A Literature Review on Routing Methods for Wireless Sensor Networks

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Abstract

Wireless sensor networks have been widely used for structural health monitoring, disaster management, military operations and many other areas. The nodes in wireless sensor networks are energy constrained devices and hence energy-efficient algorithms are used for routing to prolong the lifetime of nodes. In this paper the traditional geographic routing and cross-layer routing are reviewed. It is seen that cross-layer routing protocols are more energy efficient and stable in comparison with traditional protocols used in Wireless Sensor Networks (WSN). The routing protocol used in wireless sensor networks should be energy-efficient and deliver the message from source to sink without any packet loss. This paper reviews the existing protocols used in WSN’s and identifies the research gaps present in routing protocols.

Key Words and Phrases: Routing, Wireless Sensor Networks, cross-layer
1 Introduction

Wireless Sensor Networks (WSNs) consists of densely deployed wireless sensor nodes which does the task of sensing the environment in which they are placed. Due to high density nature of these nodes there is a need for an efficient routing algorithm for transferring data from the source node to the sink by choosing the best possible path. The nodes in a particular area transfer data to the Base Station (BS). The base station acts as a gateway for the user to query the environment in which they are placed. The routing protocols adapted for wireless sensor networks are either traditional single layered MAC protocols or cross-layer protocols which enable interaction between different layers of the OSI model. Some traditional geographic routing protocols make use of GPS or other localization techniques to determine their position. The review is achieved through research papers based solely on geographic and cross-layer routing.

2 Review of Literature

The routing problems have been addressed in various research articles in an extensive manner. On reviewing the work, various functions which include energy, security, delay and error are being used to overcome the routing problems. This section gives an overview of the different routing protocols.

2.1 Traditional Geographic Routing Methods

In 2010, Adel et al. [2] proposed an energy efficient data forwarding protocol called Energy Aware Geographic Routing protocol (EAGRP) which is more suitable for multi-hop wireless sensor networks. This protocol is based on two parameters: location and energy left in the nodes. The performance of EAGRP has been significantly better compared to previously existing protocols. In 2013, Weng et. al [13] has proposed an energy efficient routing algorithm called RIDSR (Relative Identification and direction for Wireless Sensor Networks) which divides the sensing area into sectors. Each sector consists of a manager node which transfers the data to the base station. In this protocol, the Base Station provides unique ID to all
the nodes present in a sector based on quadrant name and distance from the base station. The simulation results have shown that energy consumption and throughput have been significantly increased in this protocol. In 2014, Degan et. al [14] have proposed a energy balanced routing method called FAF-EBRM in which the next hop is determined based on the link’s capacity and forward energy density. The experimental results show that this protocol balances energy consumption and guarantees high QoS of WSN. Wang et al. [12] has proposed a pair-wise geographical routing (PWDGR) for dense wireless sensor networks (WSN) to reduce the energy consumption and maintain a balance between energy consumption and delay in communication between two nodes. They have shown that this protocol prolongs the network life by 70% compared with similar protocols. Horacio et al. [1] have proposed an enhanced greedy forward algorithm in which data packets are forwarded to the node that is closer to the sink. This protocol makes use of only Received Signal Strength Indicator (RSSI) of exchanged packets. The experimental results show that this method has better performance and packet delivery ratio without the need for position information.

2.2 Cross-Layer Routing Methods

In 2013, Zhao et al. [15] proposed a cross-layer routing method called Topology and Link Quality aware Geographic Routing (TLG) that combines features of physical and routing layers. The function includes distance, energy and quality of the link as the relay node selection parameters. In 2015, Heimfarth et al. [4] proposed a joint MAC and routing layer method called AGA-MAC in which the source node searches for a receiver and selects the node which has the minimum distance to the sink as the relay node.

In 2010, Haibo et al. [14] proposed a routing scheme called Energy-Efficient Beaconless Geographic Routing in which the source node determines the relay search region by calculating a point as the optimal relay position. The closest node to the optimal point is selected as the relay node through a handshake mechanism. In 2014, Petrioli et al. [8] proposed a cross-layer routing method called ALBA-R which integrates MAC, routing and sleep/awake schedule for relay node selection. Queue Priority Index (QPI) and Geographic Priority Index (GPI) are major factors which are consid-
ered for relay selection in this method. Considering QPI and GPI for relay selection reduced congestion by balancing traffic among different nodes. Vuran et al. [11] proposed a new cross layer routing called XLP which uses receiver-based contention and considers thresholds for potential relays to ensure reliable communication. In this method a four conditional function is used for determining the nodes which participate in the relay node selection process. The nearest node with respect to the sink is selected as the relay node. In methods proposed previously, nodes queue status are not considered. This leads to congestion and packet dropping. Because of ignorance of important parameters ineffective transmission occurs in the above mentioned methods.

In 2017, Zahra et. al [7] proposed a cross-layer routing method called Geographic Cross-Layer Routing adapted for disaster relief operations in WSN (GCRAD) which overcomes the above mentioned problems by concurrently affecting all the relay node selection criteria. They introduced a new criteria called potential relay number (PRN) for relay node selection. This method considers the average of QPI and GPI for the relay node selection process. This protocol showed significant performance compared to the previously existing cross-layer protocols like ALBA-R, IRIS, etc.

3 Research Gaps and Challenges

3.1 Practical Challenges

1. Diverse topologies: It is vast to expand merged and a couple of other topologies. In hierarchical routing, all the topologies have their own merits and demerits. Enhancing the performance with these diverse topologies is a tough task

2. Multiple assets/destinations: Most of the routing algorithms permit communication between a single source and destination. The packet collision occurs because of the contention of large number of the nodes. The researchers must substantially reduce overhead caused by more than one sinks which cause data flooding.

3. Multiple objective routing: The routing algorithms which
are designed for a particular application include various parameters such as throughput, capability, coverage, give-up, real-time delay and collision. Therefore, developing a routing protocol that meets the requirements of the application is one of the open demanding situations.

4. **QoS with constraints**: The QoS requirements such as failure probability, delay jitter, end-to-end postpones and bandwidth consumption have to be considered for designing a flexible routing algorithm. Failure probability is one of the QoS necessities for designing cooperative routing algorithms. In a few WSN, achieving a single QoS requirement is a difficult task [9].

5. **Security in routing**: Most of the routing algorithms are designed to increase the energy efficiency and end-to-end delay. However the security of the routing protocol are given much less significance. Hence there is need for a means to obtain secure routing without loss of performance and location.

6. **Energy sources**: Energy for sensor nodes can be obtained through solar or other renewable resources. The sensor nodes can be recharged through renewable energy sources. In energy-constrained wireless sensor networks there is need for energy efficient routing protocols.

7. **Network packages**: There is focus required on network packages other than the wireless sensor community packages. Application which demand cooperative routing such as LTE networks, cognitive radio networks, cellular networks and wireless LAN should be taken into consideration for future research.

8. **Development structures**: After reviewing several papers, it is found that very few algorithms are associated with practical applications [10] [6]. There is need for routing associated with practical applications.
3.2 Future Opportunities

The challenges present in the existing routing protocols can be rectified by adopting different strategies:

1. **Design of nodes**: Wireless sensor networks are found in various areas, which encompass monitoring of different environmental parameters. Some sensor nodes require the need to be in precise function for a few packages. It is critical to design the type and function of wide variety of sensor nodes for future packages.

2. **Sensor node localization**: Sensor node localization refers to the location consciousness of the sensor nodes that are deployed at a specific point. Geographic routing algorithms make use of GPS or other localization techniques to determine its position [3] [5].

3. **Routing based on energy strength**: The energy of wireless sensor nodes are very limited. Thus minimizing the use of energy in routing is an important factor. For some applications, there is need for a life expectancy of numerous years. Since some routing methods are subjected to heavy computation, there is large memory usage in Wireless Sensor Networks. The memory usage can be reduced by community clustering.

4. **QoS aware routing**: QoS is the measure of the carrier quality concerned with the end-to-end programs/users. The QoS parameters consist of packet loss, jitter, delay, available bandwidth and equity. It is very essential for the network utilization according to the application requirements.

4 Conclusion

There is no single best routing method used in wireless sensor networks. Each application has its own parameters in consideration. Hence, various parameters of the routing protocols were mentioned and analyzed in this paper. The various disaster management projects are also reviewed in this paper to better understand the
importance of routing in Wireless Sensor Networks. The routing problems mainly arise during data transmission from the source node to the destination node. Hence there is need for more efficient routing algorithms.

References


