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WEB ENEBLED TEMPERATURE SENSING USING ENERGY AWARE WSN NODE WITH ZIGBEE FOR CRITICAL SENSING ENVIRONMENTS

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ABSTRACT

Wireless Sensor Network become a promising technology to observe various universal parameters and conditions and help to diminish decline virtual and physical world. This article describes an application based temperature sensing in a critical sensing environment such as military environment or furnace temperature etc. where the cut of value of a temperature value is so important. It is based on microcontroller in the transmitter side and a web enabled management of data in the receiver side. The algorithm adopted here is SEEMd which is security enabled energy efficient Middleware for WSN.

Keywords: WSN, temperature monitoring, energy aware, zigbee.

INTRODUCTION

Wireless sensor networks (WSNs) have great potential for many distributed applications in different sensing conditions. As they grow in popularity and significance, it becomes increasingly advantageous and essential to share their data over the Internet [1,2]. Wireless sensor networks consist of a large number of small scale nodes capable of limited computation, wireless communication and sensing [3]. The position of sensor nodes need not be engineered or predetermined [2]. Sensor network are battery powered thus there is scarcity of power. A node's lifetime is defined as the node's operating time without the need for any external intervention, like battery replacement [2].

With these tiny devices it is quiet easy to collect data and information from various environmental conditions, and with this capability it could become an increasingly demandable components in pervasive computing systems. Also, the WSN is one of the many networks that will compose the Ambient Networks [4]. WSNs have been widely used in a number of application fields related to water monitoring [10], forest monitoring [11], industrial monitoring [12], agriculture monitoring [12], battlefield surveillance [12,13], intelligent transportation [13, 9] etc. For all those reasons, integrating WSN with the Internet has become increasingly desirable and necessary.

Due to the unpredictable nature of in the sensors deployments, protocols and algorithms for sensor network must have self organizing capabilities. One unique feature of WSN is the collaborative nature of sensors for transmitting data to base station. Sensor nodes do not transmit raw data directly to the central node. Sensors contain an on-board processor; they perform simple computations locally by using their processing capabilities. Only the required and partially processed data is retransmitted. But the insufficiency in bandwidth is an important issue for WSN.

There is extensive research in the development of new algorithms for sensor deployment, ad hoc routing, energy efficiency and distributed processing in the context of wireless sensor networks. As the algorithms and protocols for wireless sensor network are developed, they must be supported by a low-power, efficient and flexible hardware platform [5]. The most difficult resource constraint to meet is power management. As the size decreases the battery size and energy durability also decreases. Underlying energy constraints end up creating computational and storage limitations that lead to a new set of architectural issues [4].

ARCHITECTURE

The proposed architecture consists of two parts. A transmitter and a receiver module. Each sensor node consists of Temperature sensor. The LM35 series a precision integrated-circuit temperature sensors. The output voltage of the sensor is linearly proportional to the Celsius temperature. The sensor node is controlled by PIC16F876A microcontroller and supported by Zigbee - XBee Series module for communication

XBee

ZigBee/XBee is a low-cost, low power, wireless mesh network standard [17]. It is widely used in various wireless communication applications where control and monitoring is an essential important. ZigBee builds upon the physical layer and medium access control defined in the IEEE standard 802.15.4 (2003 version) for low-rate wireless personal area networks (WPANs). The specification completes the standard by adding four main components: network layer, application layer, ZigBee Device Objects (ZDOs), and manufacturer-defined application objects which allow for customization and favor total integration [18].

The XBee RF Module was designed to mount into a receptacle (socket) and therefore does not require

any soldering when mounting it to a board as in Figure-1. The XBee Development Kits contain RS-232 and USB interface boards which use two 20-pin receptacles to receive modules [15].

These are two main advantages over Bluetooth so that we are using Zigbee for this project. Zigbee is a communication protocol suitable for high level communications using low-power and small form factor digital radio or wireless home area networks (WHANs) [7].

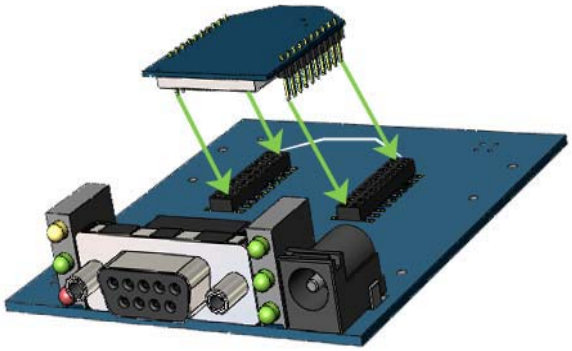

Figure-1. XBee module mounting to an RS232 interface board. Courtesy: MaxStream, Inc.

PIC micro controller

PIC microcontrollers (Programmable Interface Controllers), are electronic circuits that can be programmed to carry out a vast range of tasks. A PIC microcontroller is a processor with built in R/W memory and you can use it to control our system. This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 28-pin package and is upwards compatible [16].

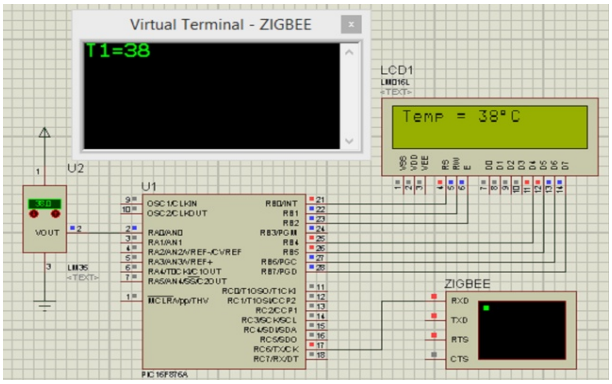

Figure-2. Circuit diagram – transmitter node 1.

Header node: This node is act as the coordinator of the network. It collects sensor readings from the sensors back to the Web server. The function of the Header node is divided into two parts: Web-Server in a PC and Zigbee Interface with a microcontroller, to the WSN.

End node: Each End node has one temperature sensor that sense the data from the real world environment and send the data according the algorithm [2] running in the microcontroller. The interfaces of sensor node consist of Sensor Interface and Zig bee Interface for communication to the header node.

Signals are read by sensor and its output is given to PIC16 microcontroller. The output to microcontroller from sensor is taken through 8 channel ADC pins. The output from microcontroller is given to Zigbee through Rx and Tx pins. There is only one Tx and Rx pins Signal is send to microcontroller and parameters like temperature. The parameter is monitored on computer using RS-232 port. The Figure-1 shows the basic diagram of the transmitter prototype and Figure-2 shows the microcontroller based Receiver Circuit at the PC module.

Currently there are two technologies are available for communication in WSN; Bluetooth and ZigBee. Both the technologies operate within the Industrial Scientific and Medical (ISM) band of 2.4 GHz, which provides license free operations, large number of spectrum allocation and worldwide compatibility [5]. Multi hop communication over the ISM band might is well suitable for WSN because it consumes a little power than traditional single hop communication. It is also possible to create a WSN using Wi-Fi (IEEE 802.11), but this protocol is usually utilized in personal computer based systems as it was developed to replace a wired LAN [5].

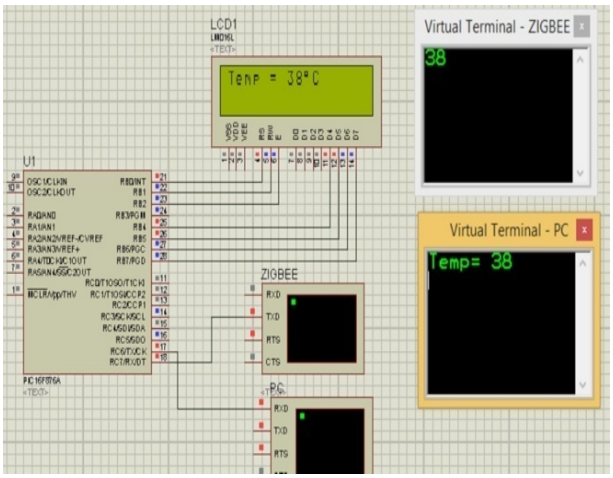

Figure-3. Circuit diagram – receiver (Header node).

The receiver end there might be a sink anode and a PC where the entire data base is running. Database is designed with MySQL program. When the data packets received from Base station or node it stores in respective tables in Database. Thus, we implement a module for

management packets. The web server that runs apache Server to manage the web based end system

ALGORITHM FOR ENERGY EFFICIENCY

WSN consumes more energy in communication between one node to another or precisely to header node so all the researches mainly focusing on reducing the communication as much as possible [14]. There are lots of methods are suggesting in various papers and the most common approach is the sleep –wake up mode of sensor nodes.

Another approach is compression the data that to be transmitted, thereby reducing the number bits transmitted. In WSNs, data compression refers to the use of compression techniques to reduce the amount of bytes required to code the different pieces of information and, thus, the traffic load which needs to be processed within the network [13]. Avoiding the redundant data for communication by comparing the data in the local node itself and make appropriate decisions with an algorithm is the one of the efficient approaches to attain energy efficiency in WSN. Here in the algorithm we avoid the redundant data for transmitting in two different conditions described bellow with a second chance approach for applications that undergo some critical sensing environments.

Sleep wake up approach

Sleep/Wake approach is an every effective process where the nodes energy is saved to a large extent [19]. In the network with single hope or multi hope system every nodes working based on a sleep wake up algorithm. In order to save energy, only the nodes with relevant data will keep in wake up mode, while others will be kept on in the sleep mode.

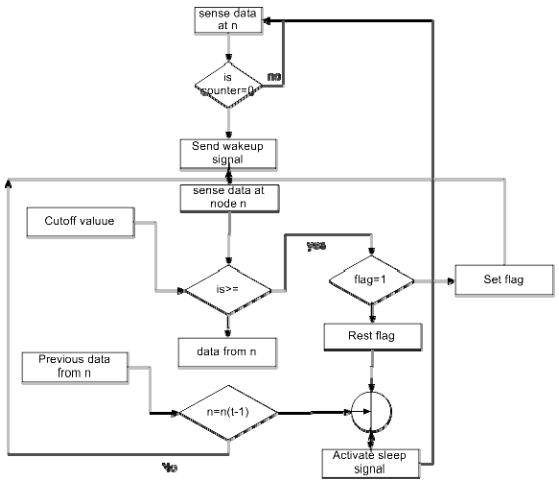

Figure-4. Flow chart of the algorithm.

Consider a scenario where WSN to sense some critical value of a temperature in a furnace or in a nuclear plant where the critical value or optimum value of the temperature or such parameter is so important [2].

The steps for the algorithm [2] is as follows: If the data sensed by the current node **Data_at_Time(t)** is not greater than the cutoff_value(critical value) then it checks with previous owned data that has been taken at **Data_At_Time(t-1)** and or if the data of current node **Data _at_Time (t)** is equal the data of other node **Odata _at_Time (t)** the sensor forced to **Active_sleep mode**. If the data sensed by the current node **Data _at_Time (t)** is greater than or equal to the cutoff_value(critical value) then a **flag bit** is set for that sensor and **sense function()** continues. After a preset time at **sense function()**the sensed data **Data_at_Time (t)** is greater than or equal to the **cutoff_value(**critical value) then reset the **flag** and activate the sleep mode function. Each node can stay in sleep mode for maximum of Max_SleepTime only. The Figure-3 shows the data flow diagram of the algorithm [2] After completion of this period, the program will send a message called **WakeUp_Active** to wake up the sensor node for regular service.

WEB BASED MONITORING

Using computer as a centralized management system, with WSN the monitoring and alert systems may be implemented automatically. Sensor node interacts with the surrounding environment, gathering information and data based on the algorithms running on the centralized systems. Sensor node generates appropriate instructions by collaborating among themselves along with Base nodes (BS) nodes.

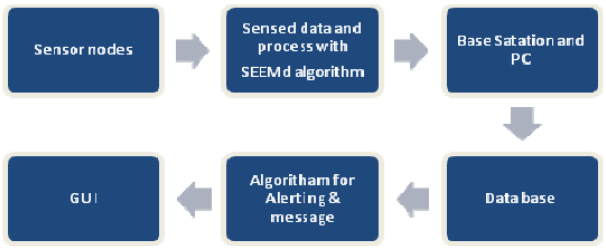

Figure-5. Web based monitoring- block diagram.

These sensors can be programmed to record the current temperature based on the above algorithm. Usually in a practical approach all the data that are collected from the sensors, using a wireless multi-hop routing technology [6], end up in a sink node that transfers them to the end user through a wireless network, internet or LAN [6,7].

WEB ARCHITECTURE AND DESIGN

Our WSN consists of the sensor nodes with capabilities such as sensing environmental data, computing locally, and communication wirelessly and

base station node which does not have sensing part and is plugged the Personal Computer. The sensing electronics can measure temperature convert raw data into an electric signal. The signals are sends to base nodes. The connection between the base station node and computer server called serial connection and the connection between client nodes and client nodes called wireless communication. Our all communications are based on IEEE 802.15.4 standard.

The Web server has connected to header node attached to typically a RS 232 port or USB port that communicates to all the nodes in the network. All the sensors send data to the header node that further sends it to the web application that display the data to a meaningful information. This web application can be accessed using Internet .The user can analyze the readings for analysis through a Graphical User Interface (GUI). It can only be accessed by the authoritative users and managed by an administrator. The basic architecture of web based WSN is shown below.

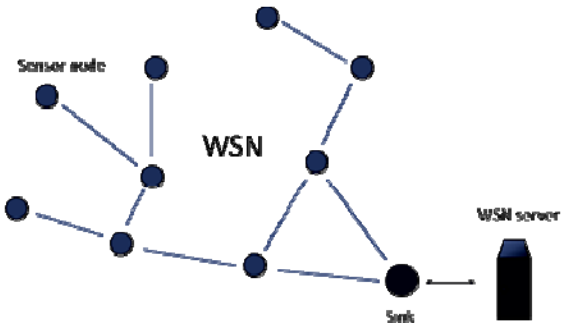

Figure-6. Architecture of web based WSN.

Database system and web sever

Database is designed with MySQL program. When the data packets are received from Base station it is stored in respective tables in Database. Web server is a system that runs in apache Server to manage the web based end system

The following tables are used in the proposed system.

DBTable-1. Node_details.

Node_ID	Primary Key
N_Location	Location of the nodes
N_Type	Type of nodes
N_Status	Status of Node

DBTable-2. NSensor_details

Sensor_ID	Primary Key
NodeID	Foreign Key
Sensor Name	Name of the sensor
Sensor Type	Type of the sensor
Max Value	Expected Maximum value of data
Min Value	Expected minimum value of data

DBTable-3. Sensor_data

Sensor_ID	Foreign Key
DateTime	Date and time of Data
Value	Sensed data
Status	0-normal, 1-Above max, 2- below min

DBTable-4. Alert_details

Alert_ID	Primary Key
Alert type	Type of alert
Name of Alert	Alert Name
Message	Message to GUI

DBTable-5. Alert_log.

Log_ID	Primary Key
Alert_ID	Foreign Key
Date Time	Date and Time of Alert

Figure-7. Analysis -GUI screenshot of the prototype

Graphic user interface (GUI)

GUI can be constituted in two ways; either in Personal computer or as an Application for Mobile Phones depending on the convenience. The figure 6 shows an simple analysis at the receiver end, of the output temperature of various sensor nodes. With the interface at the PC they can set up the Cut off values and minimum values of the sensed data for getting the accurate and appropriate messages.

CONCLUSIONS

The proposed paper is an implementation of energy efficient WSN single hope network offering an improved lifetime to sensor nodes along with security to the sensed environment. The central part of this paper working in an SEEMd algorithm, where it prevent the redundant data transmission to the header node but also impart secure environment to the ambient by giving a second chance when sensed data is equal to cut off value in critical sensing environments.. A web based monitoring is also designed in this paper with PHP and MySQL for monitoring and analysis of input data.

REFERENCES

[1] Jeisa Domingues, Antonio Damaso, Rilter Nascimento, and Nelson Rosa. 2012. Research Article "An Energy-Aware Middleware for Integrating Wireless Sensor Networks and the Informatics Center", Federal University of Pernambuco.

[2] Linoy A Tharakan and Dr. R. Dhanasekaran. 2014. SEEMd -Security enabled Energy Efficient Middleware for WSN ISBN No. 978-1-4799-3914-5/14 IEEE.

[3] N. B. Priyantha, A. Kansal, M. Goraczko and F. Zhao. 2008. "Tiny web services: design and implementation of interoperable and evolvable sensor networks," In: Proceedings of the ACM Conference on Embedded Network Sensor Systems (SenSys '08), pp. 253–266, Raleigh, NC, USA.

[4] Andreas Schieder, Ericsson Deutschland GmbH, Ericsson Allee 2004 "Components and Concepts of the Ambient Networks Architecture" WWRF12 Meeting, Toronto, Canada.

[5] Prof C. H. Chavan, Mr. P. V. Karande. 2014. Wireless Monitoring of Soil Moisture, Temperature & Humidity Using Zigbee in Agriculture. International Journal of Engineering Trends and Technology (IJETT), Volume 11, Number 10, May.

[6] Aina Hua , Huanhuan Wangb, Jianchen Wana 2013. Design of WSN-Based Remote Monitoring System for Environmental Parameters in Substation Vol. 2, No. 1.

[7] Prof. S. S. Sarade and Prof. A. C. Joshi. 2012. Wireless Temperature Monitoring System Using Wireless Sensor Networks. International Journal of Advanced Research In Electronics And Communication Engineering (IJARECE) Vol.1, Issue 4.

[9] Guobao Xu, Weiming Shen and Xianbin Wang. 2014. Applications of Wireless Sensor Networks in Marine Environment Monitoring: A Survey. Sensors 16932-16954.

[10] Lee, H.C, Banerjee A., Fang Y.M. Lee and B. J King. 2010. C.T. Design of a multifunctional wireless sensor for in situ monitoring of debris flows. IEEE Trans. Instrum. Meas. Vol. 59, pp. 2958–2967.

[11] Bayo A., Antolín D., Medrano N., Calvo B. and Celma S. 2010. Early Detection and Monitoring of Forest Fire with a Wireless Sensor Network System. Proceeding. Eng., pp. 248–251.

[12] Silva I., Guedes L. A., Portugal P. and Vasques F. 2012. Reliability and Availability Evaluation of Wireless Sensor Networks for Industrial Applications. Sensors pp. 806–838.

[13] Qian H., Sun P. and Rong Y. 2012. Design Proposal of Self-Powered WSN Node for Battle Field Surveillance. Energy Proced. Vol 16, pp. 753–757.

[14] Korkut Yegin, Adnan Kavak, Erdal Cayirci and Kapil Dandekar. 2014 Smart and Reconfigurable Antenna Applications in Wireless Sensor Networks. International Journal of Distributed Sensor Networks Article ID 658792.

[15] XBee™/XBee-PRO™ 2007. OEM RF Modules Product Manual v1.xAx - 802.15.4 Protocol MaxStream, Inc. All rights reserved.

[16]http://www.microchip.com/downloads/en/DeviceDoc

[17] ZigBee Alliance," http://www.zigbee.org/

[18] Biljana Risteska Stojkoska, Andrijana Popovska Avramova and Periklis Chatzimisios. 2014. Application of Wireless Sensor Networks for Indoor Temperature Regulation Hindawi Publishing Corporation International Journal of Distributed Sensor Networks Volume , Article ID 502419, 10 pages.

[19] Sasikala V. and C. Chandrasekar. 2013. Cluster based Sleep/Wakeup Scheduling Technique for WSNInternational Journal of Computer Applications (0975 – 8887) Vol. 72, No. 8.