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Energy Optimization Routing Protocols Based on Clustering in WSN: A Review

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Abstract
WSN is the field on recent technology that is based on sensors. Sensors have been used for sensing information from environment in which human interaction is not possible. In these types of areas sensor network has been deployed so that information can be collected from the environment and used for further processing. Due to non-interaction WSN is energy aware network that must be used in such a manner so that minimum amount energy must be used in data sensing and transmission to base station. In this paper various energy optimization routing protocols have been discussed. Clustering based routing protocols are the best resulted routing protocols that can be used for energy optimization. In this paper LEACH, C-leach, DEEC, HEED, BEC has been discussed, that describe working of these routing protocols and how these can be effective in WSN.

Keywords: LEACH, BEC, DEEC, C-Leach, HEED

Introduction

1.1 Wireless Sensor Network

Wireless sensor networks (WSNs) have gain massive attention for their wide range of applications such as environmental monitoring, military surveillance, health care, disaster management etc. WSNs consist of hundreds or thousands of tiny, independent and low power sensor nodes which are randomly or manually implemented in a target area. The purpose of sensor nodes to collect local information, processes them and send it to a remote base station (BS), called as sink. The major limitation of the sensor nodes is their limited and irreplaceable power sources. Energy consumption of the sensor nodes is the most challenging matter for the long run operations of WSNs. A Wireless Sensor Network Mobile communication and wireless networking technology has been seen as a third time advancement.

1.2 Routing protocols in WSNs

1.2.1 Location-based Protocols: In location-based protocols, sensor nodes are addressed by means of their locations. Location information for sensor nodes is required for sensor networks by most of the routing protocols to calculate the distance between two particular nodes so that energy consumption can be estimated. A sample of location-aware routing protocols proposed for WSNs is presented below:

1.2.2 Geographic Adaptive Fidelity (GAF): GAF is an energy-aware routing protocol primarily proposed for MANETs, but can also be used for WSNs because it favors energy conservation. The design of GAF is motivated based on an energy model that considers energy consumption due to the reception and transmission of packets as well as idle (or listening) time when the radio of a sensor is on to detect the presence of incoming packets. GAF is based on mechanism of turning off unnecessary sensors while keeping a constant level of routing fidelity (or uninterrupted connectivity between communicating sensors).

1.2.3 Geographic and Energy-Aware Routing (GEAR): GEAR is an energy-efficient routing protocol proposed for routing queries to target regions in a sensor field. In GEAR, the sensors are supposed to have localization hardware equipped, for example, a GPS unit or

a localization system so that they know their current positions. Furthermore, the sensors are aware of their residual energy as well as the locations and residual energy of each of their neighbors. GEAR uses energy aware heuristics that are based on geographical information to select sensors to route a packet toward its destination region. Then, GEAR uses a recursive geographic forwarding algorithm to disseminate the packet inside the target region.

1.2.4 Coordination of Power Saving with Routing: Span is a routing protocol also primarily proposed for MANETs, but can be applied to WSNs as its goal is to reduce energy consumption of the nodes. Span is motivated by the fact that the wireless network interface of a device is often the single largest consumer of power. Hence, it would be better to turn the radio off during idle time. Although Span does not require that sensors know their location information, it runs well with a geographic forwarding protocol. Span helps sensors to join a forwarding backbone topology as coordinators that will forward packets on behalf of other sensors between any source and destination.

1.2.5 Data Centric Protocols: Data-centric protocols differ from traditional address-centric protocols in the manner that the data is sent from source sensors to the sink. In address-centric protocols, each source sensor that has the appropriate data responds by sending its data to the sink independently of all other sensors. However, in data-centric protocols, when the source sensors send their data to the sink, intermediate sensors can perform some form of aggregation on the data originating from multiple source sensors and send the aggregated data toward the sink. This process can result in energy savings because of less transmission required to send the data from the sources to the sink. We review some of the data-centric routing protocols for WSNs

1.2.6 Rumor Routing: Rumor routing is a logical compromise between query flooding and event flooding app schemes routing is an efficient protocol if the number of queries is between the two intersection points of the curve of rumor routing with those of query flooding and event flooding.

1.3 Applications of Wireless Sensor Network

1.3.1 Process Management

The common application of WSN is area monitoring. In area monitoring, the WSN is deployed upon an area where some phenomenon is to be monitored. The use of sensors detects enemy intrusion is mil; a civilian example is the geo-fencing of gas or oil pipelines. Area monitoring is most important part.

1.3.2 Health care monitoring

The medical application of two types: wearable and implanted. First device are used on the body surface of a human and also just at close proximity of the user. The implantable medical devices are those which are inserted within the human body. There are also many other application like body position measurement and location of the person, overall monitoring of ill patients in hospitals and at homes. Body-area networks can collect information about an individual's health, fitness, and energy expenditure.

1.3.3 Environmental/Earth sensing

In monitoring environment there is so much application, examples of which are given below. They share the extra challenges of harsh environments and reduced power supply.

1.3.4 Air pollution monitoring

Wireless sensor networks have been deployed in several cities to monitor the concentration of dangerous gases for citizens. These can take advantage of the ad hoc wireless links rather than wired installations, which also makes them more for testing readings in different areas.

1.3.5 Forest fire detection

A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure 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.

1.3.6 Landslide detection

A landslide detection system makes use of a wireless sensor network to detect the slight movements of soil and changes in various parameters that may occur before or during a landslide. Through the data gathered it may be possible to know the occurrence of landslides long before it actually happens.

1.3.7 Water quality monitoring

Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves. The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

1.*3*.7 Natural disaster prevention

Wireless sensor networks can effectively act to prevent the consequences of natural disasters, like floods. Wireless nodes have successfully been deployed in rivers where changes of the water levels have to be monitored in real time.

1.*3*.8 Machine health monitoring

Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionality. In wired systems, the installation of enough sensors is often limited by the cost of wiring. Previously inaccessible locations, rotating machinery, hazardous or restricted areas, and mobile assets can now be reached with wireless sensors.

Review of Literature

V Xiangwen Zhang et al. (2008) "Key Technologies of Passive Wireless Sensor Networks Based on Surface Acoustic Wave Resonators" In this paper, we presents the passive wireless sensor network based on the surface acoustic wave (SAW) resonators. The sensor node consists of the SAW sensor that is small, light, reliable, stable,

sensitive, wireless and passive, so the battery is needless and its life-span is infinite. The sink node gathers data from the sensor nodes and processes the data with intelligent algorithms and transmits the needed data to the exterior network timely. The basic structure and the realization of the passive wireless sensor network are elaborated. The five main characteristics of the passive wireless sensor network, that is passive sensor nodes, simple and small sensor nodes, organized sensor nodes, intelligent sink nodes, high security, good extendibility, are explained concretely.

Yuling Lei et al. **(2009)** "The Research of Coverage Problems in Wireless Sensor Network" wireless sensor network is composed of many wireless sensor network nodes that have capabilities of perception, computing and communication. Network coverage is the main support technology in wireless sensor network application; that can be achieved by the physical information perception of the target region and the target object through the spatial distribution of sensor nodes in the network. Network coverage fundamentally reflects the network's perception ability for physical world. In addition, it largely affects the cost of the network and the performance of specific application.

Xuhui Chen et al.(2010) "Research on hierarchical mobile wireless sensor network architecture with mobile sensor nodes "In traditional wireless sensor network the nodes like the users, the sink nodes and sensor nodes are considered to be static, in the form of single layer planner the network are organized, which cannot adapt to the application of the sensor nodes with mobility. This article start from the network architecture, that introduce the architecture of traditional wireless sensor network, and takes account of the application scenario of mobile sensor nodes..

Guanglai Chen et al.(2011) "The design of wireless wave height sensor network node based on Zigbee technology" Wireless sensor network is consisted of a large number of sensor nodes, which have advantages, such as small size, lower power consumption, with wireless communication, sensing and data processing capabilities. And the Zigbee is a wireless communication protocols using at the short distance, low rate, low power consumption. It is fit for the wireless sensor network since it supports facile applying feature. Following an introduction of the performance and structural features of CC2420, this paper describes the key points of the wireless sensor network node. So the design has broad application prospects based on CC2420 wireless sensor network with low cost, energy consumption and other characteristics.

Marriwala, N. et al.(2012) "An approach to increase the wireless sensor network lifetime" A wireless sensor network consisting of small devices, called sensor nodes that are equipped with sensors to monitor the physical and environmental conditions such as pressure, temperature, humidity, motion, speed etc. The nodes in the wireless sensor network were battery powered, so one of the important issues in wireless sensor network is the inherent limited battery power within network sensor nodes. Minimizing energy dissipation and maximizing network lifetime are the most important issues in the design of sensor networks so if the power exhausted node would quit from the network, and it overall affects the network lifetime. Minimizing energy dissipation and maximizing network lifetime are the most important issues in the design of applications and protocols for sensor network**.**

Ismail Ahmedy et. al [2012] "Using store-forward technique to conserve energy in wireless sensor networks: Initial step for routing mechanism" Wireless sensor network (WSN) is a technology which consists a number of sensor nodes distributed among of an area usually for monitoring purposes. As the emerging of this technology has been rapidly increased nowadays, the successful of the wireless sensor networks application is highly depends on the reliable communication among the sensor nodes. One major problem in wireless sensor networks environment is the limitation of the physical resource in sensor nodes which energy resource has been identified as a critical constraint for achieving the demanding capabilities in wireless sensor networks application.

Approaches Used

LEACH protocol: Low Energy Adaptive Clustering Hierarchy ("LEACH") is a TDMA-based MAC protocol which is integrated with clustering and a simple routing protocol in wireless sensor networks (WSNs). The goal of LEACH is to lower the energy consumption which is required to create and maintain clusters in order to improve the life time of a wireless sensor network. LEACH is a hierarchical protocol in which most of the nodes transmit data to cluster heads, and the cluster heads aggregate and compresses the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round or not. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy.

HEED: Another improved and very popular energy-efficient protocol is HEED (Hybrid Energy- Efficient Distributed Clustering). HEED is a hierarchical, distributed, and clustering scheme in which a single-hop communication pattern is retain within each cluster, whereas multi-hop communication is allowed among CHs and the BS. The CH nodes are chosen based on two basic parameters, residual energy and intra-cluster communication cost. Residual energy of each node is used to choose probabilistically the initial set of CHs. On the other hand, intra-cluster communication cost reflects the node degree or node's proximity to the neighbor and is used by the nodes in deciding to join a cluster or not. Thus, unlike LEACH, in HEED the CH nodes are not selected randomly. Only sensors that have a high residual energy are expected to become CH nodes. Also, the probability of two nodes within the transmission range of each other becoming CHs is small. Unlike LEACH, this means that CH nodes are well distributed in the network.

DEEC: (Distributed Energy Efficient Clustering) In DEEC protocol all nodes use the initial and residual energy level to define the cluster heads. DEEC estimate the ideal value of network lifetime to compute the reference energy that each node should expend during each round. In a two-level heterogeneous network, where we have two categories of nodes,m.N advanced nodes with initial energy equal to Eo.(1+a) and (1 − m). N normal nodes, where the initial energy is equal to Eo. Where a sand m are two variable which control the nodes percentage types (advanced or normal) and the total initial energy. DEEC does not require any global knowledge of energy at every

election
Round Advanced nodes always penalize in the DEEC, particularly when their residual energy reduced and become in the range of the normal nodes. In this position, the advanced nodes die rapidly than the others.

BEC: the design of Binary Exponential CODE (BEC) back-off MAC protocol is presented and discussed elaborately. The key idea is to move the channel contention among random access stations into a code space of orthogonal codes dynamically to allow parallel transmissions of the competing communications on the same spectrum. Unlike the traditional IEEE 802.11 MAC scheme which transmits sequentially in time domain, our proposed BEC protocol allow multiple parallel transmissions at the same time but with lower data rates. This would address the problems of performance penalty and channel utilization inefficiency incurred by the temporal binary exponential back-off because the channel contention significantly impact the frame transmission because they are serialized in time domain and it is difficult to achieve coordination among random access competing stations to win channel. The binary exponential code back-off will vary the length of code words, equivalently the size of code space based on available spectrum to not only manage the contention but also to allow parallel transmissions of the competing communications on the same spectrum using code division multiple access (CDMA).

C-Leach: In LEACH-C, clusters forming in the beginning of every period are done, using the centralized algorithm by the base station. The base station uses received information from nodes that includes energy and node status, uses this information during the setup phase for finding pre-determined number of cluster heads and network con-figuration within the clusters. Next classification of nodes in the clusters is done to minimize energy consumption in order to transfer their data to the related cluster head. Results show that LEACH-C overall performance is better than LEACH because of the optimal forming of clusters by the base station. In addition, the number of cluster heads in each period of LEACH-C is equal to the expected optimal value. While in LEACH the number of cluster heads varies in different periods because of lack of global coordination.

Conclusion
WSN is used for sensing important information's from the regions in that human interaction or other devices can't be reached. In the process of WSN energy is main constraint that has been used for data sensing and transmissions over the network. Clustering is the best way that has been emerged so that energy optimization can be done. In this paper various routing protocols clustering and cluster head selection strategy has been discussed so that efficient results in terms of energy consumption can be achieved. On the basis of review of these routing protocols BEC and C-LEACH provide better energy optimization in WSN.

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