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Real Time Monitoring of Agriculture Field Accompanied by Solar Power for Energy Efficient Routing

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ABSTRACT

This paper proposes an agriculture monitoring system utilizing wireless sensor network technology to measure temperature, moisture and pH value. Energy conservation is an important issue in emerging Wireless Sensor Network (WSN). Sensor nodes can be powered by disposable batteries but it cannot match the needs of WSN for long lifetime and small form factor, which limits the use of WSN due to the need for large batteries. Researchers have made efforts to save the finite battery on power control by routing algorithm and topology optimization. On the other hand reducing the power consumption of the nodes always sacrifices performances like computing. We prefer to use solar energy instead of batteries to increase the network life time and coverage area. The real time applications in environment monitoring are presented with emphasis on energy conservation.

Keywords: Wireless Sensor network, Energy Harvesting, Life Time, Coverage Area

1. INTRODUCTION

The key objective of the research outlined in this paper is to use wireless sensor network technology to monitor an agricultural parameter such as temperature, moisture and pH values in Precision Agriculture (PA). Recently technological advances have cared at embedded sensing, computing and communication device to become integral part of daily life. In the research field of WSN the power efficiency is a major issue. This problem can be overcome by using the Zigbee technology and the main idea is how data travel through a wireless medium transmission using WSN and system monitoring. This results in power waste and to overcome this issue, Zigbee technology is used.

It is a new wireless technology powered by IEEE 802.15.4 Personal Area Network standard. Most of the proposed deployment strategies in the literature have concentrated maximizing the coverage area, optimizing the energy consumption, achieving the strong network connection, extending the lifetime of the network and/or increasing the data fidelity. In the proposed system it is possible to get solar energy from the external environment by using solar cell as power source. Hence power is a critical resource and must be used very cautiously. Therefore the power optimization and management is an important issue in the design of WSN system.

2. RELATED WORKS

A study on node deployment such as ABC algorithms is implemented for both static and dynamic node deployment and it provide better results based on parameters like coverage rate as 98.3 min/run (164s) for 1000 iterations and standard deviation as 0.0891. SEAD protocol is an energy aware node deployment protocol, it consume minimum energy than other protocols such as DD, ADMR and TTDD [1].

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An Integer Linear Program (ILP) model is used to maximize the network life time and minimize delay in the existing system. ILP represent the operation of energy Efficient Distributed Schedule Based Protocol (EDDS) as well as to charge the batteries of WSN [2]. A sleep and wakeup strategy was implemented in energy harvesting wireless network platform called the open wireless sensor node (Wise) to prolong the life time of WSN [3]. Computation of a moving schedule of each mobile sensor node so that all the nodes cover the target field without depleting battery of some of the nodes by predicting solar power generation at each point of target field was proposed by Masaru Eto. He achieves 4% reduction in the number of nodes and 10% extension of the operation life time without estimation of power generation amount [4].

Hock Guan Goh et al give a practical solution to challenges such as antenna replacement, node density, node positioning, energy constraint, and base station design and data collection[5]. In this paper author define a framework for ubiquitous wireless sensor network that employ more sensor node placed inbetween base station and sensing node act as router to forward data packet between nodes increasing coverage area up to 10 km. Two ray ground model is used in simulation scenario with simpliciTI protocol to increase maximum transmission power and receiver sensitivity [6].

Force balanced routing was developed by Nagarajan et al to obtain maximum power optimization by efficient balance of routing the traffic between sensor nodes in multi path routing in WSN. A significant energy savings up to 15% can be achieved by carryout simulations in Matlab results in longer lifetime and better coverage preservation compared with parabolistic method [7]. Zouhair A. sadouq propose a novel energy aware framework for a long lived sensor network based on clustering architecture and achieve a good performance interms of lifetime by minimizing energy consumption in network communication and balancing energy load among all the nodes. This approach is to use the physical layer transmission power as metric to optimize energy consumption and use S-MAC protocol in duty cycle[8].Coverage –preserving energy based clustering algorithm (CEC) is an improved version of LEACH, since the cluster head consume more energy than other nodes in the cluster, node having high residual energy can be selected as cluster heads improve the area of coverage and network lifetime[10].

3. SYSTEM ARCHITECTURE

The system architecture consists of sensing unit that connect the node to group of sensors, actuators and power supply sub system. It also consists of communication subsystem which involves microcontroller for short range radio wireless communication. The first step in designing energy aware system involves analyzing the power consumption characteristics of a wireless node. Power consumption in sensor nodes involves three steps namely (i). sampling the signal (ii) signal conditioning (iii) analog to digital conversion. Microcontroller unit is responsible for control of sensor and execution of communication protocol zigbee to process the sensed data.

Power supply is designed with solar cell it requires a large capacity battery and reliable DC-DC converting circuit have been used for power supply module. Duty cycle provides an effective way to achieve energy efficiency and it is calculated by the ratio of active time to total time. Solar energy has many advantages such as inconsistence weather condition, battery capacity, and current consumption may easily render the entire power management failing to perform under charging and overcharging issues in battery.

4. HARDWARE DESIGN OF WIRELESS SENSOR NETWORK

Our aim is to implement wireless sensor network with low cost, low power consumption, high performance and high sensitivity. In this paper we choose zigbee module, temperature sensor, moisture sensor, pH sensor, Solar panel for energy efficient charging.

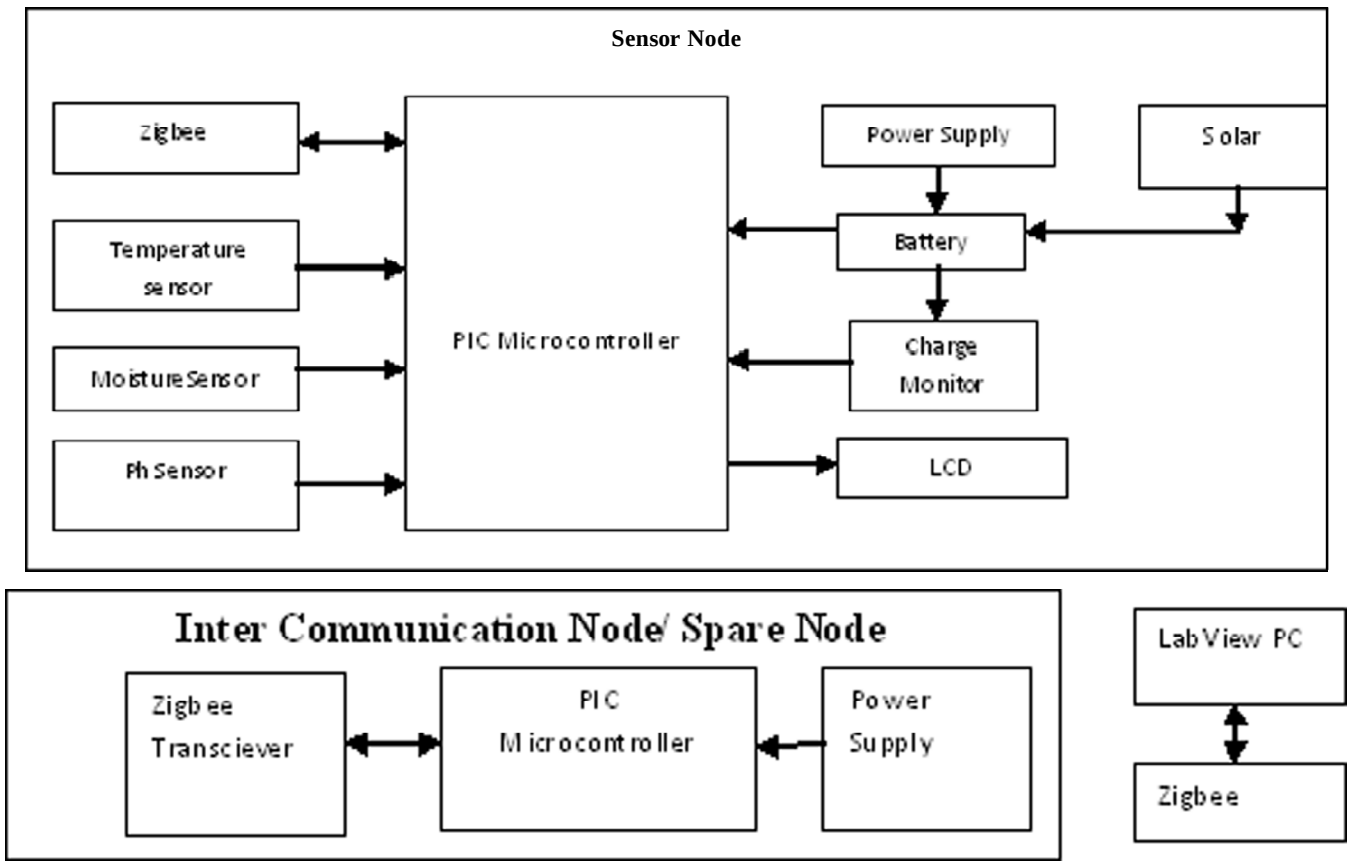

Figure 1: General Block Diagram

4.1. LM35 Temperature sensor

The LM35 series are precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (centigrade) temperature. It has advantage over linear temperature sensors calibrated in ° Kelvin. It does not require any calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full -55 to +150°C temperature sensor. As it draws only 60μA from its power supply, it has very low self-heating less than 0.1°C in still air.

4.2. Moisture sensor

Soil moisture sensors are designed to estimate soil volumetric water content based on dielectric constant of the soil. The dielectric constant of soil increases as water content of the soil increases. Measuring soil moisture is important for agricultural applications to help farmers manage their irrigation system more effectively.

4.3. pH sensor

pH meter is a scientific instrument that measures hydrogen-ion concentration in a solution, indicating its acidity or alkalinity. The pH meter measures the difference in electrical potential between pH electrode and a reference electrode. It usually has a glass electrode pluscalomel reference electrode or a combination electrode. In addition to measuring the pH of liquids, a special probe is sometimes used to measure the pH of semi-solid substances.

4.4. Zigbee module

Zigbee is a low power spin off of WiFi. It is a specification for small, low power radios based on IEEE 802.15.4-2003 Wireless Personal Area network standard. Zigbee adds logical network, security and

application software. It as many advantages compared to other wireless PAN such as it has high data rate of 250Kbps, its rangeis around 1m-100m based on settings and it can connect 256 master/ slave devices by peer-peer communication extending battery month up to infinity.

4.5. Solar panel

The basic unit of solar panel is a solar cell, which usually consists of one or two layers of silicon based two semiconductor wafers. When struck by the photons in sun light, thesolar cell generatean electrical charge due to the "photovoltaic effect" since it produces voltages from photons [11]. The flow of electrons moves in a steady electrical current from one side of the cell to the other side of semiconductor wafers.

4.6. Solar Power Vs Battery Power

Existing system use battery powered sensor node but it has many drawbacks such as cost of charger is more than the actual product for low cost applications, low energy density in the order of 650 J/cm^3 (NiCd) and 860 J/cm^3 (NiMHd). Sometimes it leads to fire explosion and chemical pollution with short life time. It may require high cost for continuous replacement. Proposed system uses solar cell to power the sensor nodes and it has many advantages over batteries such as unlimited supply of solar batteries can store charge to the storage device, low electricity bill [9]. It does not cause any pollution like batteries and it can also use in outdoor and indoor applications.

4.7. PIC Microcontroller

It is a high performance RISC CPU. This powerful 200 nano second instruction execution is yet easy to program (only 35 single word instruction) CMOS FLASH based 8 bit microcontroller. The of PIC16F877A features 256 bytes of EEPROM data memory, self-programming, 2 comparators, 8 channels of 10 bit analog to digital converter, 2 capture/compare/PWM functions. The synchronous serial port can be configured as either 3-wire Serial Peripheral Interface or the 2-wire integrated circuit (I^2C) bus and a Universal Asynchronous receiver Transmitter (USART).

5. DESIGNANDIMPLEMENTATION

If the primary node fails to send data to the base station due to power shut down or any issues, then the inter communication node send raw data of primary data to the microcontroller and transmitted via zigbee to the

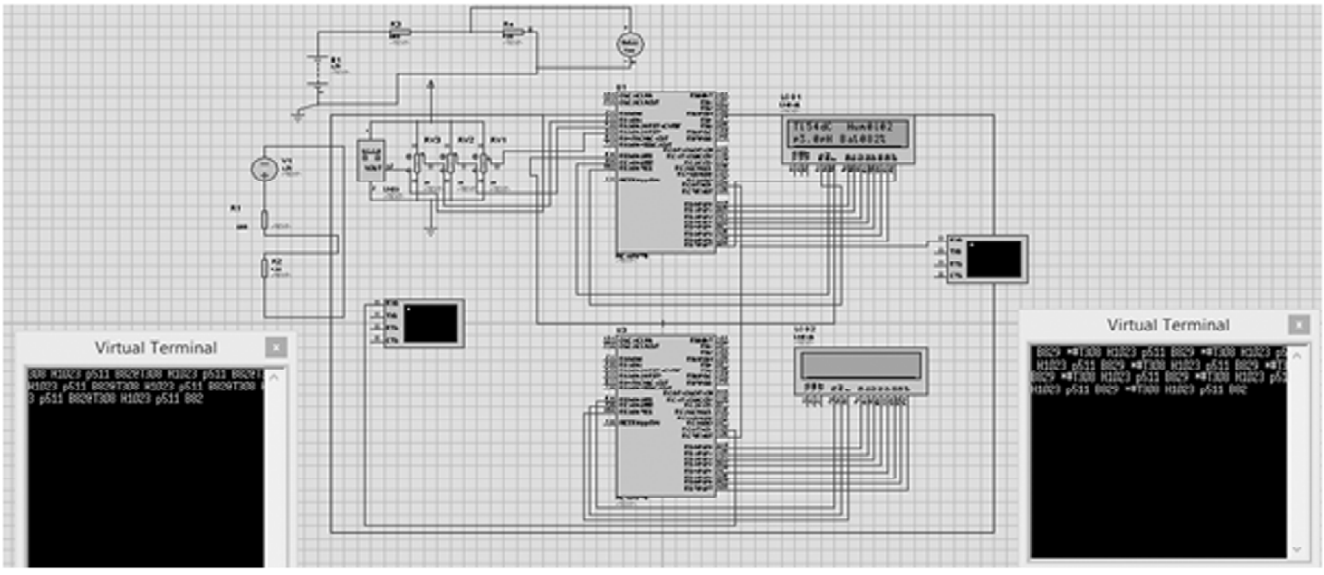

Figure 3: Implementation of sensor node with virtual terminal

base station. Spare nodes remain in sleep mode until the primary node fails to send data to PIC microcontroller. In the above connection diagram, if node1 fails to communicate with zigbee then node 2 send the data's of node 1 through virtual terminal of sensor nodes.

6. SYSTEM TEST

To effectively use WSN apromising technology, you must overcome thechallenges associated with configuring and manage data acquisition, efficiently analyzing the collected data, storing data for future analysis and displaying a data to the end user in a meaningful way.

LabVIEW a graphical programming environment used to acquire, analyze, present data and added the ability to program real time systems.With LabVIEW WSN, you can customize the node's behaviour add intelligence that extends battery life by controlling the sampling rate and determining when to transmit data.

System output shows that using LabVIEWsoftware we can obtain individual plot for temperature, Moisture, pH value and battery indication with respect to time. This real time monitoring of agricultural parameters help farmers to improve the farm output with increased network life time. Battery indication helps farmer to know the status of battery which is a major challenge in WSN.

The farmer has the ability to monitor the sensor information at his home the sensor information displays on the master LCD as well as PC. Moisture, temperature and pH value required for a particular crop are set in the microcontroller as a threshold value. Actual values in the field are sensed by the sensor and compared with threshold value; if the actual value crosses the threshold value then corresponding actuators are switched ON.

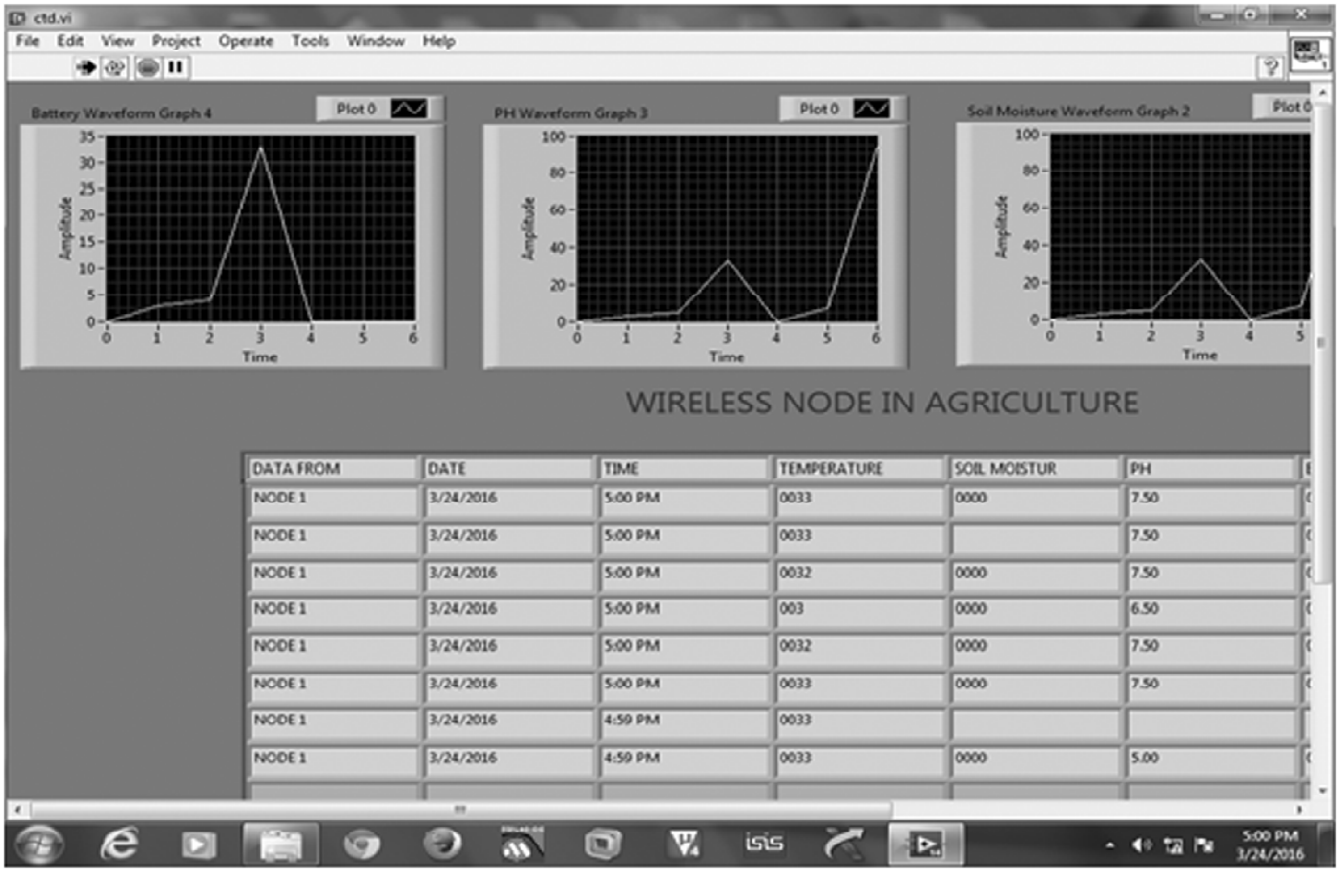

Figure 4: System Output

In the existing system only the physical parameters are monitored and displayed on the LCD or PC. But the farmers did not know the status of battery power, since it is essential for proper network management and it is also essential for sensor power management can be overcome in this paper

7. CONCLUSION AND FUTURE WORK

WSN has presented various research challenges and one major challenge is to design an efficient monitoring of agricultural parameters such as temperature, moisture, pH value and using solar power ensure automatic and long term operation. As the duty cycle is very short, Zigbee transceiver consume very low power, battery can extend up to six months to two years. Along with physical parameters of agriculture field solar power and battery level indication is displayed on PC and LCD helps farmers to increase farm output and network life time in precision agriculture. In future it can be extend by using mobile nodes rather than using static node to increase the maximum coverage area rate.

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