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Wireless Sensor Network for Automated Irrigation System in Tea Gardens

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***Abstract*— The aim of this paper is to propose a wireless sensor network in tea garden to show the path to tea gardeners to replace some of the traditional irrigation technique. The present paper focuses on set of technical skills environments to overcome technical backwardness present in traditional tea garden in terms of Moisture level and P^H value of soil. This paper describes the technical analysis background for development of expert moisture sensor equipped with monitoring and recording system for real time data of tea gardens soil pH in details. The present study introduces about the parameters to be considered for the design of soil moisture sensor & P^H value monitoring system. The cost effectiveness of the sensor/s to be developed and its future perspective of use will depend upon the considering parameters. This paper emphasis only on basic evaluation before development of soil moisture sensor, manageable and workable in tea gardens with minimum cost of production.**

***Keywords*— Expert system, Soil moisture, P^H value, sensor, WSN.**

I. INTRODUCTION

The scenario of tea estate is comprised of vast area for plantation which requires huge volume of water, a key nutrient, which is also a life sustaining natural resource [1]. Due to application of water in almost every sector of industry and rising level of industrial product consumption worldwide, water is quickly becoming a natural resource of utmost urgency of preservation. In this context implementation of smart watering [2] system in agricultural industry can bring retardation in depletion rate of this priceless life supporting natural resource. The key facts that gets easily ignored in the process of watering that any volume of water supplied to plants beyond requirement takes the form of wastage. Also the method of watering in dry season is different compared to other seasons, but the requirement is not same on each day hence neglecting this fact will results in water wastage. Smart watering system takes close notice of key factors in watering and attempts to analyze soil condition and accordingly nurtures plant with minimum wastage of water. For analysis, the vast area can be divided into smaller units which make Smart Watering System more effective as it supplies only necessary areas without wasting resource on adjacent non-demanding areas.

The significance of P^H monitoring is directly proportional to plant health and growth. As P^H directly affects the availability of essential nutrients. For example, though iron, manganese, and zinc become less available as the P^H rises above 6.5, molybdenum and phosphorus become more available. When the soil is acidic, minerals such as zinc, aluminum, manganese, copper, and cobalt become more soluble for plants' uptake. However, an excess of these ions can be toxic to plants. Alkaline soil contains a higher quantity of bicarbonate ions, which interferes with the normal uptake of other ions, harming plant growth.

The periodic record keeping of soil moisture and P^H value forms a database over a period, which can be developed as soil activity chart, valuable for enhancing agricultural soil quality.

II. OBJECTIVE

1. Development of software platform for operation on collected data for maintaining soil moisture.
2. Minimization of water wastage in watering process; reduction in labour and management cost.
3. Data logging for future reference i.e. incorporation of soil P^H and moisture values in statistical analysis of soil health.
4. Database development for faster decisive action in change of gardening techniques based on statistical analysis of soil health.
5. Smart energy efficient system. Ease of accessibility to monitor and control water level of storage tank even at of field using GSM service.

III. BACKGROUND STUDY

The application scenario of sensor based operation for automation is easily available in process, food packaging, aeronautics and other industries etc. Although the history of sensors and their application is very ancient but yet no full-

fledged establishment has been observed when it comes to irrigation sector. The advancement is very narrow and dim, however, in tea industry the work involved in processing the green leaves to tea has comparatively high standard of automation than any other agricultural product. But no significant work of automation has been done for nurturing and caring of tea plants. However a recent research development work in drip irrigation has been done by K. Prathyusha, M. Chaitanya Suman which features; automated platform with PT1000 as temperature sensor and tensiometer as moisture sensor with 16X1 LCD display for monitoring all the present readings of sensors and current status of control valves. In addition to it a chemical injection unit is used to mix required amount of fertilizers, pesticides, and nutrients with water, whenever required; in addition to flow meter for analysis of total water consumed [2]. Another similar work in the field of tea industry at Tocklai tea estate by C-DAC, Kolkata and Tocklai Experimental Station which features; fully automated, real time, round the clock, online wireless field hourly basis data collection system with help of sensors for ambient & soil temperature, soil moisture and pH, solar radiation, CC camera (infra red imaging even in night) for insect invasion and diseases. Additionally, the system is computer interfaced for enriching database with accurate data; with user friendly online Decision Support System for handling multiple input parameter. [3]

IV. APPROACH FOR EFFECTIVE IRRIGATION SYSTEM

The vastness of tea gardens present the hurdles of effective irrigation system hence transforming the gardens to smaller grids will smooth out operation of irrigation. Also for automation of irrigation system it is essential to have communication between grid networks and since final operation will be on soil i.e. watering on soil hence we need to have a feedback from soil. A moisture sensor can serve as a feedback from soil which is received by a controlling unit in tea garden for making logical decision by computers to start/stop watering process. The feedback from moisture sensor will be stored into database for purpose of statistical analysis at the time of preparing soil health report. In addition to soil moisture values another parameter i.e. P^H value of soil will also be taken into account during preparation of soil report.

SYSTEM DESIGN

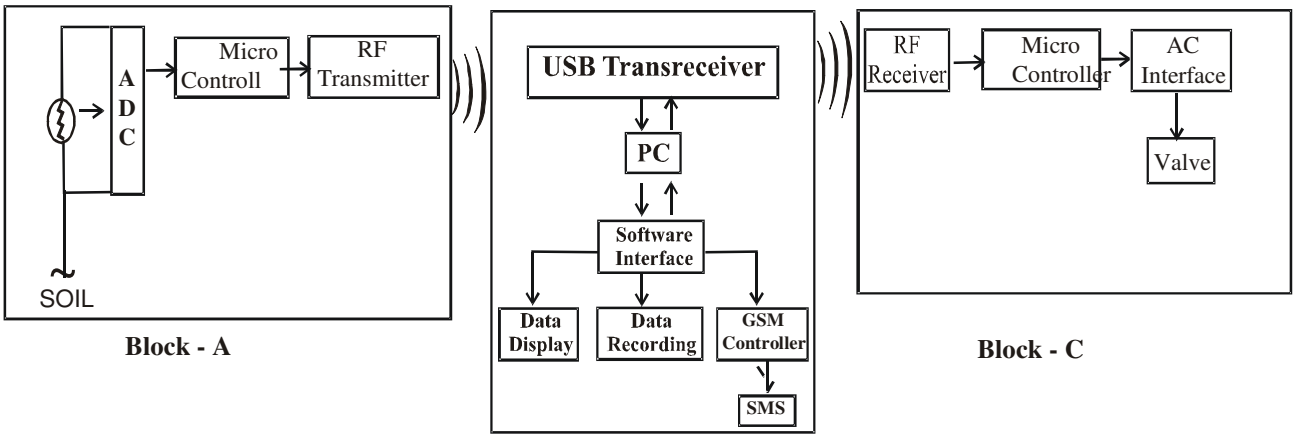

Figure1: Block diagram for Automatic watering system

Block A

The system will acquire soil moisture information from soil individually for different plots through a moisture sensor probe installed in individual plots. The information thus obtained through sensors, will be converted to digital data thorough analog to digital converter. The information signal thus generated by micro-controller will be propagated to central controlling unit and received with wireless RF modem [6].

Block B

The information signal thus received will be provided to the RF trans-receiver which analyses and process the signal for next stage. After trans-receiver the information will be dealt by the software developed in Microsoft platform installed in a desktop PC. This software then delivers the task of monitoring, recording (for database development) and controlling in the field by generating control signals. There

will also be a GSM unit that sends whole day summary of data acquired to the owner of estate through an SMS.

Block C

Moreover the task of restoration of soil moisture will be made available in manual and fully automatic mode. In manual mode, the operator needs to authorise the control signal for opening and closing of electric control valve. However in auto-mode, after complete analysis of signal information, the embedded system will self-generate control signal which independently open/shuts control valve.

V. BLOCK DIAGRMA FOR SOIL MOISTURE SENSOR

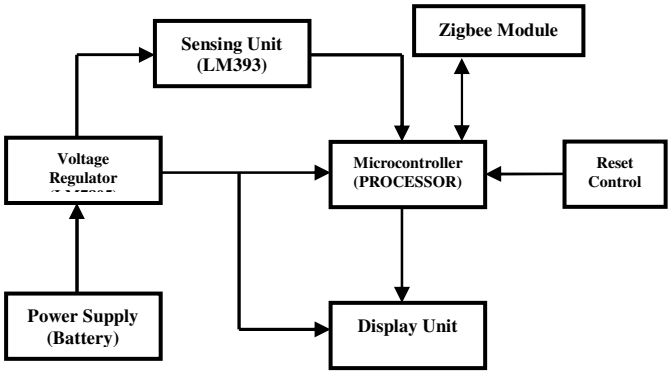

Figure2 : Block diagram for soil moisture sensor

Sensing Unit

The LM393 IC detects change in resistance of soil trapped between two conductive probes and transfers the difference signal for further processing.

Power Supply Unit

A 12V battery will supply necessary voltage for working of the sensor; however all the units of sensor will be using maximum 5V voltage. This exact voltage is provided by voltage regulator LM7805 to avoid possible scarcity of voltage or damage to sensor units.

Processing Unit

The micro-controller performs all the processing on signal from sensor and converts the analog signal to digital form, using the in-built analog to digital converter for digital display, on display unit in percentage level.

Zigbee Module

A ZigBee network is set up to enable data messages to be sent efficiently across the ZigBee network that may extend over considerable distances. With applications including lighting and heating control, the ZigBee network must be able to communicate over distances that may be well in excess of the single hop distance achievable by each individual node.

VI. RESULT AND DISCUSSION

Data Access about GUI

Through the login window user can enter to the sensor application program authentically.

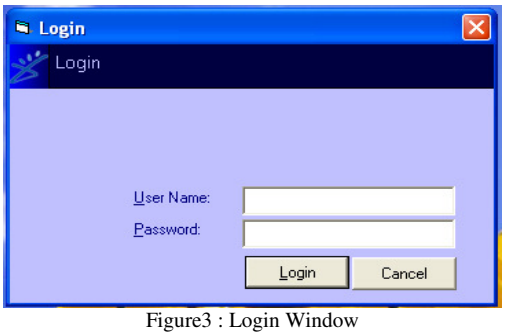

Figure3 : Login Window

Sensor Data Monitoring Window

From this window user can view the date, time Sensor id and receiver value from the sensor. Against this sensor value we can also view the date, time and sprinkler's ON/OFF status. Using this window user can set the sprinkler start and stop value as per the moisture requirement of the plant. We can also select the no of working sensors as per the requirements of the area plot.

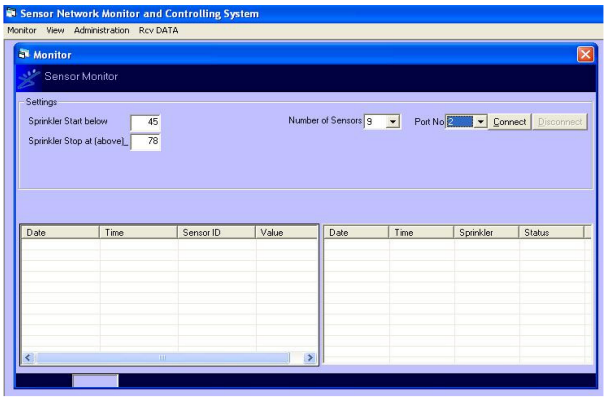

Figure4: Sensor data monitoring window

Sensor Data Log

Using this window we can view sensors previously recorded data by sorting Sensor ID or serial ID.

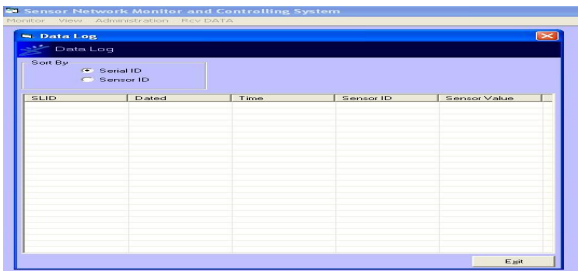

Figure5 : Sensor data log

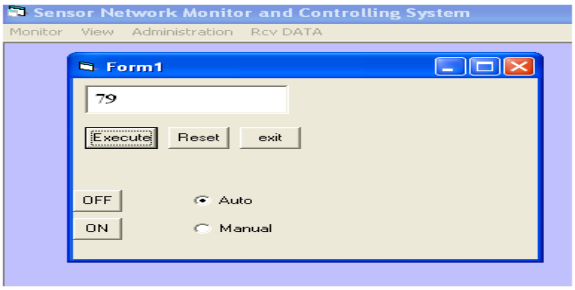

Figure6: *Sprinkler controlling window*

In this window user can able to select the sprinkler mode Auto or Manual Mode. If user selects the auto mode the sprinkler works the set value by the user. If we select the manual mode then sprinkler can works depending on the user. Continuous acquiring of the data by the moisture sensor it was stored in database. A graph was prepared for monthly basis data was collected, four times in month both manually and traditionally. Here is the graph to comparing how accurate sensor collected data to the traditionally collected data.

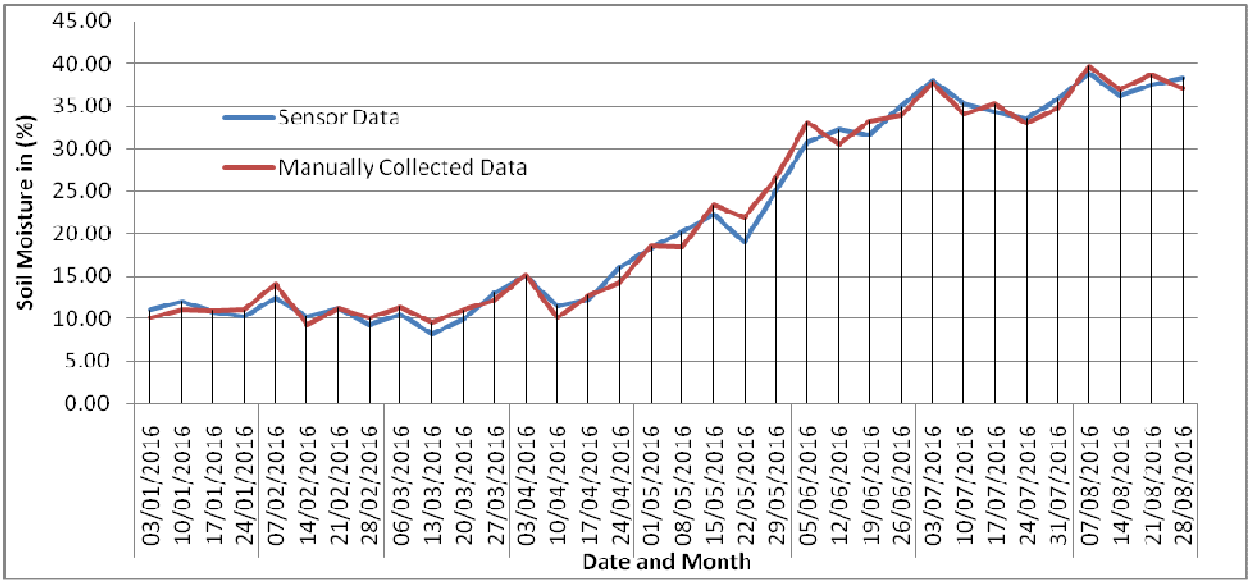

Figure7 : Comparison of sensor generated and manually collected soil moisture data in tea garden

From the above graph we revealed that the sensors acquire data and manually collected data (Laboratory analyzed data) has a closed match. It is tedious job to collect data manually in frequent time duration. But it can be done by the wireless sensor network to get the moisture level of the soil in frequent time duration for proper and better irrigation in the garden.

VII. CONCLUSION

The above paper presents the challenges, significance and advantages of Effective Watering System in tea gardens. Its approach in keeping track record of soil health, with key parameters as soil moisture and pH values, will help agricultural scientists in suggesting progressive measures in favour of both plants and soil. It describes the role of key components in development of such system for tea gardens. Its application in real life will reduce production cost, enhance productivity and introduce automation in tea gardening. However with a proper set of tools this approach can be used as automated platforms with multiple functions like data logging, GSM [7] based monitoring and AI [8] based automated watering and monitoring system.

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