

Wireless Communication with Power Saving Techniques

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ABSTRACT

Power effectiveness is the largest part for addressing the wireless sensor network in communication networks for wireless big data. In wireless sensor network the sensors are motorized by battery that drain sooner or later and will have to be taken out and then replaced or recharged. In the existing system nodes have utilized same amount of energy for communication inspite of their distances. To deal with this issue the proposed algorithm focused on proficient utilization of an energy based on the node distance. Maintaining the lowest transmission power in wireless sensor network is open to the interference fluctuations because of the bad signal-to interference-plus-noise-ratio (SINR). The proposed method is to harvest energy from radio frequency. The exact distance between the nodes can be calculated and obtained by RSSI measurement. The parameter of measurement model are determined by anchor nodes, and further correct the measurement data, which can reduce the measurement error. Each node dynamically adjusts the transmission power and the received signal strength (RSS) target, hence the optimal energy is used for the transmission.

Keywords: Wireless Sensor Network, Radio Frequency, Received Signal Strength, Transmit Power Control, Interference aware transmission power control .

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I. INTRODUCTION

A Wireless Sensor Network (WSN) is a distributed network and it comprises a large number of distributed, self-directed, tiny, low powered devices called sensor nodes alias motes . WSN naturally encompasses a large number of spatially dispersed, petite, battery-operated, embedded devices that are networked to supportively collect, process, and convey data to the users, and it has restricted computing and processing capabilities. Motes are the small computers, which work collectively to form the networks. Motes are energy efficient, multi-functional wireless device . The necessities for motes in industrial applications are widespread. A group of motes collects the

information from the environment to accomplish particular application objectives. They make links with each other in different configurations to get the maximum performance. Motes communicate with each other using transceivers. In WSN the number of sensor nodes can be in the order of hundreds or even thousands. In comparison with sensor networks, Ad Hoc networks will have less number of nodes without any infrastructure. The differences between WSN and Ad hoc Networks are presented in the Table 1.

Table 1: Wireless sensor networks vs adhoc networks

	WSN	MANET
Similarity	Wireless	Multi-hop networking
Security	Symmetric Key Cryptography	Public Key Cryptography
Routing	Support specialized traffic pattern. Cannot afford to have too many node states and packet overhead	Support any node pairs Some source routing and distance vector protocol incur heavy control traffic
Resource	Tighter resources (power, processor speed, bandwidth)	Not as tight.

Now a days wireless network is the most popular services utilized in industrial and commercial applications, because of its technical advancement in processor, communication, and usage of low power embedded computing devices. Sensor nodes are used to monitor environmental conditions like temperature, pressure, humidity, sound, vibration, position etc. In many real time applications the sensor nodes are performing different tasks like neighbor node discovery, smart sensing, data storage and processing data aggregation, target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station. Wireless sensor nodes are equipped with sensing unit, a processing unit, communication unit and power unit . Each and every node is capable to perform data gathering, sensing, processing and communicating with other nodes. The sensing unit senses the environment, the processing unit computes the confined permutations of the sensed data, and the communication unit performs exchange of processed information among neighboring sensor nodes. The basic building block of a sensor node is shown in Figure 1.

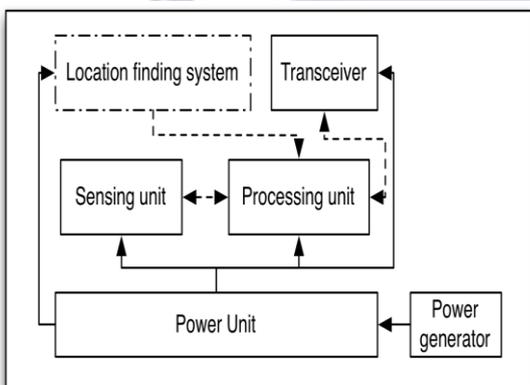


Fig 1. Basic Building Blocks of Sensor Node

II. RF BASED WIRELESS CHARGING

RF energy is currently broadcasted from billions of radio transmitters around the world, including

mobile telephones, handheld radios, mobile base stations, and television/ radio broadcast stations. The ability to harvest RF energy, from ambient or dedicated sources, enables wireless charging of low-power devices and has resulting benefits to product design, usability, and reliability. Battery-based systems can be trickled charged to eliminate battery replacement or extend the operating life of systems using disposable batteries. Battery-free devices can be designed to operate upon demand or when sufficient charge is accumulated. In both cases, these devices can be free of connectors, cables, and battery access panels, and have freedom of placement and mobility during charging and usage.

RF energy can be used to charge or operate a wide range of low-power devices. At close range to a low-power transmitter, this energy can be used to trickle charge a number of devices including GPS or RLTS tracking tags, wearable medical sensors, and consumer electronics such as e-book readers and headsets. At longer range the power can be used for battery-based or battery-free remote sensors for HVAC control and building automation, structural monitoring, and industrial control. Depending on the power requirements and system operation, power can be sent continuously, on a scheduled basis, or on-demand. In large-scale sensors deployments significant labor cost avoidance is possible by eliminating the future maintenance efforts to replace batteries.

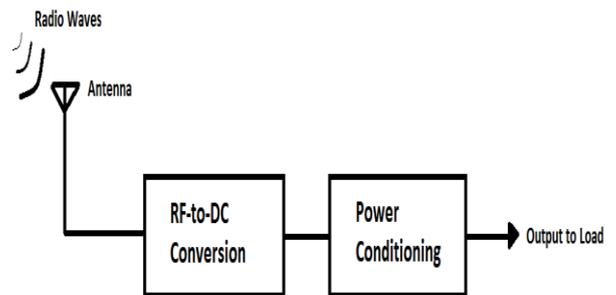


Fig 2:RF based energy harvesting structure

III. ZIGBEE PROTOCOL AND ITS ARCHITECTURE

Given the IEEE 802.15.4 specifications on PHY and MAC layer, the ZigBee Alliance defines the network layer and the framework for the application layer. The responsibilities of the ZigBee network layer include: mechanisms to join and leave a network, frame security, routing, path discovery, one-hop neighbors discovery and neighbor information storage. The ZigBee

application layer consists of the application support sublayer, the application framework, the ZigBee device objects, and the manufacturer-defined application objects. The responsibilities of the application support sublayer include: maintaining tables for binding (defined as the ability to match two devices together based on their services and their needs) and forwarding messages between bound devices. The responsibilities of the ZigBee device objects include: defining the role of the device within the network (e.g., PAN coordinator or end device), initiating and/or responding to binding requests, establishing secure relationships between network devices, discovering devices in the network, and determining which application services they provide.

GND Pin10 to the ground. Since we are using AT mode no register setting is required for the communication with the microcontroller. Each RF data packet sent over-the-air contains a source address and destination address field in its header [9]. XBee modules have a unique and permanent address on earth, this address is a 64-bit serial number assigned by the manufacturer. XBee modules also have a 16-bit short address assigned within the network. Finally, Node Identifier can be assigned to each module as a string of text.

Table2: Comparison between wireless devices

Characteristics	Bluetooth	Wireless USB	WiFi
Standard / Reference	IEEE 802.15.1	Certified USB-IF compliance	IEEE 802.11 B-G and others
Distance (max)	100m (class I)	10m (110Mbps)	100m
Data rate (max)	3Mbps	480Mbps (3m)	54Mbps
Connections	Ad hoc, max 8 devices	127 devices (max)	Point-to-hub
Line of sight	No	No	No
Relative power consumption	Medium	Low	High
Typical application	Voice and data applications for consumer electronics and personal computing devices	Data applications for consumer electronics and PC peripherals	Data and voice applications, wireless LAN, broadband internet access
Security	Authentication and encryption	Authentication and encryption	Authentication and encryption (WEP/WPA)
Characteristics	WiMax	ZigBee	IrDA Infrared
Standard / Reference	IEEE 802.16a	IEEE 802.15.4	IrDA specifications
Distance (max)	50km	100m nominal	1m
Data rate (max)	70Mbps	250kbps (2.4Ghz)	16Mbps
Connections	Point-to-hub, mesh	Ad hoc, Peer-to-peer, star	Point-to-point
Line of sight	No	No	Yes
Relative power consumption	High	Very low	Low
Typical application	Wireless metropolitan area network or last mile technology for rural areas	Sensing and controlling applications in home automation	Remote controls, mobile phones
Security	Authentication and encryption	Several measures, 128-bit AES encryption	n/a

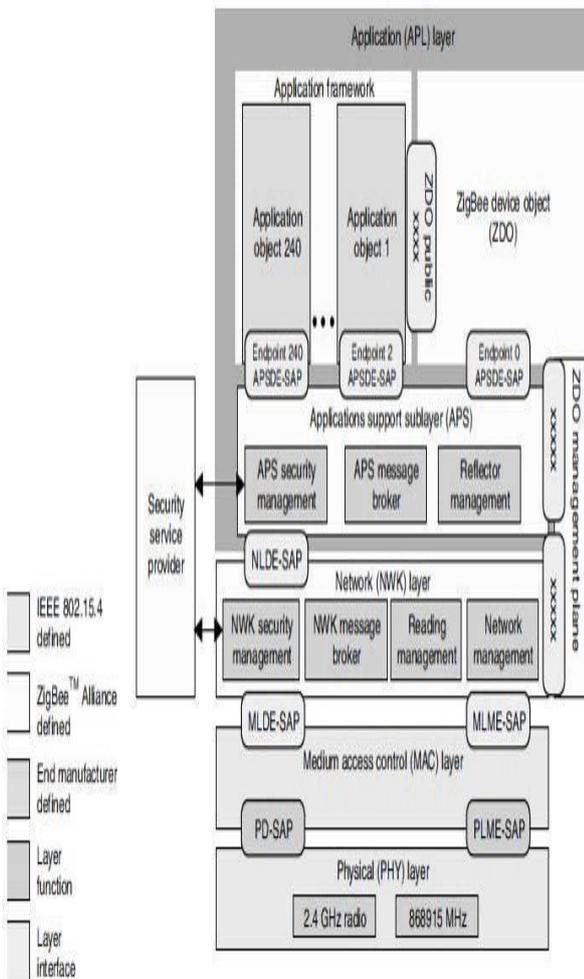


Fig 3:A detailed overview of ZigBee stack Architecture

IV. XBEE

XBee module configured as an XBee end device in this sensor node. Communication between XBee and Microcontroller is done by UART interface. We connect the DIN Pin3 of XBee to UART2 TX2 of microcontroller, VCC Pin1 to power supply and

For example, a router node can be built without the need for a microcontroller. XBee has digital input/output pins that can be used to read a digital value by a sensor or to control a motor. XBee also has PWM/analog pins; a 10-bit PWM pulse width modulated output may be sent to another XBee. One important feature is line passing where a digital input on one XBee can be reflected on the digital output of another, thus controlling the output of the second XBee.

V. RECEIVED SIGNAL STRENGTH INDICATOR

In telecommunications, received signal strength indicator(RSSI) is a measurement of the power present in a received radio signal. RSSI is usually invisible to a user of a receiving device. However, because signal strength can vary greatly and affect functionality in wireless networking, IEEE 802.11 devices often make the measurement available to users. RSSI is often done in the intermediate frequency (IF) stage before the IF amplifier. In zero-IF systems, it is done in the baseband signal chain, before the baseband amplifier. RSSI output is often a DC analog level. It can also be sampled by an internal ADC and the resulting codes available directly or via peripheral or internal processor bus.

VI. METHODOLOGY AND ITS BLOCK DIAGRAM

This is the methodology and its block diagram for an energy efficient data transfer in communication networks for wireless big data.

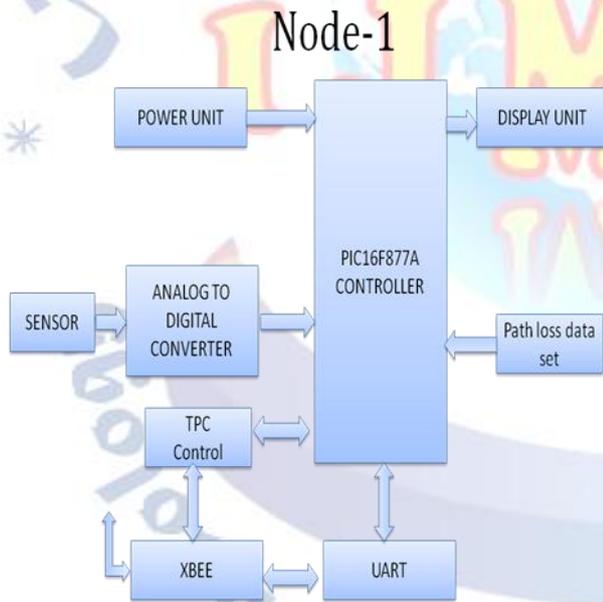


Fig 4:Block Diagram

The wireless temperature sensor node was implemented in this paper based on a PIC microcontroller that Utilizes XBee-Pro S2B to create sensing phenomena. Thus implementing a WSN model in which we study some factors which affect the design of such networks. Although the design of sensor nodes is different for different applications, but the basic structure is similar. The architecture of sensor nodes consists of a processing unit which is responsible for collecting and processing the data sensed by a sensor. A radio transceiver works as the communication unit

among sensors and a battery is the power supply unit in this system. In this section, we will study the capabilities of each chosen item in implementing the sensor node. Moreover the constraints and designing issues along with troubleshooting will be discussed as well. Figure shows our embedded wireless sensor node.

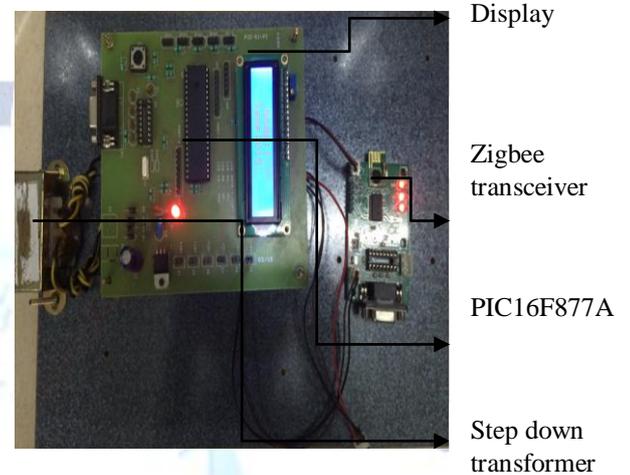


Fig 5:Wireless Temperature Sei

In this work PIC18 microcontroller is used due to its popularity, availability and available development tools. The requirements for the microcontroller in this design are: The Xbee module works with a supply voltage of 3.3V, so it is more flexible for the design to have the process unit using the same voltage. Hence, a second regulation circuit is not needed. Power usage should be as low as possible. Two UART interfaces are needed. UART1 to send data to XBee module. UART2 for further development such as serial interface with computer. The software programmed on the microchip is about 5 KB of program memory. After investigating microchip comparison utility, we found that PIC18F46K22 has the capabilities to meet all our requirements. In order to achieve the lowest possible power consumption, we choose the frequency of the oscillator to be 1 MHz. Since the default baud rate of XBee module is 9600, we have to configure the setting of the Microcontroller to function on baud rate 9600 with the frequency 1 MHz. Thus we follow the following setting :Set the value of register BRGH to 1, Set value of register SPBRGH to 0 and SPBRG to 25. The Microcontroller is connected to DS18B20 via pin RA0, UART interface is connected to XBee. The Microcontroller sends data through UART to XBee. The PIC is programmed using MPLABX software which utilizes C language using C18

compiler. The program is developed to receive the reading temperature from DS18B20 and send this data through UART to XBee which is configured as an end device to the coordinator.

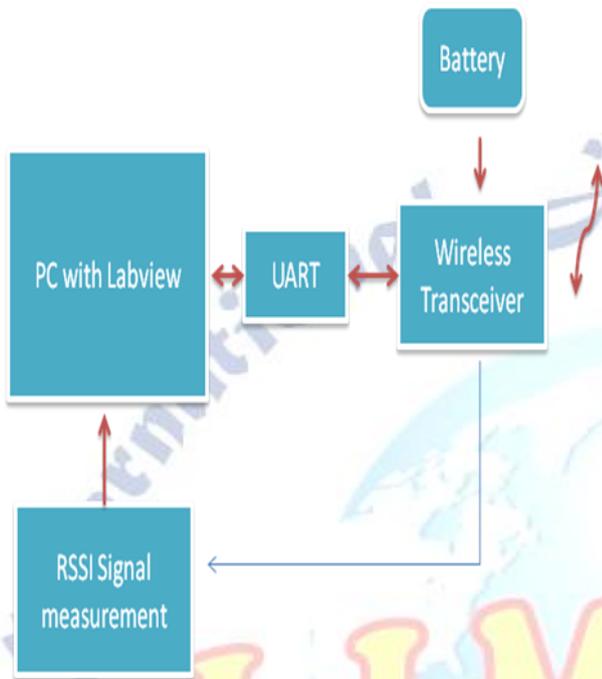


Figure 6:Receiver Side

VII. TRANSMIT POWER CONTROL

Transmit Power Control (TPC) or sometimes called Dynamic Power Control (DPC) is a mechanism used in radio communications to reduce the power of a radio transmitter to the minimum necessary to maintain the link with a certain quality. TPC is used to avoid interferences into other devices and/or to extend the battery life.

VIII. INTERFERENCE AWARE TRANSMISSION POWER CONTROL

Interference aware transmission power control (I-TPC) method is to provide an appropriate active margin is directly applied rather than a step-by-step margin as in the conventional TPC method. Interference aware -margin transmission power control (I-TPC) is based on an algorithm that selects an optimized transmission power by considering the channel conditions in mobile and static environments. For obtaining the optimal transmission power, effective minimum detectable signal (EMDS) has been introduced which considers the change both in the channel noise and in the path loss (PL) dispersion caused by multipath fading. The transmission power is

determined by the EMDS and active margin to improve the efficiency of the communication. The I-TPC improves the reliability and reduces the power consumption, because it prevents unnecessary retransmission by reducing the number of error packets. By using the I-TPC in mobile environments, we have experimentally obtained 28.3% reduction in current consumption when compared with using maximum power transmission.

IX. EXPERIMENTAL RESULT ANALYSIS

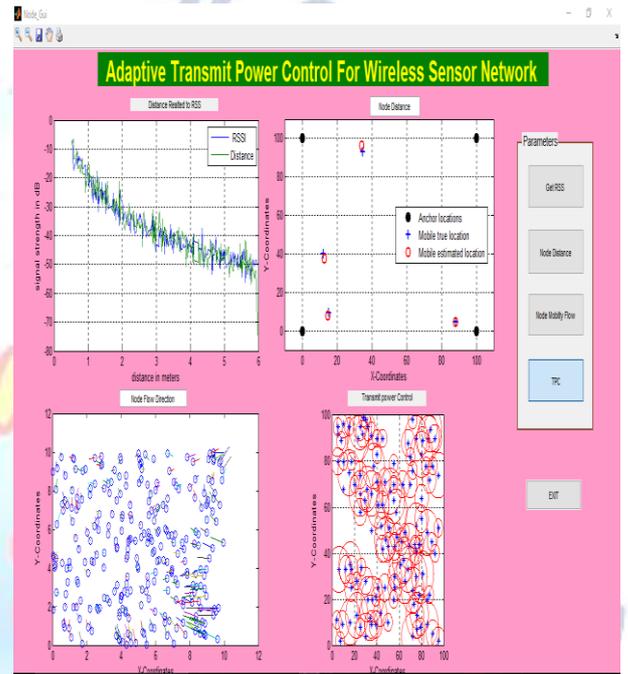


Fig 7: Simulation results confirm the effectiveness of the proposed algorithm.

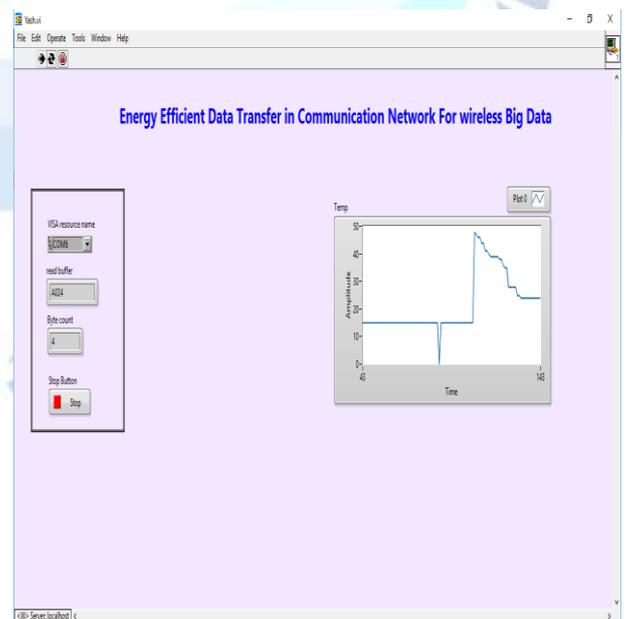


Fig 8: Monitoring data's received from sensor nodes in Labview

X. CONCLUSION

In this paper, the energy is optimally used for the transmission by calculating the distance of the node using the received signal strength value. After getting the distance, the value should be applied in the transmit power control algorithm to transmit the accurate power needed for the transmission. Hence, the energy is shared optimally.

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