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Survey of Cooperative Routing Algorithms in Wireless Sensor Networks

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Abstract Wireless Sensor Networks(WSN) are the self-configurable networks which can be used to monitor the external environment like temperature monitoring, pressure sensing, human health monitoring and much more. The monitored data will be forwarded via intermediate sensor nodes and sink nodes to the database server. These networks work in the concept of multi-hop routing in which all the nodes can act as data sensing as well as data relaying. This kind of distributed routing technique will reduce the energy of the sensor nodes in turn will reduce the network lifetime. And this energy consumption is directly proportional to the distance between the sensor nodes and the server. As the sensor nodes transmit in the open medium, these networks are vulnerable to black hole attacks also. In this paper, a list of secured and Load balanced cooperative routing algorithms are reviewed and analysed.

Keywords : WSN, Routing, Cooperative Routing, Energy Efficiency and Black hole attacks.

Introduction:

A wireless sensor networks are the self adjustable networks consists of sensor nodes normally with limited memory, processing and battery power. These sensor nodes are connected with each other through wireless medium like Bluetooth, Zigbee or Wi-Fi. WSN consists of three types of nodes namely Coordinator node or Sink node, sensor node and Routing nodes [Bougard et al]. A sink node is used to aggregate the data from a group of nearby sensor nodes and forward to the server via some intermediate routers. These routers may be a separate routing device or one of the sensor node itself. In order to reduce the small packets in the network, a Cluster Head (CH) node is identified in a group of nodes, to aggregate the data, apart from the sink nodes [Parmar and Jinwala]. Figure 1 shows the data transfer between source node to base station with clustering [Gopalakrishnan et al.]. The cluster heads are selected based on their trust-ability, residual energy and the distance from the base station. The cluster heads should have highest residual energy and it should be closer to the base station within one hop distance [Vinothkumar et al [2019],Visnupriya et.al [2015] and Sharma].

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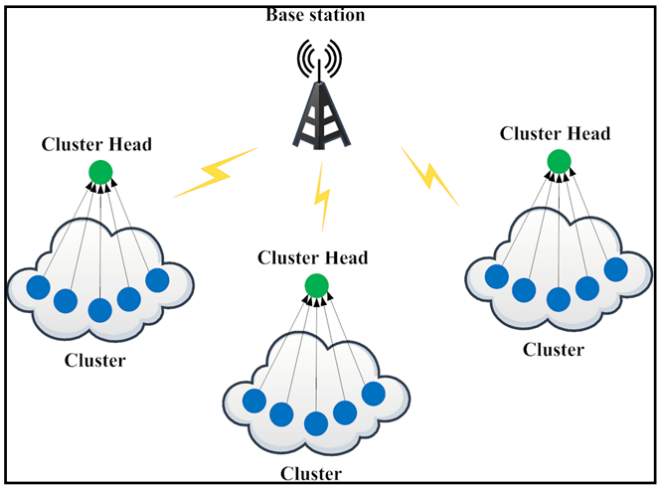

Figure 1: WSN without clustering and with clustering

As the wireless medium is open access, the security of the transmission is also a major constraints in the WSN. The black hole attack is one of a common attack in WSN. These black hole nodes are captured by the malicious outsiders, and reprogrammed to drop the packets or generate false packets to collapse the network.

The rest of the paper is organized in the following manner. Section II provides the literature survey and Section III concludes the survey.

II. Literature Survey

Mohammed et al.[2019], proposed a LEACH based clustering scheme. The node with maximum energy than the average network energy is selected as a Cluster head. It also introduced 3 types of nodes called master, advance and normal Nodes through which different levels of transmission is taken place. Vinothkumar et al.[2020], introduced Improved Energy Efficient protocol in which, the energy consumption is reduced further by preventing the cluster heads that are very close to the base station to participate in the cluster head election.

A 3-level heterogeneous network model was proposed by Singh et al.[2017]. In this the network lifetime is characterized by only one parameter to categorize the network in to 1-level, 2-level and 3-level. By using a weighted election probability, the cluster head and its members are identified.

An efficient distributed and scheduling algorithm was proposed by Xu and Song[2015]. To minimize delay, interference is considered. Alromih and Kurdi[2019], proposed Energy-Efficient Gossiping protocol (EEGossip). The routing is done by selecting the optimal path by using Chebysev distance, the distance between the current and the sink node and the residual energy.

For a heterogeneous sensor networks, Hybrid Firefly With Differential Evolution Algorithm was proposed by Anuradha et al[2021]. For this, the WSNs in a same geographical area form a heterogeneous network. The transmission of the event packet and residual energy decides the routing paths dynamically by Gopinath et al[2019].

A reinforcement learning based multicast routing protocol (FROMS) was proposed by Forster et al. [2008], by modified the transmission back-offs and acknowledgements. From their proposal, they demonstrated that, machine learning algorithms can be effectively used for limited restricted devices.

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Hu et al. [2010], used machine learning approach to under water wireless sensor nodes routing to overcome the difficulties in propagation delay and power consumption. This method suggests a balanced routing protocol called QELAR which distributes routing through all sensor nodes.

To utilize the sensor node's energy efficiently, Hierarchical routing protocols were used. Based on this, patel and shah, [2015] proposed an energy efficient shortest path Q-Routing algorithm. This algorithm works in the basis of reinforcement learning which enhances the network lifetime.

Wireless sensor networks are the self configurable networks of wireless nodes which are used to sense the environmental or physical changes such as pressure, temperature, motion and etc. The dynamic topology of these networks made the routing process as very complex Anankumar et al [2020]. The other challenge lies in minimizing the resource utilization in routing. For this, machine learning algorithms are popularly used. Khan et al.[2016] proposed a Support Vector Machine based clustering method. This method assigns the sensor nodes to the nearest cluster head to minimize the energy consumption. Arun kumar et al. [2018] proposed a Naive Bayesian based classification method to predict the energy and traffic load in the chosen path.

To find the link cost of the sensor nodes is a major task in routing. In order to estimate the link cost, Singh and Kaur [2017] poposed a machine learning based approach. It used Multilayer perceptron, Radial Basis Function Neural Networks, Bayes Net, Naïve Bayes and C4.5 Decision tree and they evaluated the performances of these algorithms.

In order to enhance the network life time, Masoud et al. [2019] and Ramesh et.al [2021]proposed a hybrid routing protocol (HCRP-HD) by detecting the holes and edge nodes. This process try to generate a connected graph which covers all the nodes. The sink nodes are responsible for the detection of holes and edges which reduces the sensor node's energy consumption. To overcome the energy consumption of direct transmission, the network is converted in to number of rings.

Table 1: Merits and drawbacks of existing works.

Author name	Merits	Drawbacks
Mohammed et al.[2019] Singh et al.[2017]	Balancing energy consumption among sensors.	packet may pass through many more hops
Alromih and Kurdi[2019]	Reduced relaying costs.	sensor statuses need to be collected periodically
Hung et al[2020]	Reduced energy consumption	sensor statuses need to be collected periodically
Forster et al. [2008]	Improved security	Delay is not considered

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Hu et al. [2010] patel and shah [2015] Khan et al.[2016] Arun kumar et al. [2018] Singh and Kaur [2017] Masoud et al. [2019]	Reduced Delay and power consumption	Security is not considered

III Conclusion

The Wireless Sensor Networks faces many issues as the nodes have limited memory, processing and energy. And the medium is also open, the security issue also needed to be addressed. In this survey, an attempt is made to identify the issues in the WSN and the identified issues are summarized. Most of the papers provide either security or issues related to delay and energy consumption. From our survey, it is concluded that a combined approach is required to improve the lifetime of WSN.

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