International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 09 | Sep-2016 www.irjet.net p-ISSN: 2395-0072

Energy Attentive Steering Algorithms in WSN: A Survey

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Abstract – *Over past few decades a form of wireless networks i.e. wireless sensor networks (WSNs) has becomes as a centre area of research. Typically, a large amount of small autonomous sensing devices made up WSN for sensing different environmental condition and cooperatively passes their data through the network to a main location or base station. Since the nodes of WSN are battery operated and has limited energy, low bandwidth with high propagation delay. Therefore the guarded battery power of sensor nodes makes the network design a challenging task. However, since the age of WSN a number of energy efficient steering algorithms have been proposed by different researchers but each one has its own limitation. This paper presents a hypothetical overview to study the strengths and weaknesses of existing algorithms in WSN which may be helpful for the new investigators and motivates them to design a fresh distributed and energy efficient steering algorithm for such network.*

Key Words: Wireless Sensor Network, Energy-efficiency, Routing, Routing Protocol,

1. INTRODUCTION

In present era of communication, users are moving from the personal computer age to the ubiquitous computing in which they can access all the required information through several electronic platforms. The nature of ubiquitous devices makes wireless networks the easiest solution for their interconnection and, as a consequence, the wireless arena has been experiencing exponential growth in the past decade. Typically, Wireless Sensor networks (WSN) are networks of small, battery powered sensor nodes, usually used to monitor or measure the frequently varying environmental characteristics in areas where human intervention is difficult or impossible. Figure 1 presents a typical WSN Scenario.

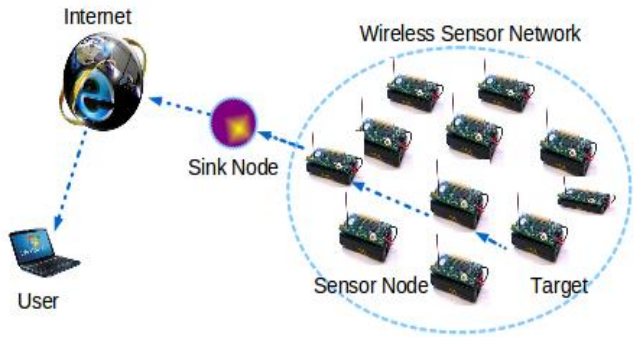

Fig -1: Wireless Sensor Network

Sensors are deployed in an ad - hoc manner in the area of interest to monitor events and gather data about the environment. They have the ability of sensing, data processing and communicating with each other in the network environment. WSNs are not a centralized network scenario as there is possible of peer-to-peer communication between the nodes. Therefore there is no requirement of prior established infrastructure to deploy the network. WSN gives flexibility of adding nodes and removing the nodes as required. But this gives rise to many drastic changes to deal with in the network topology such as updating the path, or the network tree, etc. In a WSN the node that gathers the data information refers to sink. The sink may be connected to the outside world through internet where the information can be utilized within time constraints [1].

Since the sensor nodes are battery-powered and are expected to operate without attendance for a relatively long time. But in most cases it is difficult and even impossible to change or recharge batteries for the sensor nodes. Therefore the network lifetime is depends on the life of sensor node battery which makes effective data routing as an especially challenging task in WSNs. This is due to fact that the size of a sensor node is expected to be small and this leads to constraints on size of its components i.e. battery size, processors, data storing memory, all are needed to be small. So any optimization in these networks should focus on optimizing energy consumption in the network [2].

2. STEERING ALGORITHMS IN WSN

Typically, a routing protocol is a procedure that specifies how routers communicate with each other, disseminating information that enables them to select and the implementation of a routing algorithm in software or hardware. The inherent characteristics of WSN make routing as a very challenging task in such environment and also differ it from other wireless networks like mobile ad hoc networks or cellular networks. Typically, on the base of WSN network structure the routing can be classified into three ways [3].

- Flat Network Routing.
- Hierarchical Network Routing.
- Location-based Network Routing.

In flat network routing, all nodes have the same functionality and they work together to perform sensing and routing tasks. The Sensor Protocols for Information via Negotiation (SPIN) [4] and Directed Diffusion [5] fall into this category.

Hierarchical network routing divides the network into clusters to achieve energy-efficient, scalability and one of the famous hierarchical network routing protocol is low-energy adaptive clustering hierarchy (LEACH) [6].

In location-based network routing, location information of nodes is used to compute the routing path. This information can be obtained from global positioning system (GPS) devices attached to each sensor node. Examples of location-based network routing protocols include geography adaptive routing (GAF) and Geographic and Energy-Aware Routing (GEAR) [7].

For improving steering performance in an environment of WSN a lot of approaches have proposed by number of researchers. Since the nodes of WSN are sensor nodes and are constrained to limited resources itself, so the main target is to design an effective and energy aware protocol in order to enhance the network lifetime for specific application environment. The next section has discussed a number of energy efficient approaches which has been proposed by a number of investigators for improving the power of steering in typical environment of WSN.

3. RELATED WORK

In [8] authors has presents a data aggregation paradigm for wireless sensor networks called directed diffusion to achieve energy savings by selecting empirically good paths and by caching and processing data in network. Typically data aggregation has some advantages as

- Since it is data centric, communication is neighbor-to-neighbor with no need for a node addressing mechanism. Each node can do aggregation and caching, in addition to sensing. Caching is a big advantage in term of energy efficiency and delay.
- Direct Diffusion is highly energy efficient since it is on demand and there is no need for maintaining global network topology.

However such approach is enhance the energy consumption but has some associates some limitations, such as it is not a good choice for the application such as environmental monitoring because it require continuous data delivery to the sink will not work efficiently with a query driven on demand data model.

A new group of authors has presented the energy efficient zigzag routing protocol for WSN [9]. In this study author has gone through the issues of sensor nodes i.e. limited power and developed a routing protocol to optimize the energy consumption. In same direction a new approach provided the efficient communication purpose medium access protocol for clustered WSN. In WSN, the resource allocation and energy efficiency is the challenging issues as the SN of it have low power battery. Hence author has presented the cluster based MAC protocol for WSN to bring efficiency [10].

The low power adaptive RP for WSN is presented in [11] to bring the energy efficiency and resolve, the data aggregation issue author has presented the adaptive routing algorithm for clustering. In this clustering, head was selected based on node density in the measuring area. The results of adaptive routing algorithm are compared with LEECH algorithm and concluded that the algorithm brings energy optimization & improved communication quality in distribution situation

A new multipath routing for cluster tree WSN (ZigBee) has been discussed in [12]. The investigation has also concerned with efficiency, throughput and data transmission at low and high data rates.a new approach introduced a cross-layer design protocol for WSN to bring the energy efficiency using token passing mechanism. To overcome the issues of traditional energy efficient WSN method, the design, and optimization layer of WSN a new algorithm has proposed [13]. The mechanism gives efficient results than some other routing mechanisms.

In [14] a self-stabilizing algorithm has been proposed to minimize the energy usage in WSN. In this, the approximation algorithm is presented to build the backbone for a sensor that brings the efficient routing. The author has achieved the efficiency in their method by simulation results.

In [15] authors proposed the concept of constructing minimum spanning tree among the various nodes that are dispersed in the wireless sensor field. They claimed to consume minimum energy by constructing minimum spanning tree among the sensor nodes & thus reducing the cost of transmission between the nodes.

In [16] authors has use neural network for reducing the energy consumption as to find the exact positions of node for the efficient routing of packets and location aware services. The technique used to find the exact location of nodes is time difference of arrival (TDOA) with artificial neural network to find the exact location of nodes. TDOA is here us ed to calculate the distance between anchor node and sensor node by sending radio frequency signal and ultra sound signal, then sensor node note down the current time of both the signals. As the distance between the anchor node and the sensor node are available a neural network is created and is trained with these distance values and finds the approximate location coordinates of the system. The paper uses two types of neural network for training the WSN. First, Radial Basis Network Function, Second, Multilayer perception it contains 3 Layers Input, Hidden and Output. In the different scenarios both the type of neural network provides better results than another. The error is also calculated between the exact position and the randomized position to provide the better results and to increase the network lifetime. WSN is used to monitor the interested region using multi-hop transmission, and coverage is the primary metrics to evaluate the monitoring capacity. Also the connectivity should be guaranteed so the BS is able to receive all the sensed data for further processing. Nodes have processing and communication capabilities which are used to collect the information and transmit it to the base station. Then the BS analyses and decides whether or not an exceptional event occurring in the network.

4. MODERN ROUTING CHALLENGES & DESIGN ISSUES IN WSN

There are various parameters which provide a very challenging criterion in routing for WSN. Due to reduced computing, radio and battery resources of sensors, routing protocols in wireless sensor network are expected to fulfill the following requirement:

- The cost of single node is enough to justify the overall cost of the sensor network. So the cost of each sensor node should be kept low.
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- Routing schemes make efforts with the vast collection of motes in WSNs which should be scalable enough to talk back to the events take place in the environment.
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- Data Reporting Method should be configured in the network. Efficient Data delivery model overcomes the problem of fault tolerance domain by providing the alternative path to save its data packets from nodes or link failures. It severely affect the routing protocol in wireless sensor network, especially with regard to use the limited energy of the node, security purpose, energy consumption and route immobility.

- Energy Consumption in the network should occur without losing of accuracy of the network.

- Requirement such as long life time of sensor networks and restricted storage capacity of sensor nodes has directed to search a new scope to alleviate power consumption. Several schemes discussed as power aware protocol, cross-layer optimization, and harvesting technologies which help in reducing power consumption constraint in WSNs. In multi-hop sensor networks, the multi-functioning of some nodes such as data sender and data router can cause topology change due to power failure which require new path for data transfer and restructure the network.

- Data Aggregation process within the clusters in the network. The main goal of data aggregation algorithms is to gather and aggregate data from different sources by using different functions such as suppression, min, max and average to achieve energy efficient and traffic optimization in routing protocols so that network lifetime is enhanced.

- Transmission Media should be fault tolerance.

- QOS policies of the network.

- Dynamics Network. Node/Link Heterogeneity of the network.

5. CONCLUSIONS

Routing in sensor networks is a new research area, with a limited but rapidly growing set of results. In this paper, routing protocols are discussed based on three categories: Flat based routing, Hierarchical-based routing and Location-based routing on the basis of network structure. They have the common objective of trying to extend the lifetime of the sensor network. The main purpose of designing energy efficient routing protocol in WSN is to efficiently use the energy of the network so that the network lifetime get increased. Now-a-days many energy efficient routing protocols are available in WSNs but most of the protocols require location information for sensor nodes in wireless sensor networks to calculate the distance between two particular nodes on the basis of signal strength so that energy consumption can be estimated. These approaches are unable to provide efficient high data rate transmission in wireless sensor networks due to the limited capacity of a multi-hop path and the high dynamics of wireless links. Many routing protocols have been proposed which are not suitable for all applications in WSNs. Many issues and challenges still exist that need to be solved in the sensor networks.

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