REVIEW ON WIRELESS SENSOR NETWORK PROTOCOL WITH AI TO ENHANCE THE NETWORK LIFETIME

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ABSTRACT

Wireless sensor networks (WSNs) are big applications for monitoring and tracking. The vast number of sensors installed in remote and inaccessible areas will therefore be easy and scalable to install and maintain. Sensors have minimal backup of batteries, as they are small in scale. Energy is a crucial factor to prolong the network's lifespan, as nodes cannot be recharged as deployed in risky areas once deployed. In general, clustering or chain-based strategies are used in WSNs to reduce the energy consumption of the sensor nodes. In this paper we discussed routing protocols for WSNs based on clustering and the chain special nodes called cluster heads in cluster-based routing form a wireless backbone to the sink or Base Station. Every head of a cluster collects data from the sensors that belong to its cluster and forward it to the sink. A node called the leader node forwards the data to the Base Station is established in chain-based routing protocol system.

Keywords -: Leach, Pegasis, Genetic Algorithm, Wsn's, Network lifetime, energy efficiency etc.

INTRODUCTION

Wireless Sensor Networks (WSNs) is seen as one of 21st century's most important technologies. Recent advances in Micro-electronic-mechanical-systems (MEMS) and wireless communication systems, small, cheap and smart sensor nodes collaborated with wireless connectivity and the internet deployed in the physical sector , providing many possibilities in different applications, such as battlefield surveillance, environmental monitoring, and healthcare applications[1].

Wireless Sensor Network is a special category of non-infrastructure networks capable of providing wireless communication with a large number of low-cost sensor nodes with limited power and multifunctional capabilities[2]. There are four basic components in a typical sensor node: a sensing unit, a processing unit, a communication unit and a power unit.

WSNs are not centralised and there is no centralized network. There's peer-to - peer networking between nodes. Multi-hopping will cause a sensor node to communicate through intermediate nodes with a node that isn't within each other's radio range. Thus WSN provides flexibility to add or delete nodes in the network. The network can be split into cluster no. called clustering. Each of the sensor nodes is chosen as Cluster Head (CH) in-cluster and the remainder serve as Cluster Members (CM). Within each cluster all sensor nodes work together to meet the order.Cluster head collects the data from its members and data aggregation is done by each cluster head to remove data redundancy and forwarded to the sink[3]. As cluster head consumes more energy than cluster members, the workload of cluster heads is distributed among all nodes in wireless sensor network by rotating their roles to equalize energy consumption called Cluster Head rotation.

Energy consumption is an significant problem in WSN, because sensor nodes are powered by batteries and cannot work without adequate power level. The ever-changing topology of the network and small power-supply nodes make WSN very difficult and a common field of research.

CHARACTERSTICS OF WSN's

Unlike traditional wireless sensor networks like MANETs, WSN has unique characteristics as follows:

A. Dynamic Network Topology**:** Network topology changes frequently as nodes can be added or removed, node failure, energy depletion, or channel fading.

B. Application Specific: The design requirement of the network varies with required application.

C. Energy constrained**:** Nodes are portable and are highly limited in energy, computation and storage capacities. This is the most important design consideration of WSN.

D. Self-configurable: Nodes are randomly deployed without careful planning. Once deployed, nodes have to configure autonomously themselves into a communication network.

WSN ROUTING PROTOCOLS

To optimize energy consumption in the network, it is important to enforce routing protocols specifying rules that define how message packets transfer efficiently and with less energy consumed from source to destination in a network. Routing protocol classification in WSNs as given below.

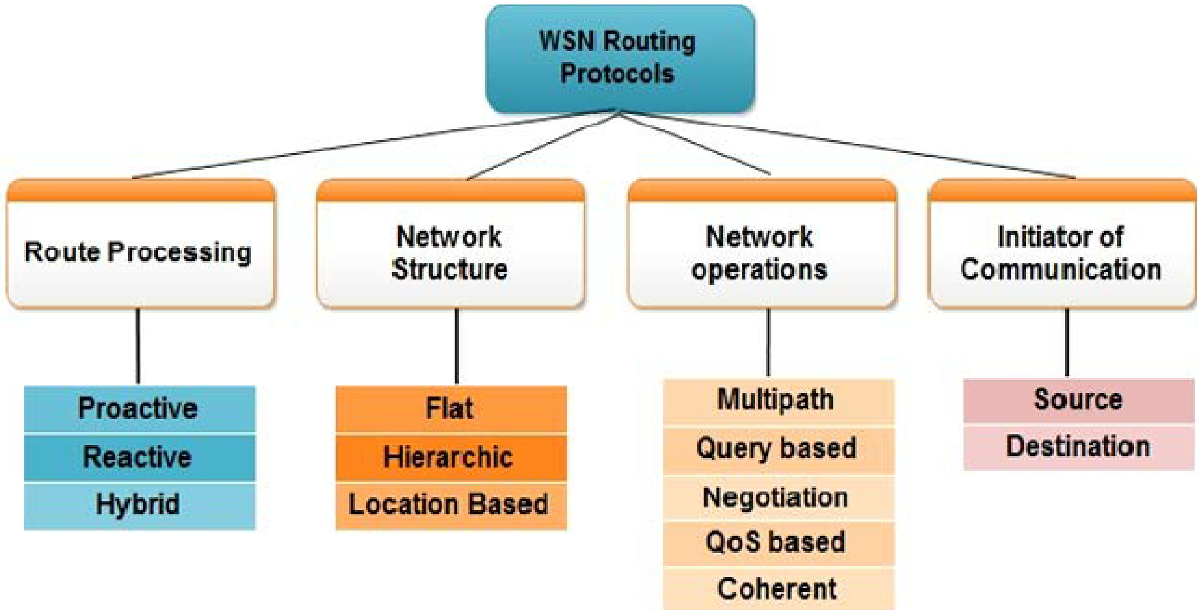

Fig 1. Routing protocols in Wsn[4]

A. Path Establishment

a. Pro-Active (or Table Driven): Routing Protocols measure all routes using classic routing strategies such as distance-vector before they are really needed, and then store these routes in each node in a routing table. If a path changes, the change needs to be regularly propagated across the network. Since a WSN could consist of thousands of nodes and require a higher rate of routing table updates, the routing table that each node will need to maintain might be massive and thus proactive protocols are not ideal for WSNs.

b. Reactive (or on-demand): Routing Protocols discover routes to destination only when they are needed by broadcasting route query or request messages into the network.

c. Hybrid protocols: Hybrid protocols use a combination of these two ideas.Hybrid Routing Protocols have the merits of proactive and reactive routing protocols by neglecting their demerits.

B. Network Structure

a. Flat-based Routing Protocols: Each node plays the same role in performing a sensing task and all sensor nodes are peers.
b. Hierarchical-based Routing Protocols: Sensor nodes are grouped into clusters in this form of routing, where higher-energy nodes are used as cluster head(CH) to collect data from lower-energy cluster members(CM). Cluster participants send the sensed data to cluster heads where data compression and data fusion is performed to minimize the number of messages sent to the sink[5]. This process of building clusters and head rotation of clusters increases network life cycle, network scalability, and reliability of the network.
c. Location-based Routing Protocols: Sensor nodes in this form of routing protocols interact with other nodes based on the location of each node. This location or distance can be determined by two methods-by incoming signal intensity from the source or by GPS (Global Positioning System), the distance between two adjacent nodes can be calculated.

C. Protocol Operation

a. Multipath-based Routing: To order to keep them alive, it uses multiple paths rather than single paths to improve the network's fault tolerance at the cost of increasing energy consumption and sending regular messages overhead to alternate paths.
b. Query-based Routing: The destination node propagates a query for the transmission of data to the network. The node that has data corresponding to the query sends data to the appropriate node. Such questions are generally in natural language.
c. Negotiation-based Routing: This routing protocol takes communication decisions based on availability of resources in the network suppressing duplicate information and prevent redundant data from being sent to the next sensor node.

d. QoS-based Routing: This routing protocol balances the network between energy consumption and data quality in order to satisfy certain QoS metrics such as delay, and bandwidth.
e. Coherent-based Routing: In this routing protocol, the local processing of data is based on minimum processing (coherent) and the full processing (non-coherent).

CLUSTER BASED HIERARCHIAL ROUTING PROTOCOL: OVERVIEW

Low-Energy Adaptive Clustering Hierarchy (LEACH)] is a standard hierarchical routing clustering protocol that adopts distributed clustering algorithms where cluster-head rotational mechanism, data aggregation, and data fusion technologies effectively boost network lifetime. To maximize the energy in the network, nodes are circularly and randomly selected as the cluster leader. The regular nodes, called cluster leaders, join the respective cluster head nodes based on proximity theory. Normal nodes sense data and send it directly to the headnodes of the cluster. The cluster head nodes receive sensed data, aggregate the data to remove redundancy and fusion processes are carried out and data is send to the sink (or Base Station). So LEACH increases network lifetime by decreasing network energy consumption, and reducing number of communication messages by data aggregation and fusion[6].

In order to achieve the design goal the key tasks performed by Leach are as follows:

- Randomized rotation of the cluster heads and the corresponding clusters.
- Global communication reduction by the local compression.
- Localized co-ordination and control for cluster setup and operation.
- Low energy media access control.
- Application specific data processing.

A. Running Process of LEACH

The Leach operation is classified into different rounds, and each of these rounds has mainly two phases: the Set-up Phase and the Steady-state for data transmission.

a. The Set-up Phase: First, the LEACH protocol randomly selects cluster heads (CHs) by randomly generating a number (n) between 0 and 1, for each node. If this randomly generated number is less than the threshold value given by threshold function T (n), the node would be selected as cluster head node.

$$T(n) = \begin{cases} p/\left(1 - p\left(r \bmod \frac{1}{p}\right)\right), n \in G \\ 0 \qquad\qquad\qquad\qquad n \in G \end{cases}$$

Where P is the cluster-head probability and G is the set of nodes that never be chosen as cluster-head nodes before 1/p round.

After the selection of cluster head nodes, each cluster-head node will send information via CDMA code to other nodes and normal nodes will join the corresponding cluster-head nodes. Then the cluster head nodes use TDMA to provide data transmission time for every node connected to them.

b. The Steady-state: This stage is for data transmission where normal nodes sense data and send this sensed data to their respective cluster-head nodes. The processing of received data (data aggregation and data fusion) is done by cluster head nodes and processed data will be sent to the base station.

DEFENCIES IN CLASSICAL LEACH PROTOCOL

Unreasonable cluster head selection: For the selection of the cluster head node, LEACH protocol does not take into account the residual energy of each node, as each node has equal likelihood of being a cluster head. If low-energy node is chosen as a cluster head node, the network will soon fail due to high energy consumption resulting in detrimental effects on the network's energy balance. This results in loss of data, and lower network survival time.

Unreasonable distribution of cluster heads: The random selection algorithm of cluster head nodes causes problem of imbalance in energy load. Distance factor is not considered in cluster formation due to which sometimes very big clusters and very class clusters exist at the same time in the network.More the distance between cluster head node and base station, more the energy consumption of that node.

More responsibility on Cluster Head node: Cluster head nodes perform data aggregation and send processed data to the base station in single-hop due to which cluster head nodes deplete their energy too fast as compared to normal nodes. Also if a cluster head node fails, the whole nodes linked to it will deplete their energy too.

PEGASIS

PEGASIS is Power-Efficient Gathering in Sensor Information Systems. PEGASIS form open chain staring from node which is farthest from Base Station .PEGASIS assume that global information is available. This algorithm uses greedy algorithm for chain construction. Before first round of communication chain formation is done. During formation of chain care must be taken so that nodes already in chain should not revisited .When a node die then chain is reconstructed by bypassing that node. In data gathering cycle each node forms a data packet of its own in network[7]. For each data gathering cycle leader is elected among all nodes in network. Each node in network receives a data packet and fuses it with its own data and forwards it to other neighboring node. PEGASIS uses a simple token passing approach which is initiated by leader to start data transmission from ends of chain.

PEGASIS WITH GENETIC ALGORITHM

Genetic algorithm Long communication distances between sensors and a sink (or destination) in a sensor network can drain large amounts of sensor energy and reduce network life. We can significantly reduce the total contact distance by clustering a sensor network into a number of independent clusters using a GA, thereby prolonging the network lifetime. This approach also refers to multiple network topologies (uniform or non-uniform) or problems with optimization of shortest distances. A genetic algorithm (GA) is used to create energy efficient clusters for wireless sensor networks to disseminate the data. Since energy consumption is a major factor in energy depletion during communication, the number of transmissions must be reduced in order to achieve an extended battery life. In order to pick the best population a Genetic Algorithm performs fitness tests on new structures. Fitness defines the individual's efficiency, based on the criteria specified. Throughout fact, the health of an person is their capacity to pass on their genetic material.All that contributes to that capacity contributes to the overall fitness of the organism. Its ability includes characteristics which allow it to survive and reproduce further. In a GA, the fitness function which defines the problem is evaluated. The fate of a single chromosome depends on the fitness value; the higher the fitness value, the greater the survival chance.

RELATED WORK

Xiaohan Li, Fengpeng Yuan and JanneLindqvist [2016] Have suggested using the most energy-efficient GPS service cycle, without losing precision. Real-life traffic monitoring findings reported in this paper claim to save 78 percent energy, if the sampling period is increased beyond 120 seconds. Accuracy losses stabilize about 23 percent, relative to continuous GPS sampled. The Wireless Sensor Network (WSN) is made up of sensors, microcontrollers and tools for communication. Sensor nodes vary in size from shoebox to particle of dust. Continuously battery operated nodes are involved in monitoring applications for long periods of time. Human intervention isn't necessary after initial deployment.

Massinissa Saoudi [2016] Environmental monitoring is a wide area including monitoring of air emissions, detection of forest fires, detection of landslides, monitoring of water quality etc. Early identification of the occurrence is critical in case of forest fire incident. Early detection technique for such case is proposed in "Energy Efficient Data Mining Techniques for Emergency Detection in Wireless Sensor Networks." Rather than collecting vast volumes of data for hazard identification, each node contributes individual data to the cluster. Fire detection is performed using the technique for classifying artificial neural networks.

K.Lokesh Krishna [2016] Environmental monitoring is a broad field including air pollution control, forest fire detection, landfill detection, water quality monitoring etc. In case of an incident of forest fire, early detection of the event is important. In "Energy Efficient Data Mining Strategies for Emergency Detection in Wireless Sensor Networks," early warning strategies for these cases are proposed. Instead of gathering vast amounts of data for hazard recognition, each node contributes individual data to the cluster. The fire detection technique is used to identify artificial neural networks.

Kaushledra Kumar Pandey [2016] Has proposed an excellent energy efficient clustering solution. Cooperatively, the LEACH and TEEN clustering strategies are combined to ensure efficient wireless communication. Proactive and reactive strategies of clustering ensure the area is tracked frequently and regularly. All LEACH and TEEN protocols are by definition energy efficient and consider the residual energy of each node before selecting the head of the cluster. This smart use of sensors takes care that all sensors live the longest possible life and thus increases the lifespan of the network. Using conventional LEACH and TEEN technique and cooperative technique, the proposed technique is evaluated by contrasting sensor node live volume.

Xunpeng Rao1 [2017] Environmentally installed sensor nodes are either with rechargeable batteries or with one-time power source. Rechargeable power source networks are known as wireless rechargeable network. Mobile vehicle recharging charges sensor nodes according to predefined timetable. Sensor deployment topology in real time applications causes poor sensor node charge efficiency and can hamper node lifetime. This paper takes into account the impact of charging distance and angle on load. Within this paper, the suggested approach focuses on recharging sensor nodes to increase the service life of the network.

Beihua Ying [2017] An adaptive data compression strategy to increase the energy efficiency of the entire network has been proposed. Data compression is the best way to reduce energy consumption in WSN but it can be a boring process to compress data. The proposed adaptive compression technique uses prediction and feature extraction of specific parameters for each sensor node in the network. Density of the sensor nodes varies according to the deployment strategy. Sensor data is compressed in a highly dense region to prevent redundancies in sensor network.

Zahra et. al (2017) Proposed a cross-layer routing system called Geographic Cross-Layer Routing adapted for WSN disaster relief operations (GCRAD) that overcomes the aforementioned problems by simultaneously affecting all relay node selection criteria. We implemented a new criterion for the selection of relay nodes, called possible relay number (PRN). This approach takes into account QPI and GPI averages for the process of selecting relay nodes. This protocol showed significant performance against existing cross-layer protocols such as ALBA-R, IRIS, etc.

Shahul Hameed A (2018): This paper addresses the standard spatial routing and the cross layer routing. Compared to traditional protocols used in Wireless Sensor Networks (WSN), cross-layer routing protocols are seen as more energy efficient and reliable. The routing protocol used in wireless sensor networks should be energy efficient, and the message should be transferred from source to sink without any loss of packets. This paper addresses existing protocols used in WSN's, and explains the routing protocol study weaknesses.

Usha Kumari [2019] We propose three different protocols in this paper – distributed energy-efficient clustering (DEEC), developed DEEC (DDEEC) and enhanced distributed energy-efficient clustering (E-DEEC). Those protocols are compared with cluster head and lifetime energy depletion. Simulations are carried out by taking into account 500 sensor nodes and 30 cluster heads for 10,000 iterations within a contact range of 200 to 200 m. The number of nodes alive is found to be 70 per cent higher in E-DEEC than in DEEC and DDEEC. For E-DEEC, the packets sent to the BS are 80 per cent higher than DEEC and DDEEC. The E-DEEC protocol improves the lifetime of the network as compared to DECC and DDEEC.

Umer Farooq [2019] Wireless Sensor Network (WSN) is the authoritative convenient and inexpensive key for tracking and monitoring environmental and physical conditions of various types. These sensors help to wirelessly collect, process and communicate data. WSN technology offers usability for small-size and low-cost sensors, and is very useful for data processing in different applications. Wireless sensor network, however, also needs further upgrades for communication, data storage , distribution, power consumption, and data routing. As in wireless sensors, network sensor nodes have restricted transmission range, storage space, and power backup capabilities.

PROPOSED WORK

In order to resolve the question of data transmission in large-scale wireless sensor networks with mobile sinks travelling along fixed paths at constant speed, we propose an efficient data collection scheme that simultaneously increases total data volume and decreases energy consumption. The use of genetic algorithms makes data aggregation simple. When genetic algorithms are applied, less energy is required to collect the data. Lifetime of the network is increased because of lower energy usage.

OBJECTIVES

(1) Understanding various artificial intelligence techniques

(2) Implementation of PEGASIS

(3) Implémentation of GENETIC Algorithm

(4) Implémentation of LEACH Algorithm

(5) Comparison of these algorithms on the parameters like energy consumption, end to end delay, packet drop etc. in the wireless sensor network.

METHDOLOGY

(1) Firstly we implement pegasis by following given steps:

a) Initialize the network parameters. Determine the number of nodes, initial energy, BS location information et al. Then chain construction starts.

b) BS broadcasts the whole network a hello message to obtain basic network information such as ID of nodes alive and distance from each node to BS.

c) Set the node which is farthest from BS as end node, it joins the chain first and is labeled as node 1.

d) End node of the chain obtains the information of distance between itself and other nodes which have not joined the chain yet, finds the nearest node and sets it as node I waiting to join the chain, i represents the i-th node joined.

(2) Implementation of pegasis using genetic algorithm by following given steps.

Step 1: firstly the numbers of relay nodes are calculated.

Step 2: now M sets of 2*(n + 1) chromosomes are generated. Where M is the population size and n is the number of relay nodes.

Step 3: now odd chromosomes of each set is used as x coordinate location of the relay nodes and sink node and even chromosomes is used as y coordinate locations for same.

Step 4: Ones the locations of all relay nodes and sink node is calculated the life time and transmission cost of each relay nodes and normal nodes are calculated.

Step 5: Calculate the fitness value for each of M sets of chromosomes.

Step 6: Select the chromosomes with best fitness value and perform crossover to get the new generations and delete the others.

Step 7: repeat steps 3 to 7 till the maximum generations completed or the goal is found.

CONCLUSION AND FUTURE WORK

Wireless sensor network consists of battery-powered sensor nodes; to communicate with one another for monitoring of the environment. The key problem in the wireless sensor networks is energy efficiency. Therefore routing techniques have been developed to maximize network life and achieve maximum reliability and scalability.

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