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Review on Various Data Gathering Techniques Using Artificial Intelligence

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Abstract: ***Tiny and low-cost sensor nodes capable of sensing different types of physical and environmental environments, data processing, and wireless communication are now available thanks to advancements in wireless sensor network (WSN) technology. The wide range of sensing capabilities leads to a plethora of application areas. The characteristics of wireless sensor networks, on the other hand, necessitate more efficient data forwarding and processing methods. The sensor nodes in a WSN have a restricted transmission range, as well as limited processing and storage capacities and energy resources.Routing protocols for wireless sensor networks are responsible for maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this paper, we give a survey of routing protocols and artificial intelligence techniques for Wireless Sensor Network.***

Keywords: Wireless Sensor Networks, Routing Protocols, LEACH, PEGASIS, HEED, ACO, GA, PSO etc.

1. Introduction

One of the most important developments for the twenty-first century is the wireless sensor network (WSN). It has gotten a lot of attention from academia and industry all over the world in recent decades. A wireless sensor network (WSN) is made up of a large number of low-cost, low-power, multifunctional wireless sensor nodes that can perform sensing, wireless communications, and computation.These sensor nodes communicate over a short distance using a wireless medium and work together to complete a common mission, such as environmental monitoring, military surveillance, or industrial process control [1]. The basic premise of WSNs is that, while each individual sensor node's capacity is limited, the network's total power is adequate for the necessary task.

A wireless sensor network (WSN) is a set of sensor nodes that are homogeneous and self-organized. These nodes are capable of sensing, processing, and wirelessly communicating data with one another through radio frequency channels. Sensor networks' primary function is to detect events, collect data, and send it to the desired location. Many characteristics distinguish these networks from conventional wired and wireless distributed systems.Traditional wired or [2] wireless networks have enough resources like unlimited power, memory, fixed network topologies, enough communication range and computational capabilities. These features make the traditional networks able to meet the communication demands.

WSNs are low-energy, low-bandwidth, and short-range distributed networks with limited resources. Self-organizing capabilities, short-range connectivity, multi-hop routing, dense deployment, energy and memory limitations, and constantly changing topology due to fading and failures are all characteristics that distinguish WSNs from conventional networks.WSNs face numerous design and coordination challenges due to their limited resource availability and volatile network structure (sensor nodes are dispersed throughout the environment). As shown in Figure 1, the wireless sensor network process usually involves data collection and reporting, so it has a data acquisition network, a data distribution network, and a management centre responsible for monitoring and control.

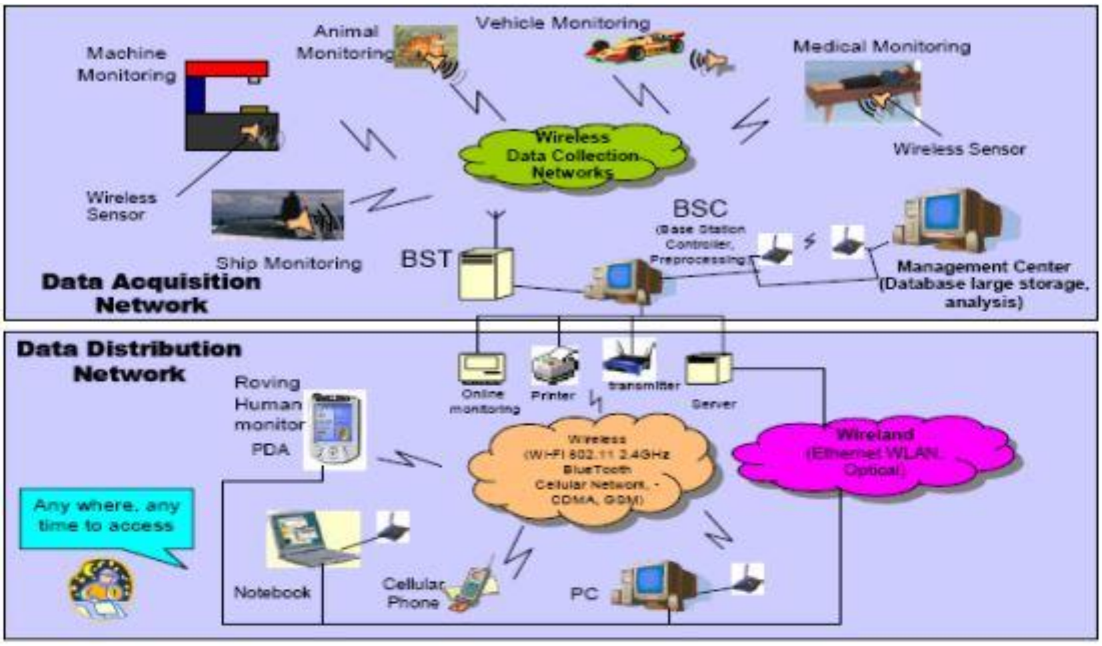

Figure 1: Wireless sensor network [1]

Characteristics of Wireless Sensor Network

- Scalability to a large scale of distribution
- Capability to ensure strict environmental conditions
- Simple to use
- The consumption of Power limits for nodes with batteries
- Capacity to handle node failures
- Some mobility of nodes and Heterogeneity of nodes
- Cross-layer design

Advantages of Wireless Sensor Networks

- Apt for the non-reachable places like mountains, over the sea, rural areas, and deep forests.
- It might provide [3]accommodations for the new devices at any time.
- It can be opened by using centralized monitoring.
- Network arrangements can be carried out without immovable infrastructure.
- Flexible if there is a casual situation when an additional workstation is required.
- Execution pricing is inexpensive.
- It avoids plenty of wiring.

Wireless Sensor Network Applications

Wireless sensor networks may comprise numerous different types of sensors like low sampling rate, seismic, magnetic, thermal, visual, infrared, radar, and acoustic, which are clever to monitor a[4] wide range of ambient situations. Sensor nodes are used for constant sensing, event ID, event detection & local control of actuators. The applications of wireless sensor networks mainly include health, military, environmental, home, & other commercial areas.

Figure 2: Wireless sensor network applications [4]

Routing Protocols in WSN

Wireless sensor network routing varies from traditional fixed network routing in a number of ways. There is no infrastructure, wireless links are unreliable, sensor nodes may fail, and routing protocols must meet stringent energy conservation requirements [5][6]. For wireless networks in general, several routing algorithms have been developed. As shown in Table 1, all major routing protocols proposed for WSNs can be divided into seven groups.

Table 1: Wireless Sensor Network Routing Protocol

Category	Representative Protocols
Location-based Protocols	MECN, SMECN, GAF, GEAR, Span, TBF, BVGF, GeRaF
Data-centric Protocols	SPIN, Directed Diffusion, Rumor Routing, COUGAR, ACQUIRE, EAD, Information-Directed Routing, Gradient-Based Routing, Energy-aware Routing, Information-Directed Routing, Quorum-Based Information Dissemination, Home Agent Based Information Dissemination
Hierarchical Protocols	LEACH, PEGASIS, HEED, TEEN, APTEEN
Mobility-based Protocols	SEAD, TTDD, Joint Mobility and Routing, Data MULES, Dynamic Proxy Tree-Base Data Dissemination
Multipath-based Protocols	Sensor-Disjoint Multipath, Braided Multipath, N-to-1 Multipath Discovery
Heterogeneity-based Protocols	IDSQ, CADR, CHR
QoS-based protocols	SAR, SPEED, Energy-aware routing

Hierarchical Protocols

Low Energy Adaptive Cluster (LEACH) Hierarchical Protocol

In LEACH the current Cluster Head (CH) energy level is tested after every round and if its energy is drained and below the threshold value then new CH will be selected based on the probabilistic principle.CH's roles are to be rotated or shared among the network's sensor nodes. The CH obligation distribution stabilizes the energy consumption of network nodes, so that no node is overwhelmed.

Hybrid energy efficient distributed computing protocol (HEED)

To increase the energy consumption balance between different parts of the sensor network, remaining or residual energy, node degree or node density have been used as the main parameter for CH selection.The HEED protocol operates on the three key parameters i.e. distribution of energy[6] usage to increase the lifespan of the network, selection of CH is to be terminated after a fixed or predefined number of iterations and thirdly the CH is distributed or placed in such a way that the maximum number of nodes has an simple access to them.

PEGASIS

One such hierarchical routing protocol, which follows a chain-based approach and a greedy algorithm, is PEGASIS Power Efficient Gathering in Sensor information systems. The nodes of the sensors arrange themselves to form a chain.If any node dies in between then the chain is reconstructed to bypass the dead node. A leader or a cluster head node is assigned and it takes care of transmitting data to[7] the base station/ sink node. The main goal of PEGASIS is to receive and transmit data to and from the neighbour and take turns being the cluster head for transmission to the Sink Node.

AI Algorithms for data gathering

1) Genetic Algorithm

The Genetic Algorithm is a heuristic search algorithm focused on natural selection and evolution principles. Genetic algorithms are evolutionary algorithms (EA) that use genetic operators, such as mutation, selection and crossover, to solve optimization problems. In a genetic algorithm, the candidate solution (fitness value) is created by developing a population of chromosomes. The chromosome population is generated randomly.

2) Ant Colony Optimization

Ant Colony Optimization (ACO) is one of newly emerged swarm intelligence technologies [Dorigo& Gambardella, 1997]. Inspired from a famous ant experiment in 1989, in which ants were found to be always able to find the shortest path between the food source and their colony, the first ACO algorithm, Ant System (AS), was proposed in 1991 to solve the traveling salesman problem (TSP) [Dorigo*et al.*, 1991]. The preliminary experimental results were very promising and encouraged more research efforts for this new optimization method. After AS, many different ACO algorithms have been proposed and successfully applied in different discrete optimization problems including the TSP problem, scheduling, vehicle routing, etc. as well as the routing problem in telecommunication networks [Dorigo& Gambardella, 1997]. Many of these algorithms provide world-class performance. Further, it has been shown that ACO algorithms are not only suitable for static applications but also successfully applied in dynamicsetting, such as network communication where the traffic at different points keeps fluctuating with time [Cordon *et al.*, 2002].

AntChain Algorithm

For a WSN, after one round of data-gathering, related sensor nodes need to send the collected data to the base station, either directly or indirectly. It is often too time-consuming to solve this least energy cost problem especially when considering a large number of sensor nodes. We simplify this problem into a typical TSP problem, in which the cost between any two sensornodes (cities) is the energy needed for wireless radio transmission (the amount of energyneeded for receiving is only related to hardwareand package size, which are assumed to be constant). According to the radio propagation theory, the energy needed can be roughly modelled as a power law function of the distance between the transmitter and receiver. Based on the above assumptions, we develop a centralized approach, called the AntChain algorithm, for data gathering and communications. In this algorithm, sensor nodes behave by following commands from the base station. Compared to other data-gathering schemes, which are self-configuring during the entire lifetime, the base station plays a critical role in the AntChain algorithm.

3) Particle Swarm Optimization

PSO is old and is the most used swarm intelligence algorithm. The general idea of PSO is inspired by a flying swarm of birds searching for food. In Kwolek (2013), the task of object tracking is considered as a numerical optimization problem, where a PSO is used to track the local mode of the similarity measure and to seek a good local minimum, and then the conjugate gradient is utilized to find the local minimum accurately. But the ordinary PSO is not well suited for multiple object tracking. As presented in Keyrouz (2012), the proposed algorithm introduces two new components to PSO: a self-adapting component, which is robust against drastic brightness changes of the image sequence, and a self-splitting component, which decides to track the scene as one connected object, or as more stand-alone objects.

2. Related Work

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.

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.

Shahul Hameed A (2018): The conventional geographical routing and cross layer routing are discussed in this paper. Cross layer routing protocols are seen to be more energy efficient and robust compared to conventional protocols used in Wireless Sensor Networks (WSN).The routing protocol used in wireless sensor networks should be energy efficient and the message should be transmitted from source to sink without any packet loss. This paper discusses current protocols used in WSN's and describes the research weaknesses in the protocols for routing.

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.

Heimfarth et al. (2015) Suggested a joint MAC and routing layer method called AGA-MAC in which the source node searches for the receiver and selects the node that has the minimum sink distance as the relay node.

Petrioli et al. (2014) Proposed a cross-layer routing system called ALBA-R that integrates MAC, routing, and relay node selection schedule for sleep / awake. The Queue Priority Index (QPI) and the Geographic Priority Index (GPI) are significant variables considered for relay selection in this process by the International Journal of Pure and Applied Mathematics Special Issue 345. Taking QPI and GPI into consideration for relay selection decreased congestion by balancing traffic between various nodes.

Deganet. Al (2014) suggested an energy balanced routing system called FAF-EBRM in which the next hop is calculated on the basis of the capacity of the connection and the energy density forward. The experimental results show this protocol balances energy consumption and maintains high WSN QoS.

Zhao et al. (2013) Proposed a cross-layer routing system called Topology and Link Quality-Conscious Geographic Routing (TLG), incorporating physical and routing layer features. As relay node selection parameters, the function includes distance, energy, and quality of the link.

Wenget. al(2013) An energy-efficient routing algorithm called RIDSR (Relative Identification and Guidance for Wireless Sensor Networks) has been proposed which divides the sensing region into sectors. Each sector is a manager node that transmits the data to the base station. The Base Station offers unique ID in this protocol to all the International Journal of Pure and Applied Mathematics Special Issue 344, the nodes present in a sector centered on the name of the quadrant and the distance from the base station. The simulation results showed that this protocol substantially improved the energy consumption and the throughput.

Vuran et al. (2010) Proposed a new cross-layer routing, called XLP, which uses recipient-based contention and considers possible relay thresholds to ensure efficient communication. A four conditional function is used in this approach to evaluate the nodes that participate in the selection process for the relay node**.**The nearest node is chosen as the relay node with respect to the sink. In previously proposed approaches, status of queue nodes is not considered. This results in congestion and a drop in packets. Due to ignorance of important parameters ineffective transmission occurs in the methods described above.

Adel et al. (2010)suggested an energy-efficient data transmission protocol called the Energy Aware Geographic Routing Protocol (EAGRP) which would be more suitable for wireless multi-hop sensor networks. This protocol is based on the two parameters left in the nodes: position and energy. EAGRP's efficiency was substantially better compared to protocols previously in use.

3. Proposed Work

Wireless sensor networks are strewn through vast swaths of land. WSNs play an important role in our lives, providing us with knowledge even in cases where humans are unable to access. Many new developments are being made these days to solve the limitations of sensor networks. Sensor networks are made up of a variety of nodes that are dispersed over a wide area or even a small area. Sensor node structure is determined by requirements. The sensor network has some limitations. Particularly in terms of data collection, which is the primary function or, as we like to call it, the backbone of a wireless sensor network.The aim of my research work is to study the concept of data gathering in the wireless sensor network. The focus of our work lies on making the process of data gathering to be efficient. We are using PEGASIS, LEACH, ACO (ant colony optimization), Genetic algorithm and Particle swarm optimization techniques for data gathering. And compare these algorithms and find out which one is best for data gathering.

Research Objectives

1) Understanding various artificial intelligence techniques
2) Implementation of PEGASIS
3) Implémentation of LEACH
4) Implémentation of Ant Colony Optimization algorithm
5) Implémentation of Genetic algorithm
6) Implémentation of Particle Swarm Optimization algorithm
7) Comparison of these algorithms on the parameters like energy consumption, end to end delay, packet drop etc. in the wireless sensor network.

4. Research Methodology

- Study of clustering algorithms in wireless sensor network.
- Study of hierarchical schemes.
- Implement leach, pegasis.
- Study artificial intelligence technique
- Implement ANT COLONY OPTIMIZATION.
- Implement Genetic algorithm.
- Implement Particle Swarm optimization.
- Compare these hierarchical and artificial schemes and find which one gives better results.
- Reducing the number of nodes that compete for channel access
- Cluster head updates, regarding cluster topology; and Routing through an overlay among cluster-heads, which has a small network diameter.

5. Conclusion

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.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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