to this question, since the effects of pH are complex and vary with different nutrients.

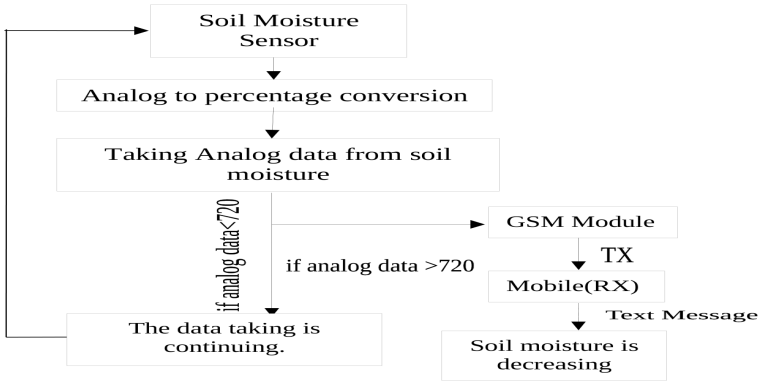

Figure 12. Flow chart of soil moisture interfacing using thresholding with GSM module system.

However, some broad generalizations are useful to keep in mind when making nutrient management decisions....

Soil pH The first order of business is a quick review of pH and -the associated terminology. Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases, thus becoming more acidic.

From pH 7 to 0, the soil is increasingly more acidic, and from pH 7 to 14, the soil is increasingly more alkaline or basic. Using a strict chemical definition, pH is the negative log of hydrogen (H+) activity in an aqueous solution. The point to remember from the chemical definition is that pH values are reported on a negative log scale. So, a 1 unit change in the pH value signifies a 10-fold change in the actual activity of H+, and the activity increases as the pH value decreases.

To put this into perspective, a soil pH of 6 has 10 times more hydrogen ions than a soil with a pH of 7, and a soil with a pH of 5 has 100 times more hydrogen ions than a soil with a pH of 7. Activity increases as the pH value decreases. Agronomists generally use soil pH as measured in a 2:1 water-to-soil mixture as an index of a soil is acidity or alkalinity. In a soil test report, pH is often reported with descriptive modifier as shown in Table 5. It can be observed that this gain chart in the table can be used for interpreting the type of the soil tested based on the measured pH values as Acidic, Normal or Alkaline. The green colour represents the Acidic soil range between the pH ranging from 4 to 6. The pH ranging 7.5-8.5 represented by red colour is for alkaline soil. The most suitable soil for the crop field is the pH value ranging from 6.5 to 7.5 represented from yellow colour in the chart. The soil ph is tested and gain chart is used for decision making for utilization of the fertilizers.

The percentage nutrient availability in the soil is represented by the bar graph in the Figure 13. It can be observed from Figure that as the soil pH range increases the Acidity of soil decreases as a result the percentage of nutrients (as Nitrogen Phosphorus and Potassium (NPK)) also increases[19]. For the pH ranging around 7, approximately 100% nutrients are present in the soil and thus the soil is suitable for the crops. The relation between the nitrogen, Phosphorous, and Potassium (NPK) with the soil pH values are discussed sequentially in this section.

Table 5. Soil pH Test Ranges for Validation and Interpretations

soil type	Soil pH Range								
	4.5	5	5.5	6	6.5	7	7.5	8	8.5
Acidic									
Medium Acidic									
Slightly Acidic									
Normal					Best range for crops				
Slightly Alkaline									
Moderate Alkaline									

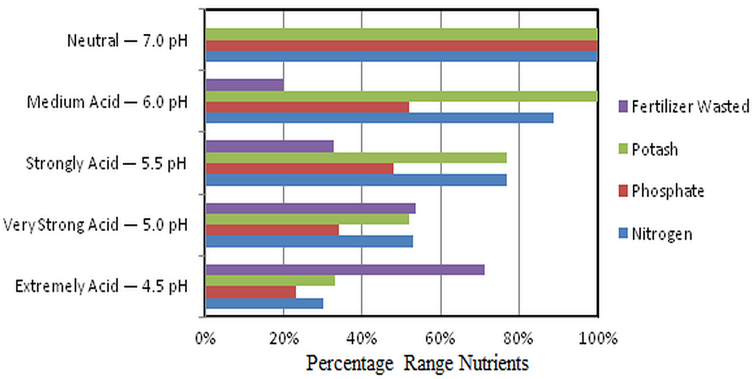

Figure 13. Comparative ranges of percentage nutrients available in the soil with the fertilisation

6.2.1 pH Value Analysis

In this paper an experiment is performed in the pharmacy lab for measuring the pH values of the soil samples from the Gwalior district of central India. The results of the pH values measured using the pH meter is shown in the Figure 14. It can be observed that the pH values increases with the decreasing soil moisture percentage in the sample or in other words as soil gets dense. During the each test value the water is kept constant.

Since, soil pH availability plays a significant role in identifying the nutrient availability. Keeping this fact in mind this paper presents the pH value analysis for the Gwalior soil samples. It is observed that a soil tends to acidic with the time due to the excessive uses of the NH4 + based fertilizers by the formers. The soil pH values are taken using the pH meter in the lab environment with the increasing proportion of the soil content and decreasing moisture content. It is observed that the availability of the nutrients in the soil depends on the pH ranges.

Nitrogen Vs pH: The nitrogen (N) .is a most important soil nutrients. At pH is near neutral (6.5 pH 7.5), crops generally absorbed nitrate. It was observed that content of the nitrate in the soil increases with the pH value increase. As an example, for ph of around 7 the equilibrium condition is near 99% of ammonium (NH4+) and just only 1% nitrate (NH3.) .this range of nitrate increases to around 1 to 10% for pH of 8. The content of the more nitrate signifies the loss of the fertilizers like urea. It can be observed from the Figure 14 that with the increasing soil weight the amount of pH reaches to around 8 for 11 gm

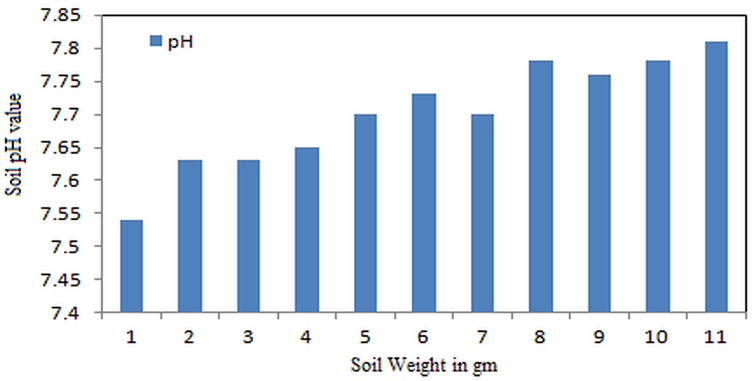

Figure 14. Measurement of the soil pH values for the Gwalior soil with 20 ml water and increasing the soil weight

of soil. This makes the soil to have more nitrate (NH3) and may cause loss of fertilizers. Although, pH value is not only factor which is responsible for these losses? There are many other factors as climatic condition and kind of soil is also responsible for loss of the fertilizer efficiency.

Phosphorus Vs pH: It is observed that the availability of the phosphorus (P) in the soil can also be analysed based on the pH rages. For the acidic soil with pH lies within 6 to 4 the presence of the micro nutrients like iron (Fe) and aluminium (A1) may react with P to form the A1-P and Fe-P minerals. These at les pH are more stable and additive in the soil and may cause loss of P in the soil. while at higher pH>8 for alkaline soil P react to form Ca-P which is more dissolvable thus relatively more suitable for crop and plants.

Potassium Vs pH: In the long term increasing the pH value of the soil using fertilizers may reduce K availability but this is a slow process due to the displacement of exchangeable K particle by Ca.

Micronutrients

The presence of the micronutrients particles like iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), or boron (B) in the soil may decrease with the increasing pH value in the soil. It is because of the formation of compounds with low solubility in the soil,

Conclusion

In this paper the multi-level security and alarming system is proposed for automatic monitoring of the soil moisture using the GSM modems. As exponential mobile uses and coverage with the time the GSM availability is not an issue at the farm field and with the formers. Paper discusses the each and every aspect of the connectivity and communication issues for improving the performance of the GSM based system in agriculture uses. The interfacing of the Arduino boards with the GSM modem and with the sensor units are also discussed. The Bi-directional communication is established between the user and the sensor unit using GSM modem. The short message service (SMS) is utilized for communication and alert. The sequential implementation detail of the WSN using the proposed GSM system is explained. The proposed system will provide the better connectivity of farmer with the field.

As another experiment the soil pH value is analysed and is correlated with the nutrients availability in the soil. As an experiment the ph values are measured with the increasing weight of the soil. It is observed that the soil pH increases with the increase in the soil weight for the same water content. This causes soil to have more nitrate (NH3) content and it may cause loss of fertilizers efficiency. Overall paper contributes to provide multilevel alerting system for improving the connectivity and response by the users. And also performs the analysis of correlation between the soil pH and the nutrients availability in the soil and its productivity. In the future uses of fully automatic pH analysis system a bit difficult task can improve the performance.

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