INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 3 ISSUE 3 (2017) PAGES 2291 - 2298
RECEIVED : 20.04.2017 PUBLISHED : 14.05.2017
May 14, 2017

HYBRID WIRELESS SENSOR NETWORKS: A RELIABILITY, COST AND ENERGY-AWARE APPROACH

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ABSTRACT

A WSN on average consists of a hefty number of low cost, low power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities. These sensor nodes communicate over short distance via a wireless medium and collaborate to accomplish a common task, for example, environment monitoring, military surveillance, and industrial process control. These sensor nodes are typically battery-powered sensor nodes (BPSNs) and Energy-harvesting sensor nodes (EHSNs). BPSNs meet the goals of network lifetime and high reliability. EHSNs are an alternative type of sensor nodes with a long lifetime but a high cost. The cost of an EHSN is relatively higher than a typical BPSN because of energy harvester devices. Combining BPSNs and EHSNs has potential to deal with the conflicting design goals of WSNs in terms of long lifetime and reasonably low cost. A heterogeneous WSN consisting of both BPSNs and EHSNs and proposing a comprehensive cost function-based routing approach that integrates end-to-end path reliability, cost and energy consumption for providing satisfactory quality of service to applications running on hybrid WSNs. It presents a comprehensive genetic algorithm to find the optimised locations for hybrid WSNs with a mixture of EHSNs and BPSNs. Network lifetime depends on many factors such as network architecture and protocols, data collection, sensor node lifetimes, channel characteristics and energy consumption model. One approach to maximise the network lifetime is through an energy-efficient reliable genetic algorithm for data communications within WSNs, which can provide the best combination of total energy usage, communication reliability and cost.

1. INTRODUCTION

WIRELESS SENSOR NETWORK

A wireless sensor network (WSN**)** consists of spatially circulated self-governing sensors to supervise physical or green environment, such as temperature , sound , vibration , pressure , motion or pollutants and to courteously surpass their records during the association to a main location. The more present networks are bi-directional, enabling also to control the activity of the sensors. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process

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monitoring and control, machine health monitoring, and so on. Sensor nodes are distributed in a sensor field to observe a phenomenon of interest (i.e., environment, vehicle, object, etc.). Sensor nodes in the sensor field form an ad hoc wireless network and transmit the sensed information (data or statistics) gathered via attached sensors about the observed phenomenon to a base station or sink node.

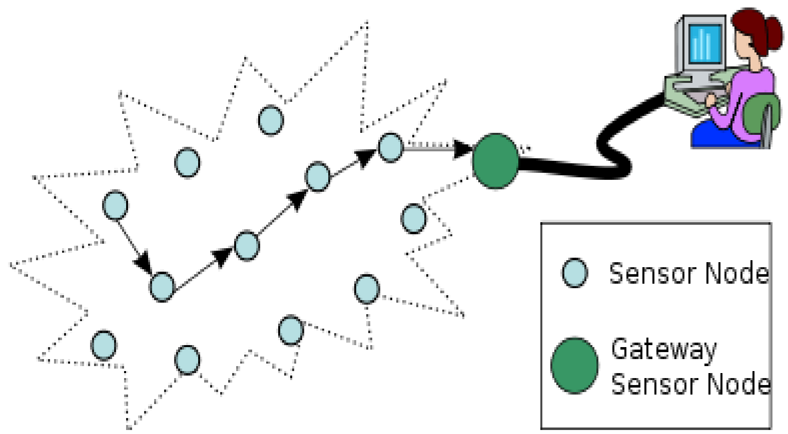

Fig 1.1typical multi-hop wireless sensor network architecture

The sink node relays the collected data to the remote requester (user) via an arbitrary computer communication network such as a gateway and associated communication network. Since different applications require different communication network infrastructures to efficiently transfer sensed data, WSN designers can optimize the communication architecture by determining the appropriate topology (number and distribution of sensors within the WSN) and communication infrastructure (e.g., gateway nodes) to meet the application's requirements.

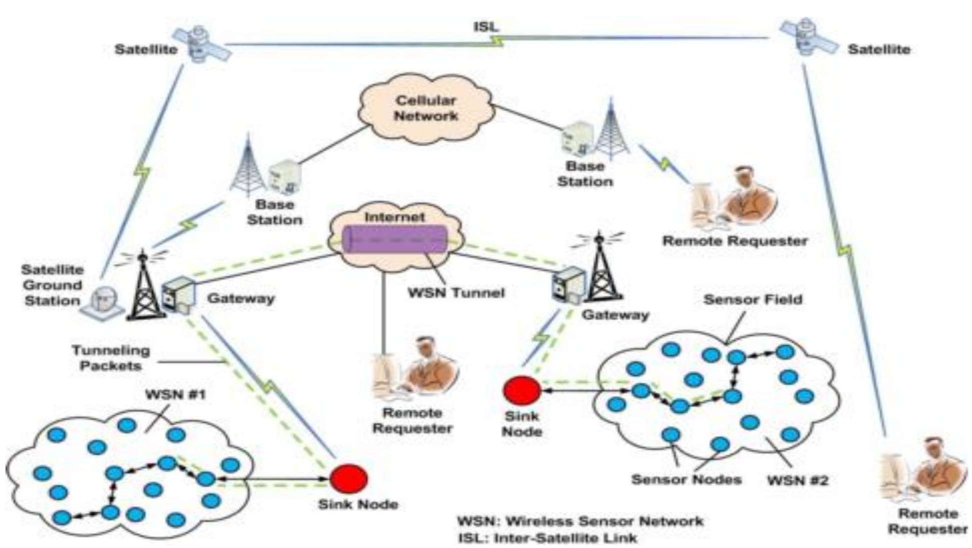

Fig 1.2 Wireless Sensor Network Architecture

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An infrastructure-level optimization called bridging facilitates the transfer of sensed data to remote requesters residing at different locations by connecting the WSN to external networks such as Internet, cellular, and satellite networks. Bridging can be accomplished by overlaying a sensor network with portions of the IP network where gateway nodes encapsulate sensor Optimization .node packets with transmission control protocol or user datagram protocol/internet protocol Selecting the optimum sensors and wireless communications link requires knowledge of the application and problem definition. Battery life, sensor update rates, and size are all major design considerations.

2. RELATED WORKS

Recent advances have resulted in the ability to integrate sensors, radio communications, and digital electronics into a single integrated circuit (IC) package. This capability is enabling networks of very low cost sensors that are able to communicate with each other using low power wireless data routing protocols. A Wireless sensor network (WSN) generally consists of a base station (or)“gateway” that can communicate with a number of wireless sensors via a radio link. Data is collected at the wireless sensor node, compressed, and transmitted to the gateway directly or, if required, uses other wireless sensor nodes to forward data to the gateway. The transmitted data is then presented to the system by the gateway connection. On the other hand the recent development of high- performance microprocessors and novel sensing materials has stimulated great interest in the development of smart sensors – physical, chemical, or biological sensors combined with integrated circuits. It is not uncommon to place multiple sensors on a single chip, with the integrated circuitry of the chip controlling all these sensors. These smart sensors can be relatively inexpensive to build, allowing for the large-scale deployment of networks of smart sensors. Technical advances are expected to improve the capabilities and performance of these devices.

3. CHARACTERISTICS

The main characteristics of a WSN include

- Power consumption constrains for nodes using batteries or energy harvesting
- Ability to cope with node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity of nodes
- Scalability to large scale of deployment
- Ability to withstand harsh environmental conditions
- Ease of use
- Unattended operation
- Power consumption

4. EXISTING SYSTEM

Existing system presents a comprehensive CF-based routing approach for hybrid WSNs with a mixture of EHSNs and BPSNs. In WSNs, a comprehensive routing protocol is needed to maximize the network lifetime while considering important factors such as energy consumption, implementation cost and reliability. The minimum and maximal RE (Residual energy) levels of a BPSN are 0 and 1, respectively. In the beginning, every BPSN has the same amount of energy and the value of RE is 1. As time passes, the value changes between 1 and 0 according to the position of the node and network traffic to the sink node. We consider a uniform data generator for all BPSN nodes and evaluate the RE of each node based on the number of paths passing the node and energy consumption for delivering messages.

Existing Methods:
Protocol: Cost Function **(**CF) based routing Protocol
BPSN: Battery-Powered Sensor Nodes
EHSN: Energy-Harvesting Sensor Nodes

Disadvantages of Existing System:

- In WSNs, link failures can be caused by factors such as radio fading or interference, signal attenuation and background noise.
- With BPSNs and EHSN, it is difficult or even impossible to optimise all performance parameters at the same time.
- The cost of an EHSN is relatively higher than a typical BPSN because of energy harvester devices

5. PROPOSED SYSTEM

Wireless sensor networks (WSNs) are collections of sensor nodes to monitor and control physical or environmental conditions. Proposed system presents a genetic algorithm to find the optimised locations for hybrid WSNs with a mixture of EHSNs and BPSNs, which integrates end-to-end path reliability, cost and energy consumption for providing satisfactory QoS to applications running on hybrid WSNs. BPSNs and EHSNs, deployed in a two-dimensional monitored area. Path reliability is the reliability of acquisition of sensed data from a specific sensor node, and delivering the sensed data to the sink node along a specific path. Reliability-importance measures are useful metrics to rank components regarding their impacts on network performance. The importance of a component typically depends on two factors: its location in the network structure and its reliability. A first-order radio model is used for considering energy dissipation in transmitting and receiving modes.

Proposed method:
Algorithm: Genetic Algorithm
BPSN: Battery-Powered Sensor Nodes

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EHSN: Energy-Harvesting Sensor Nodes

Advantages of proposed system:

- The proposed system tries to optimize and adapt energy usage to maximize the lifetime of a sensor node.
- Proposed system maximize the network lifetime, through an energy-efficient reliable genetic algorithm for data communications within WSNs.

SYSTEM IMPLEMENTATION

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning, investigation of the existing system and it's constraints on implementation, designing of Methods to achieve changeover and evaluation of changeover methods.

Modules

1. **Assumptions**
2. **Java Network Simulator**
3. **Power Consumption**
4. **Coverage**

Module Description

Assumptions

Following are assumptions that were made in the implementation of the network simulator the area of surveillance is a rectangular two-dimensional area whose dimensions are known the surveillance area is on one plane, a flat terrain each sensor node is placed randomly on the two-dimensional surveillance area and knows its coordinates each sensor node is powered by two AAA batteries, each of which initially has approximately 1000 mAH of power.

Java Network Simulator

This wireless sensor network simulator was written in the programming language Java. The simulator is comprised of four Java classes: the Main class, the Node class, the Node Field Frame class, and the UserInput class. The network simulator has been given a name which is to demonstrate the purpose of the project, Minimize Usage – Extend Life, or the MUEL simulator. Each of these classes will be discussed.

The first class, Main.java, is the class that contains the *main()* method, which is the driver for the whole program. There are several key components to this class that contribute to the overall simulation of wireless sensor network operation. These contributions are:

- create an object of the User Input class that facilitates the user in inputting key data for the simulator
- uses a random number generator to randomly determine the coordinates of each sensor node
- creates an array that holds data type Node, which facilitates accessing each unique node by the index of the array.

Power Consumption

In order to understand the means by which power is consumed by the sensor node, a brief discussion of the different states, or modes of operation, of the sensor node must be included. The states that a sensor node may exist in are 1), an active state in which the sensor node is fully powered, listening and transmitting signals; and 2) a sleep state in which the sensor node is reduced to the minimum required to maintain memory and allow it to awake and return to an active state.

Coverage

It is necessary to define coverage, and to establish how a wireless sensor node will be able to establish a positive reading, or make a measurement or reading of the parameter it is to be monitoring. In this simulation, it will be assumed that a wireless sensor node will be able to take a reading in a pure circular coverage area, and the intensity of the parameter that is being monitored will behave as for a radio signal, where the strength of the signal varies inversely with the square of the distance from the monitor.

6. APPLICATIONS

Area Monitoring

Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors to detect enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.

When the sensors detect the event being monitored (heat, pressure), the event is reported to one of the base stations, which then takes appropriate action (e.g., send a message on the internet or to a satellite). Similarly, wireless sensor networks can use a range of sensors to detect the presence of vehicles ranging from motorcycles to train cars.

Water/Wastewater Monitoring

There are many opportunities for using wireless sensor networks within the water/wastewater industries. Facilities not wired for power or data transmission can be monitored using industrial wireless

I/O devices and sensors powered using solar panels or battery packs and also used in pollution control bord.

Forest Fires Detection

A network of Sensor Nodes can be installed in a forest to control when a fire has started. The nodes will be equipped with sensors to control temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading.

Greenhouse Monitoring

Wireless sensor networks are also used to control the temperature and humidity levels inside commercial greenhouses . When the temperature and humidity drops below specific levels, the greenhouse manager must be notified via e-mail or cell phone text message, or host systems can trigger misting systems, open vents, turn on fans, or control a wide variety of system respons

CONCLUSION

A comprehensive CF-based routing approach for hybrid WSNs with a mixture of EHSNs and BPSNs. The proposed routing approach integrates end-to-end path reliability, RE in BPSNs and cost of communication paths to provide satisfactory QoS to applications running on the WSN. Efficiency of the proposed routing method was investigated via a case study with different QoS requirements. The method can be used for WSNs with any given topology. In addition, we study a method based on component importance analysis to find the best locations for EHSNs. The results show that the average end-to-end path reliability can increase significantly in comparison to random location selection for the same number of EHSNs. In the future, we plan to apply the genetic algorithm to find the optimised locations for EHSNs, improving the end-to-end path reliability as well as the overall CF value.

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