Comparison of Data Gathering Techniques Using Artificial Intelligence

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Abstract: ***This study examines the requirement for energy - efficient communication in wireless sensor networks and analyses the major causes of energy dissipation, as well as countermeasures, to assure the network's long lifetime. Wireless sensor networks can gather trustworthy and accurate information in remote and dangerous locations, and may be utilised in national defence, military affairs, industrial control, traffic management, medical care, smart home, and other applications. Because the sensor whose resources have been allocated is low - cost and relies on the battery for power, it is critical to make optimal use of its power for routing. This research looks at the need for energy - efficient communication in wireless sensor networks, as well as the primary sources of energy dissipation and countermeasures that may be taken to ensure the network's extended lifespan. In national defence, military affairs, industrial control, traffic management, medical care, smart home, and other applications, wireless sensor networks can gather reliable and accurate information in remote and dangerous places. Because the sensor whose resources have been assigned is low - cost and runs on battery power, making the best use of its power for routing is important.***

Keywords: wireless sensor network, Routing Protocol, Leach, Pegasis protocol, Genetic Algorithm, Ant colony optimization, Particle swarm optimization, Energy efficiency etc.

1. Introduction

Wireless Sensor Networks (WSNs) are a type of non - infrastructure network that may provide wireless connection to a large number of low - cost sensor nodes with limited power and multifunctional capabilities. A typical sensor node has four fundamental components: a sensing unit, a processing unit, a communication unit, and a power unit.

There is no centralised network and no centralised WSN. Between nodes, there is peer - to - peer networking. Multi - hopping allows a sensor node to interact with a node that is not within radio range of the other through intermediary nodes. As a result, WSN allows for the addition or deletion of nodes in the network. Each of the sensor nodes is chosen as Cluster Head (CH) in - cluster and the remainder serve as Cluster Members (CM). To fulfil the order, all sensor nodes in each cluster collaborate. Each cluster head receives data from its members, aggregates it to reduce redundancy, and sends it to the sink [2]. Cluster heads spend more energy than cluster members, therefore their burden is spread among all nodes in a wireless sensor network by rotating their responsibilities to equalise energy consumption, a process known as Cluster Head Rotation.

Because sensor nodes are powered by batteries and cannot function without sufficient power, energy consumption is a key issue in WSN. WSN is a challenging and common topic of research due to the network's ever - changing topology and tiny power - supply nodes.

LEACH

LEACH (Low - Energy Adaptive Clustering Hierarchy) is a hierarchical routing clustering system that uses distributed clustering algorithms with cluster - head rotating mechanisms, data aggregation, and data fusion technologies to extend network lifespan. The cluster leader is chosen in a circular and random manner to optimise the network's energy [3] [4]. On the basis of proximity theory, the regular nodes, known as cluster leaders, join the corresponding cluster head nodes. Data is sensed by normal nodes and sent straight to the cluster's head - nodes. The cluster head nodes collect sensed data, aggregate it to eliminate redundancy, perform fusion operations, and transfer the data to the sink (or Base Station). As a result of data aggregation and fusion, LEACH extends network lifespan by lowering network energy consumption and reducing the amount of communication messages [5].

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

- Randomized rotation of cluster heads and clusters. Local compression reduces global communication.
- Cluster construction and operation need localized coordination and management.
- Controlling access to low - energy media.

PEGASIS

Power - Efficient Gathering in Sensor Information Systems (PEGASIS) is an acronym for Power - Efficient Gathering in Sensor Information Systems. PEGASIS establishes an open chain that begins at the furthest node from the Base Station. PEGASIS is based on the assumption that worldwide data is available. For chain building, this method employs a greedy approach. Prior to the completion of the first round of communication chain creation. Care must be taken during chain creation to ensure that nodes previously in the chain are not revisited. When a node dies, the chain is rebuilt without that node. During the data collection cycle, each node in the network creates its own data packet [6]. A leader is chosen from among all nodes in the network for each data gathering cycle. Each node in the network gets a data packet, fuses it with its own data, and sends it to another node in the network. PEGASIS employs a basic token passing technique in which the leader initiates data transmission from the chain's endpoints.

Genetic Algorithm

Genetic Methods (GAs) are a type of adaptive heuristic search algorithm that falls within the category of evolutionary algorithms. Genetic algorithms are built on the foundations of natural selection and genetics. These are sophisticated random search apps that use past data to guide the search to a solution space area with better performance. They're commonly used to provide high - quality solutions to optimization and search problems.

Genetic algorithms imitate natural selection, implying that organisms who can adapt to changes in their environment would survive, reproduce, and carry on to the next generation. For the aim of solving a problem, they simulate "survival of the fittest" among people of consecutive generations [7]. Each generation is made up of a group of people, each of whom symbolises a potential solution and a position in the search space.

In GAs, we have a population or pool of possible solutions to a problem. These solutions are then exposed to recombination and mutation (like in natural genetics), resulting in the birth of new children, and the process is repeated generations after generations. Each individual (or candidate solution) is assigned a fitness value (based on its objective function value), with the fitter ones having a higher chance of mating and creating more "fitter" individuals. This is in line with Darwin's notion of "Survival of the Fittest. "

Particle Swarm Optimization (PSO)

Particle swarm optimization (PSO) is a computer approach for optimising a problem by iteratively trying to improve a candidate solution in terms of a specific quality measure in computational science. It solves a problem by generating a population of potential solutions, which are referred to as particles, and moving them around in the search space using a simple mathematical formula based on their position and velocity. The movement of each particle is affected by its local best known position, but it is also directed toward the best known positions in the search space, which are updated when better places are discovered by other particles.

PSO shares many similarities with evolutionary computing techniques such as Genetic Algorithms (GA). The system starts with a population of random solutions and then searches for optima via updating generations. However, unlike GA, PSO lacks evolution operators like crossover and mutation. Particles follow the current optimum particles through the problem space, which are viable solutions in PSO. The next sections will give more detailed information. PSO starts with a [8] collection of random particles (solutions) and then iterates over generations to find the best solution. Every cycle, each particle is updated by comparing two "best" values. The first (fitness) is currently the most effective choice. (The fitness value is also kept.) P - best is the name given to this number. Another "best" value monitored by the particle swarm optimizer is the best value gained so far by each particle in the population. G - best, which stands for "global best, " is the name given to the highest value. When a particle utilises the population as its topological neighbours, the best value is a local best, abbreviated L - best.

A swarm of possible solutions (also known as a swarm) is used in a basic variant of the PSO algorithm (called particles). A few basic formulas are used to move these particles about in the search space. [9] Their movements are guided by their personal best - known position in the search space as well as the swarm's best - known position. When more suitable locations are discovered, they will be utilised to guide the swarm's travels. The method is repeated in the hopes of eventually finding a satisfactory solution, however this is not assured.

Ant Colony Optimization

[Dorigo & Gambardella, 1997] Ant Colony Optimization (ACO) is a freshly developed swarm intelligence technology. The first ACO algorithm, Ant System (AS), was presented in 1991 to solve the travelling salesman problem (TSP) [Dorigo et al., 1991]. It was inspired by a famous ant experiment in 1989, in which ants were discovered to always be able to locate the shortest path between the food source and their colony. The earliest experimental findings for this novel optimization approach were highly promising, encouraging additional study into it. Following AS, several ACO algorithms were devised and successfully used to a variety of discrete optimization problems, including the TSP issue, scheduling, vehicle routing, and the routing problem in telecommunication networks [Dorigo & Gambardella, 1997]. Many of these algorithms are among the best in the world. Furthermore, it has been demonstrated that ACO algorithms are not only suited for static applications, but can also be successfully implemented in dynamic settings, such as network communication, where traffic at various locations varies over time. [Cordon *et al*., 2002].

Implementation steps

- 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.

2. Result and Discussion

All simulations were run on a 100m*100m grid, with nodes placed at random over the field. PEGASIS is simulated using 100 nodes and the implemented protocol LEACH. PEGASIS constructs the chain using a greedy method, ACO, PSO, and a Genetic Algorithm. The simulations are run when 10%, 30%, 60%, and 90% of the nodes die, in order to determine the number of nodes. The starting energy level of each node is the same.

Table 1 shows the energy analysis of the aforementioned designs. The proportion of nodes surviving at the same beginning energy level correlates to the number of rounds completed by the various methods when compared to each other.

Energy	Protocol	Percentage of alive nodes						
		90	70	60	50	40	30	20
.25	Leach	650	700	720	750	760	790	795
	Pegasis	700	730	750	780	790	799	800
	Pegasis Aco	900	950	970	1000	1050	1100	1250
	Pegasis Ga	1410	1570	1590	1600	1790	1960	2100
	Pegasis Pso	2900	3190	3320	3390	3590	3780	3920

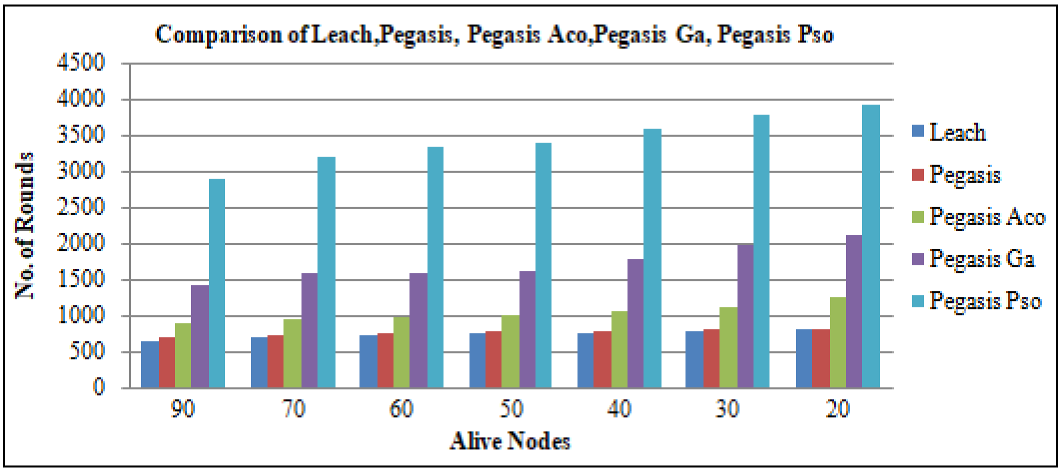

Figure 1: WSN Protocol comparison on the basis of energy

In the case of PEGASIS being implemented using PSO, the results indicate better efficiency.

3. Conclusion and Future Work

The PEGASIS protocol discussed guarantees that resources are used efficiently, therefore extending the network's lifespan. PEGASIS shows several drawbacks when utilising Greedy Chain, such as the incremental growth in inter - nodal distances when approaching the end of the chain, which may be overcome by implementing PEGASIS using Ant Colony Optimization (ACO), Genetic Algorithm (GA), and PSO. In MATLAB, simulations are run that are associated with one another based on the amount of energy consumed in the form of distance travelled. GA's Particle Swarm Optimization PSO outcomes are better than ACO's.

Other optimization algorithms, such as the artificial bee colony algorithm (ABO) or the shortest path, should look into possible adjustments to the gathering methods to enhance dependability even further.

References

[1] Farooq, Umer. (2019). Wireless Sensor Network Challenges and Solutions.10.13140/RG.2.2.22191.59043.

[2] Kumari, Usha & Padma, Tatiparti. (2019). Energy - Efficient Routing Protocols for Wireless Sensor Networks: Proceedings of ICSCSP 2018, Volume 2.10.1007/978 - 981 - 13 - 3393 - 4_39.

[3] Vinay Kumar, Ganjeev Jain, Sudarshan Tiwari, "Energy Efficient Clustering Algorithms in Wireless Sensor Networks: A Survey", International Journal of Scientific & Engineering Research, 2011.

[4] N. Xu, A survey of sensor network applications, IEEE Communications Magazine 40 (8) (2012) 102–114.

[5] D. J. Dechene, A. El Jardali, A. Sauer, "A Survey of Clustering Algorithms for Wireless Sensor Networks", International Journal of Computer & Wireless Communication, Vol 4, No2, Decemebr, 2013.

[6] B. Revathy, G. Rekha, "Latest Algorithms in Wireless Sensor Networks for Energy Conservation A Survey", International Journal of Engineering Research & Technology, Vol 3, Issue 10, October 2014.

[7] Gaurav Kumar Nigam, Chetna Dabas, "A Survey on Protocols and Routing Algorithm for Wireless Sensor Networks", Proceedings of the World Congress on Engineering and Computer Science, Vol 2, 2015.

[8] Mohini Kumrawat, Manoj Dhawan, "Survey on Clustering Algorithms of Wireless Sensor Networks", International Journal of Computer Science & Information Technologies, Vol 6 (3), 2015.

[9] Beihua Ying, School of Information Science and Engineering, Ningbo Institute of Technology, Zhejiang University, Ningbo, "An Adaptive Compression Algorithm for Energy - Efficient Wireless Sensor Networks" in Advanced Communication Technology (ICACT), 2017 19th International Conference Bongpyeong, South Korea on 19 - 22 Feb.2017, pp.861 - 868

[10] K. Sabahein and F. Wang, "A Review On Recent Advances In Routing For Wireless Body Area

Network, " *2019 SoutheastCon*, Huntsville, AL, USA, 2019, pp.1 - 8, doi: 10.1109/SoutheastCon42311.2019.9020641.

[11] Arora, N., Gupta, S. H. & Kumar, B. An approach to investigate the best location for the central node placement for energy efficient WBAN. J Ambient Intell Human Comput (2020).

[12] Medenou, D., Ahouandjinou, M. H., Piaggio, D. et al. New intelligent network approach for monitoring physiological parameters: the case of Benin. Health Technol.10, 1311–1322 (2020).

[13] Hämäläinen, M., Anzai, D., Fortino, G. et al. Preface to Special Issue on Wireless Body Area Networks: Based on Bodynets 2018 Conference. Int J Wireless Inf Networks 27, 1–3 (2020).