Automated Soil Testing And Monitoring

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Abstract –
For ages, agriculture has always had a very special place in the lifestyle of an Indian. Agriculture and its associated activities contribute about 15% of Indian gross domestic products. However, in spite of all the development, the agricultural methods that Indians use are still way old. The inability to obtain soil characteristics rapidly and inexpensively remains one of the biggest limitations of precision agriculture. Major constrain in these methods includes inadequate soil testing facilities and lack of awareness among farmers. Soil fertility is the major factor to be looked for getting better yield. This paper is about how the system checks the moisture, pH and nitrogen content in the soil along with temperature. The system increases soil productivity and enables optimum use of available resources.

Keywords— Microcontroller, soil analysis , soil sensor, CCD, LCD, Zigbee module.

I. INTRODUCTION

In our country the economy is mainly based on agriculture. Conventional soil testing methods are costly and time consuming. This expense limits the number of samples analyzed per field and we are not able to make optimal, profitable and sustainable use of our land resources[1]. The main reason is the lack of knowledge regarding the soil analysis for the growth of crops. In every state around 9 to 10 lakhs soil samples have been received in laboratories and it is very difficult to test all the soil samples in time. By the time test reports are generated, harvesting is on the verge of completion. Hence there is a need for soil analysis to be made available to the farmers[1].

This paper focuses on how to develop on field testing system which can be used for soil analysis which in turn helps the farmers to cultivate and produce the proper crops. Crop requires the essential nutrient for its normal growth, Nitrogen (N), Phosphorus (P) and Potassium (K) are known as primary nutrients. Secondary nutrients: iron, manganese, copper, zinc, boron, molybdenum and chlorine trace fewer in amount. The fertilizers available are the complex of NPK which are mixed in different proportion[2]. The idea about monitoring the crop fields area without man power, which utilizes the sensors in crop field area using wireless Sensor network (WSN). The sensing and monitoring the temperature, pH, humidity and nitrogen level of the crop gives efficient filed monitoring. The advantage of using wireless sensors networks in agriculture are distributes data collection, monitor and control of climate, irrigation and nutrient supply.

II. SYSTEM DESCRIPTION

The main objective of our project is to design an automated system which on field measures soil parameters using sensors. Here we are using self designed soil moisture, pH and temperature sensors. Moisture sensor measures the relative humidity of the soil. pH sensor gives the pH value of soil between 0 to 14[3]. Nitrogen content present in leaf is analyzed by using Charged Coupling device (CCD). MATLAB image processing is implemented to extract the green content of the leaf. In this system, the main controlling device is Microcontroller PIC 18f25k20. It has high performance RISC CPU, C Compiler Optimized Architecture and Optional extended instruction set to optimize re-entrant code. Here the sensors will give the status of the soil to the microcontroller which performs tasks and processes data. The sensing unit converts the analog signal to digital signal (ADC), based on that microcontroller will display the status of the soil on the LCD. The collected data is transmitted wirelessly through the Zigbee module[1]. The wireless trans-receiver transmits the data to a remote location or designated authority in the agriculture department for further analysis & suggestions.

Automated Soil Testing Device is a portable device which can be used either in laboratories or on the identified spot selected for farming so that the farmer need not take the pain of visiting the soil testing laboratories which are normally located in district headquarters. It is a simple & user friendly device so that any person can test the

the soil without the presence of an operator.

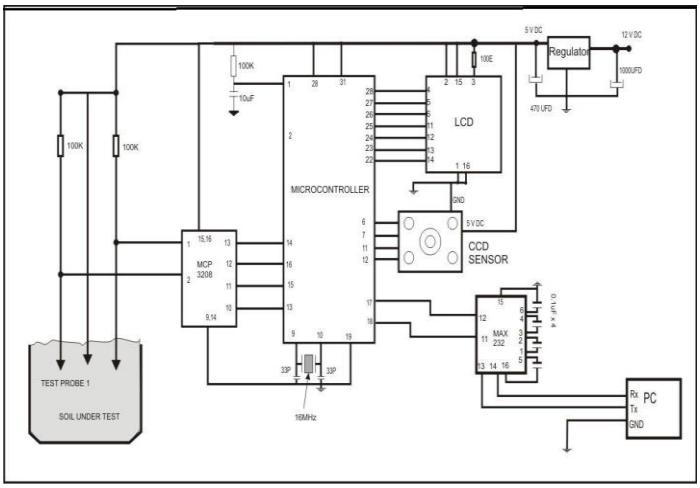

Fig.1 Block Diagram

A. Field sensor system

We implanted various sensors like temperature, light sensor, pH electrode, and water level throughout the test field. The sensor system composed of the following elements: 1)PIC18F25k20, 2) Zigbee, 3) CCD, 4)Power source.

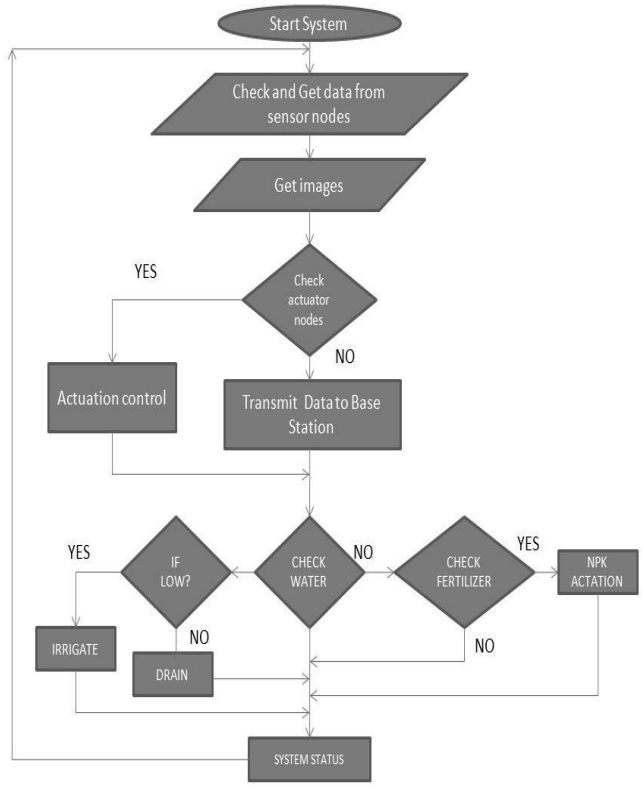

Fig.2 Flowchart of Field Process

Moisture is the amount of water content in soil. It is the most important factor for plant to survive and plays important role in photosynthesis. The water-holding capacity of a soil depends on its type, organic matter content, and past management practices, among other things[4]. Moisture sensor works on the principle that water conducts electricity. The wetter the soil, the lower the electrical resistance and the better the block conducts electricity. Electrical resistance blocks work by absorbing water from the surrounding soil. They need to be buried carefully[5].

pH stands for potenzy hydrogen. 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 and conductivity increases. The output of pH sensor is given to MCP 3208 ADC which gives digital value to Microcontroller and pH is displayed on LCD. Agronomists generally use soil pH as measured in a 2:1 water-to-soil mixture as an index of a soil's acidity or alkalinity[1]. In a soil test report, pH is often reported with descriptive modifier as shown in Table 1.

Soil Reaction Description	pH Range	Crop Response
Extremely acid	Below 4.5	Very Poor
Very strongly acid	4.5-5.0	Poor
Strongly acid	5.1-5.5	Moderately good
Medium acid	5.6-6.0	good
Slightly acid	6.1-6.5	Very good*
Neutral	6.6-7.3	Very good*
Mildly alkaline	7.4-7.8	Moderately good
Moderately alkaline	7.9-8.4	Poor
Strongly alkaline	8.5-9.0	Very good*
Very strongly alkaline	Above 9.0	Few grow

Table1. Crop response for different pH range

The CCD is a major piece of technology in digital imaging. In a CCD image sensor, pixels are represented by p-doped MOS capacitors. These capacitors are biased above the threshold for inversion when image acquisition begins, allowing the conversion of incoming photons into electron charges at the semiconductor-oxide interface; the CCD is then used to read out these charges[6].

B. Field Actuator System

Of all plant nutrients, nitrogen is required in the highest amounts. It is also the nutrient that is most often

deficient because of the dynamic nature of its cycle in the soil and many pathways of loss. Most of the nitrogen (N) in the soil is held in organic matter as organic nitrogen, a form that plants cannot use. Soil micro- organisms convert organic nitrogen into ammonium (NH4+) and nitrate (NO3-).It is an essential component of proteins such as chlorophyll, which are necessary for plant growth. It aids in the uptake of other nutrients .It is involved in root growth and development.

The actuators includes 1) Micro valves, 2) Irrigating Channel. Each valve is connected to tank which contain fertilizer in liquid form and water. The status of each tank is got by the sensor system. The NPK proportional is decided by the computation process[11]. With the help of CCD sensor we will determine the green content of leaf using digital image processing.The nitrogen content will be determine from the green content of leaf.

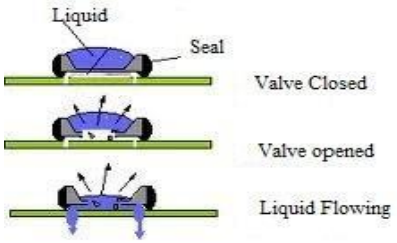

Fig.3 Micro valves

C. Transmission System

The data collected at each sensor node is transmitted wirelessly through the ZigBee module. It is low data rate, low power and low cost wireless personal area networks. It is a RF transreceiver module with operating frequency of 2.4 Gigahertz and data transmission rate of 256kbits/sec. The microcontroller performs tasks, processes data and controls the method in sensor system[9]. The sensing unit have the sensor node which converts the analog signal to digital signal (ADC).

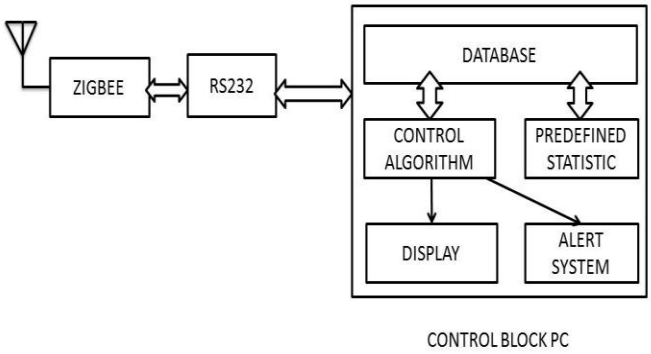

Fig.3 Base Station

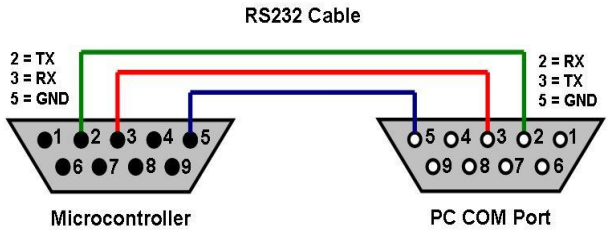

Fig.4 RS232

RS-232 stands for Recommend Standard number 232.It is a protocol with which Microcontroller communicates with the external world. It provides communication between Microcontroller and Zigbee in RS 232 format. It converts the TTL logic to CMOS logic and vice versa[8]. The hardware used in this project is simulated using the Proteus.

III. CONCLUSION

This paper presents a system with features which are not available in present system of soil monitoring. After conducting a detailed survey on present system of soil testing, we found that it is not farmer friendly and had many constraints. To overcome these constraints we have designed a device which will on-field measure the soil nutrients. The future work includes implementing into large field and different climate condition to study the wear and tear of the sensor. We can use ANDROID application to give instant information of soil status to farmers and controlling unit. These information may be stored in government records and required action may be taken by the concerned body to improve soil productivity. This will help farmers to make optimum use of their land resources.

IV. REFERENCES

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