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Automatic Drip Irrigation System using Wireless Sensor Network and Data Mining Algorithm

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***Abstract* – India is an agricultural country and agriculture is backbone of Indian economy. Agriculture provides the principal means of livelihood for the major Indian population. The optimum use of agriculture resources can lead to a good crop yield. Water resource is major constrain in agriculture so efficient distribution of available water is certainly beneficial to get good crop yield and hence profit. The sensor based irrigation system is able to provide optimum solution by continuously monitoring the parameters like, soil temperature, soil moisture air temperature, wind direction, wind speed. The proposed system consists of sensors placed in the farm area, a control station and a base station. Wireless sensor network (WSN) uses ad-hoc networks which support flexibility and self configuration which is beneficial for agricultural application. Data acquired from different sensors is provided to the base station by wireless transmission using zigbee. Once the data are received at the base station, further data processing and computation requirements for decision making are carried out by using data mining algorithm. The result of data processing and computations are utilized for controlling automated drip irrigation system. Data processing provides all real time data in the integrated form and generates information or observations in formats that are convenient for farmers or to other end users and this data is transmitted for web applications so that observations can be remotely monitored. When real time data is delivered, farmers are able to achieve intelligent crop irrigation system. Hence such enhanced automation for irrigation provides a good electric & water conservation with more efficiency.**

***Keywords* – Wireless Sensor Network (WSN), Agriculture, Soil Moisture, Soil Temperature, Wind Speed, Data Mining, Electric and Water Conservation.**

I. INTRODUCTION

The most basic need of living things on the earth for their survival is food. With the help of intelligence which makes human being different from other animals, human being has been fulfilling this basic need by cultivating crops that is agriculture. India is an agricultural country and agriculture is backbone of the Indian economy. Agriculture provides the principal means of livelihood for the major Indian population. This field has been developing from ancient times. In this era of technology, how this field can be untouched by the technology. Technical innovations for agriculture will definitely helpful for reducing the problems increase the yield. Agriculture requires large amount of water so water management is very important constrain in agriculture field. Many times because of improper or unplanned use of water farmers have to keep their fields uncultivated in summer season. It has been observed that the drip irrigation is very good solution for water management particularly for precise agriculture and is considered to be a more efficient distribution system. Especially in drought prone areas farmers should be able to get a satisfactory production of crops with the optimum use of available water. Use of wireless sensor networks within the farm is increasing day by day. It makes the farmer free from the maintenance of wiring in a difficult environment. Wireless sensor networks let users to make precise monitoring of the crop at the time of its growth, farmers can immediately know the state of the item at all its stages which will ease the decision process regarding the time of harvest.

In many wireless communication products radio frequency (RF) technology is widely used and it also supports use of wireless communication in agricultural applications. Less installation cost and time are the factors which support for use of wireless communication rather than hard wired system .The potential use of feedback from the sensors system plays important role to enhance the precision of the automated drip irrigation system. Ad-hoc network of Wireless sensor network (WSN) supports flexibility and self configuration, and provides suitable solution for agriculture application. [1] This system allows continuous monitoring of real time in field information which is certainly beneficial for more precise decision making which leads to good yield with optimum use of water.

II. LITERATURE SURVEY

There are many systems designed for water saving for various cropping systems from very basic ones to technologically advanced ones. In one system plant water status was monitored and irrigation controlled based on canopy temperature distribution. In site specific control system closed loop irrigation system is used and irrigation amount based on distributed soil water measurement is determined. [2] Bluetooth radio for various farming conditions and environments, power consumption and for different data transmission rates has been evaluated. [3] For transmitting moisture concentration data wirelessly Lee observed and explored range limitation of Bluetooth.

[4] Smart soil moisture sensor design and sprinkler valve controllers design used for implementing plug and play technology is explored. [5] Various commercial WSNs exist, ranging from limited and low-resolution devices with sensors and embedded processors to complete and expensive acquisition systems that support diverse sensors and include several communication features. [6].

III. System Overview

The Configuration of an automatic drip irrigation system using WSN is shown in fig.1. The system consists of wireless sensor units placed in the field which are used to acquire the real time data, a base station which processes on data acquired and transmitted by wireless sensor unit, and a control section which controls the drips when it receives control command from the base station. The Wireless sensor unit comprises radio modem, sensors, a microcontroller, and power sources. Thus sensors in the field acquire data such as soil moisture, soil temperature, and air temperature. Power management is quite challenging for the wireless sensor unit. Once the data are acquired by the sensors further it is transmitted to the base station using wireless communication. ZigBee is used for wireless transmission of data from wireless sensor unit to base station.

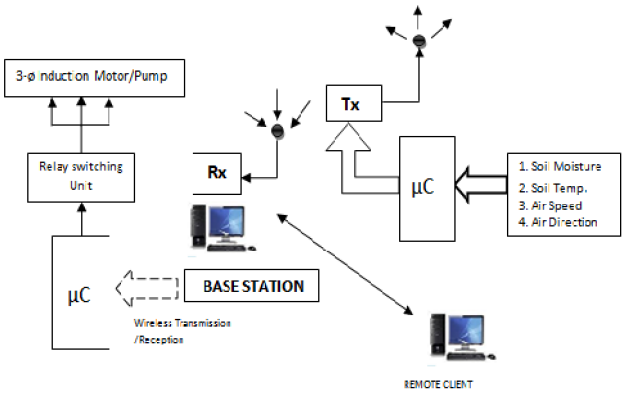

Fig.1. Configuration of automatic drip irrigation system

Base station receives the data from wireless sensor unit and processes on it using data mining algorithm. The data are bring up to date continuously and updated data are processed and accordingly final values are calculated which are utilized for decision making. At the base station farmers are able to observe the data as it is generated in the form convenient to them and this data is in the integrated format. Once the data are processed and decision is determined at the base station then control command is sent to control section by wireless communication. Control section consists of microcontroller, and relay switching unit, receiver. Control section receives the control command from Base station and drips are controlled accordingly.

A. Wireless sensor Unit:

Several wireless sensor units are placed over the farm area to form a distributed WSN for data acquisition. The Wireless sensor unit consists of transmitter, sensors, a microcontroller, and power sources. Microcontroller controls the Radio Modem (Zigbee) and it also processes on data acquired by soil moisture sensor and temperature sensors. Microcontroller, sensors, radio modem are powered by the rechargeable batteries which is being charged by solar energy of the field sensing station are Sensors, wireless data communication unit, microcontroller unit. The efficient use of power is important for a long-term operational system. Power management is major constraint for sensing station as it constitutes sensors as well as data logging and transmission unit. Wireless sensor unit provides precise data acquisition by using soil moisture sensor and temperature sensor.

Measuring soil moisture plays vital role in agriculture to help farmers for managing their irrigation systems more efficiently. Analysis of information regarding soil moisture not only reduces the amount of water consumption to grow a crop, but also increases the yield and the quality of the crop by better management of soil moisture during critical plant growth stages by the farmer. We are proposing the deployment of a high frequency VH400 series moisture sensor probes which enable precise low cost monitoring of soil water content suiting our purpose. A soil temperature probe used is THERM200 which provides temperature range from -400 C to 850C. It outputs a voltage linearly proportional temperature so easy to calculate temperature from voltage without using any complex equation. It consumes less current which satisfies power consumption constrain as well it is cost effective. It is highly precise with 0.1250 C of resolution. This sensory data are transmitted wirelessly via Zigbee.

B. Wireless transmission:

Most wireless communications use standard protocols such as the IEEE 802.11, Bluetooth, or Zigbee, which all use spread spectrum radio technology. Spectrum bands of 902–928 MHz, 2.4–2.48 GHz, and 5.7–5.85 GHz have been allocated for license-free spread spectrum devices. [7] The ZigBee standard is built on top of the IEEE 802.15.4 standard. The IEEE 802.15.4 standard defines the physical and MAC (Medium Access Control) layers for low-rate wireless personal area networks. Also, ZigBee provides higher network flexibility than Bluetooth, allowing different topologies. ZigBee allows a larger number of nodes more than 65,000 Sensors. Bluetooth is not suitable for application that requires low power consumption. As zigbee consumes less power it is suitable for its battery operated wireless sensor unit in the farm area. As well as its low cost and range for communication makes it suitable for agriculture applications. Power management is major concern for long term operational system. Thus, ZigBee provides optimum solution for

wireless communication in the irrigation system which at a time satisfies both constrains power and cost. Communication protocol contributes more in efficient power management than hardware optimization.

Wireless standard for this system is determined by the various parameters like range, rate of data transmission, compatibility and cost.

C. Base Station:

Data transmitted from all wireless sensor units are received by zigbee receiver at the base station. Data received from wireless sensor units are processed at base station to calculate final values. Updated data is received time to time and data processing is carried out on this updated data. Data mining algorithm provides the necessary computations required for decision making. Once the processing is completed final control command is sent to the control section via wireless communication. Then microcontroller at control section controls the drips according to the control command received from base station. It provides all real time data in an integrated form and generates information in a format convenient to farmer. The soil moisture and temperature levels are represented graphically so as to get all information at glance. The Internet connection provides the data monitoring in real time on a website, thus all information is available for remote monitoring.

D. Control section:

The receiver at the control section receives control command sent by the base station and accordingly gives command to relay switching unit. Thus system automatically controls drip irrigation depending on decision determined through decision making algorithm from the real time values received from wireless sensor unit.

V. SOFTWARE DESIGN

Data Mining refers to use of various techniques to identify suggest of information or decision making knowledge in the database and extracting these in a way that they can put to use in areas such as decision support, predictions, forecasting and estimation. [8] Data Mining is the nontrivial process of identifying valid, novel, potentially useful and ultimately understandable pattern in data with the wide use of databases and the explosive growth in their sizes. Data mining refers to extracting or "mining" knowledge from ample amounts of data. Data mining is the search for the relationships and global patterns that exist in large databases but are hidden among large amounts of data.

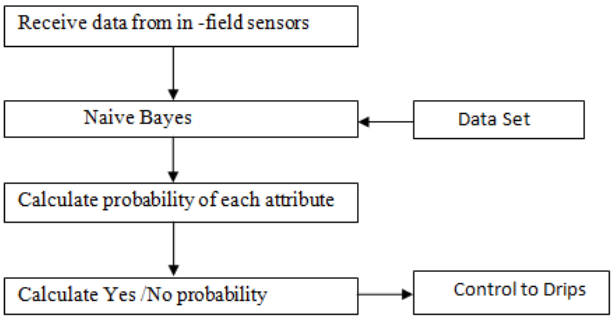

Fig.2. Implementation of Data Mining Algorithm

The conversion of data into knowledge is essential process of Knowledge Discovery which plays key role in decision making, and is referred to as data mining. Knowledge Discovery process comprises an iterative sequence of data cleaning, data integration, data selection, data mining pattern recognition and knowledge presentation. [9]Naive Bayes model identifies the characteristics of data acquired and then processes on it. It shows the probability of each input attribute for the predictable state. In our case attributes are soil moisture, soil temperature and air temperature. A conditional probability is the likelihood of some conclusion, *C*, given some evidence/observation, *E*, where a dependence relationship exists between *C* and *E*. This probability is denoted as P*(C /E)* where

P(C/E) = …… (1)

This method is preferred Naive bayes implementation as data are high. The Naive Bayes classifier selects the most likely classification Vnb given the attribute values a1, a2, …..…..an. These results in

Vnb = arg max vjєV p (vj)

We generally estimate using m-estimates:

=

Where:

n = the number of training examples for which v = vj

nc = number of examples for which v = vj and a = ai

p = a priori estimate for

m = the equivalent sample size

The Naive Bayes Classifier technique is particularly suited when the dimensionality of the inputs is high. Though it is simple, Naive Bayes can often provide more sophisticated classification methods.

VI. SUMMARY

Wireless sensor unit in the farm area collects data from the sensors, this acquired data are wirelessly transmitted to the base station. Base station reads values and compare with thresholds, applies data mining algorithm, calculates optimum values and creates drip control layout sends command to the control section which turns respective drip on or off.

VII. CONCLUSION

Using wireless sensor networks in automation for irrigation, this system provides a low-cost wireless solution for an in-field WSN and remote control of precision irrigation. Data mining algorithms used enhances automatic intelligence for WSN based drip irrigation system. This irrigation system allows cultivation in places with water scarcity, with optimum use of available water and hence offers electrical energy & water conservation.

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