International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

A COMPREHENSIVE REVIEW ON ROUTING TECHNIQUE'S IN WSN BASED ON IOT APPLICATIONS

Chaithra G S[1] , Nayana C M[2] , Mr. Srinivasulu M[3]*
University B.D.T College of Engineering,Davanagere, Karnataka, India

Abstract:

Wireless sensor networks (WSNs) encompass small nodes with wi-fi sensing, computing, and conversation capabilities. Many routing, electricity management, and records propagation protocols were evolved specially for WSNs in which electricity attention is a key layout issue. However, the focus has been on routing protocols, which might depend on software and community architecture to vary. In this article, we take a look at WSNs next-generation routing approaches. Using a high-level evaluation of alternative routing techniques, we first explain the design challenges for routing protocols in WSNs. For the most part, routing methods fall into three categories: flat, hierarchical, and location-based entirely routing. Protocols may also be classified as multipath, query, negotiation, QoS, or coherence depending on how they function. In every routing paradigm, we evaluate the layout's trade-offs between communications and power overhead reductions. In addition, we discuss the advantages and drawbacks of each method of routing. As a wrap-up, the paper suggests possible future research fields.

Keywords: Routing Protocols, WSN, IoT

1. Introduction

Recent advances in era have made manufacturing small and cheaper sensors technically and economically feasible. The detection electronics degree the environmental situations of the surroundings of the sensor and convert them into an electrical sign. Processing this
sort of sign exhibits a few characteristics approximately the positioned objects and/or the activities taking location withinside the
area of the sensor. Large numbers of those disposable sensors may be networked in lots of packages that require unattended operation. A wi-fi sensor network (WSN) incorporates loads or heaps of those sensor nodes. These sensors have the capacity to talk with every different or at once with an outside base station (BS). A large wide variety of sensors allows detection over large geographic areas with more accuracy. Figure 1 suggests the schematic diagram of the sensor node components. Basically, every sensor node consists of acquisition, processing, transmission, mover, locator, and strength units (a number of these components are non-compulsory like movers). The equal parent indicates the communication architecture of a WSN. When sensors are deployed in a field, the nodes are generally spread out throughout the whole area. By working together, the sensor nodes are able to provide a wealth of information about the physical world. Each sensor node makes its own decisions based on its aim, the data it currently has, and the computing, communications, and power resources it has at its disposal.. Data may be collected and sent by each of these fee-based sensor nodes to a wide range of sensors as well as to one or more external base stations (s). Depending on the location of the base station, it may be either permanent or mobile, and it can connect the sensor network to an existing communications infrastructure or the Internet.

2. Routing Challenges and Design Issues in WSN

Sensor nodes in WSNs have restricted bandwidth, processing power, acquisition, and power supply. Despite these drawbacks, WSNs may be employed in a wide range of applications. The major goal of the - WSN is to ensure efficient data transmission between nodes while also attempting to extend the network's lifespan and prevent node connections from failing.

a) Node Deployment: Utilization of Wireless Sensor Network nodes is application-driven. Node placement may be either predictable or random. With

the 917's deterministic deployment, sensors are manually set and data transfer is routine. In contrast, random node provisioning randomly distributes sensor nodes to form an ad hoc network.

b) **Energy consumption:** In a wireless environment, sensor nodes employ their limited energy supply for detecting, conducting calculations, and transferring data. Therefore, energy saving in communication and calculation processes is vital. Sensor node lifespan is strongly dependent on battery lifespan[1].

c) **Node Heterogeneity:** Nodes were deemed homogeneous in most cases since they had the same computation and sensing capabilities as well as a power supply. A sensor node may have a different function or capability and distribution technique depending on the application.

d) **Fault Tolerance:** Most sensor nodes will be damaged or disabled because to inadequate power, energy or environmental interference in the vast majority of cases; The overall performance of the sensor network should not be affected by the failure of these sensor nodes. Routing mechanisms must be able to build new connections and quickly route data to base stations in the event that many nodes are lost. This may require actively adjusting transmit powers and signalling rates on the existing links to reduce energy consumption, or rerouting packets through regions of the network where more energy is available. Therefore, multiple levels of redundancy may be needed in a fault-tolerant sensor network.

e) **Scalability:** Any routing technique must be able to support a large number of sensor nodes positioned in the detection zone. In order to be environmentally responsive, it has to be scalable enough to quickly respond to changes in the environment.

f) **Transmission Media:** Wireless media link the communication nodes of a multi-hop sensor network. A wireless sensor network's performance may be adversely affected by channel difficulties (such as fading or a high bit error rate), hence the transmission medium is an important consideration in the routing process[2].

g) **data aggregation:** In order to reduce the amount of transmissions, comparable packets from different nodes might be combined since sensor nodes can create large duplicate data. In the aggregation of data, for example, suppression, the minimum, the maximum and the average are all functions of aggregation. Routing protocols have made advantage of this method to improve data delivery and power efficiency. Signal processing methods can also be used for data aggregation. In this case, it is referred to as data fusion where a node is capable of producing a more accurate output signal by using some techniques such as beamforming to combine the incoming signals and reducing the noise in these signals.

h) **Quality of Service:** If the data is not given within a certain time frame, the obtained data is rendered ineffective. Another condition for time-limited applications is a limited delay in the transfer of data (e.g. military and disaster management applications).

i) **Communication Overhead:** The total number of packets are to be transferred or transmitted from one node to another is known as the communication overhead. It includes the overhead of routing process, routing table and packet preparation in a sensor node.

3. Routing Protocols in WSN

Generally speaking, there are four types of WSN routing: topology-based, network structure-based, and reliable routing.

3.1 Network Structure Based Protocols

The underlying network structure can play significant role in the operation of the routing protocol in WSNs. In this section, we survey in details most of the protocols that fall below this category.

3.1.1 Flat Routing

Coordination among nodes is critical for sensing tasks in a flat network design. Since so many of these nodes have been deployed, it is not always practical to provide each one its own unique global identification number. As a result of this concern, the BS has adopted a data-centric routing method in which it sends queries to specific areas and then waits for responses from sensors positioned inside those regions. Attribute-based naming is essential for querying since it specifies the data's attributes. SPIN and directed diffusion [3] showed that data-centric routing may save energy by negotiating and eliminating unnecessary data. Many additional protocols with a similar notion were developed as a result of these two models.hence it is not feasible to assign the global identifier to all nodes

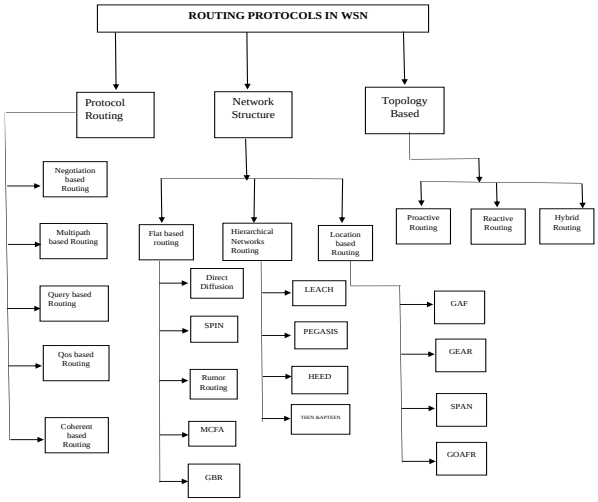

Figure 1: Taxonomy of Routing Protocols in WSN

- **Direct Diffusion:** In [6], C. Intanagonwiwat et. al. proposed a popular data aggregation paradigm for WSNs, called directed diffusion. Direct Diffusion is a very general approach toward problems of this type. Nodes requesting information are called *sinks*, while those generating information are called sources. Records indicating a desire for certain types of information are called interests. Interests are propagated across the network, looking for nodes with matching event records.
- **Sensor Protocols for Information via Negotiation (SPIN):** Assuming all nodes in the network as possible base stations, Heinzelman et.al[4] and[5] proposed the Sensor Protocols for Information via Negotiation (SPIN) to transfer all information at each node to the rest. Users may now do a search on any node in the network and get the results immediately. These protocols rely on nodes being close enough to share data, so only data that other nodes don't have is delivered via them.
- **Rumor Routing:** In rumour routing[7], questions may be made to events in the desired area of the network and answered. The majority of the time, it is used in situations when geographic routing requirements are not relevant. There is a tradeoff between setup costs and delivery dependability when it comes to the routing of rumours. Rumor routing, on the other hand, simply maintains one channel between the source and destination, while directed diffusion floods the network with requests and data may be transmitted over various pathways at reduced speeds. Instead of flooding the network with inquiries, this protocol creates pathways for them to be delivered. When a query is made, it is transmitted for a while until it finds the path.
- **Minimum Cost Forwarding Algorithm (MCFA)**: When using the MCFA algorithm, it is important to remember that the routing direction is always in the direction of a specified external base station. As a result, a sensor node does not need to keep a routing table or have a unique ID. As a result, each node retains its own estimate of the cheapest route to the base station. Each message that the sensor node intends to transmit is broadcast to the nodes around it. As soon as it gets the message, each node makes sure that it's on the most efficient route between its source and its destination.
- **Gradient-Based Routing:** Gradient-Based Routing was the name given by Schurgers et al. [8] to yet another directed diffusion version (GBR). GBR's central notion is to keep track of how many hops the interest takes to spread over the whole network. Thus, each node has a characteristic known as the height of its node, which is the number of hops it takes to reach the base station. The gradient on a connection is the difference between the height of a node and that of its neighbour. A packet is sent via a connection with the greatest gradient. In order to evenly distribute traffic over the network, GBR makes use of auxiliary methods including data aggregation and traffic dispersion. Data may be combined in many ways as it passes via a relay node, which functions as an intermediary between numerous pathways.

3.1.2 Hierarchical Protocols: Hierarchical clustering in WSN has been the subject of several studies over the past few years[1]. Clustering is a low-power communication method that sensors may utilise to communicate with the sink. Sensor clusters (or "clumps") form the basis of certain protocols in this area, which we discuss in more detail in the next section. The cluster head of each clump is responsible for coordinating the data transmission operations of all sensors in its clump.

- **Low-energy adaptive clustring**
- **Hierarchy(leach):**
- Hierarchical clustering for wireless sensor

networks (WSNs) using LEACH [9] is the earliest and most widely used energy-efficient approach. In LEACH, the clustering duty is alternated among the nodes, depending on time. Each cluster head (CH) sends data to the base station through direct connection (BS). The wireless sensor network's lifespan is extended by the utilisation of clusters. In the LEACH algorithm, the original data is combined into a smaller set of data that only contains relevant information for each unique sensor.

- **Power-Efficient Gathering in Sensor Information Systems (PEGASIS)** Using the LEACH protocol, PEGASIS [10] creates chains of sensor nodes such that each node broadcasts and receives from a neighbour and only one node is picked to communicate to the base station (sink). The data is collected and sent from node to node, before being transferred to the base station for further processing. It's done in a greedy manner while constructing the chain. While LEACH employs several nodes in a chain to transmit to the BS (sink), PEGASIS avoids cluster formation and uses just one node in a chain to send data to the BS (sink).
- **Hybrid Energy-Efficient Distributed Clustering (HEED):**[40,41] In order to accomplish power balancing, HEED improves on LEACH's fundamental design by including residual energy and node degree or density into the cluster selection criteria. It uses adaptive transmission power in inter-cluster communication via multi-hop networks. In order to maximise network life, HEED was designed to distribute energy consumption, end the clustering process within a fixed number of iterations, minimise control overhead, and produce well-distributed CHs and compact clusters. These four primary goals are summarised in the following paragraphs.
- **Threshold-sensitive Energy Efficient Protocols (TEEN and APTEEN):** TEEN (Threshold-sensitive Energy Efficient sensor Network protocol) and APTEEN (Adaptive Periodic Threshold-sensitive Energy Efficient sensor Network protocol) are two hierarchical routing systems that are suggested in [8] and [9]. These protocols have been developed for use in situations where speed is of the essence. Data transmission is less frequent in TEEN because sensor nodes constantly monitor the media. Nodes get two types of thresholds from the cluster head sensor: one hard and one soft. The hard one is the threshold value of the detected attribute, which causes a node to turn on its transmitter and communicate.
- **3.1.3 Location based routing protocols:**

  Sensor nodes are addressed by their location in this kind of routing. The intensity of the incoming signal may be used to determine the distance between two nodes that are close together. Neighbors may exchange information on the relative coordinates of surrounding nodes in order to get these coordinates. GPS (Global Positioning System) may also be used to locate nodes, but only if the nodes are equipped with a modest low-power GPS receiver[15]. Some location-based methods mandate that nodes go to sleep when there is no activity, in order to conserve power. In order to save the most energy, as many sleeping nodes as feasible should be included in the network.
- **Geographic Adaptive Fidelity (GAF):** It is possible that GAF [11] might be used to sensor networks as well as mobile ad hoc networks, given it is an energy-aware location-based routing algorithm. In order to create a virtual grid, the network region is first partitioned into predetermined zones. Nodes in each zone work together to fulfil various responsibilities. For example, a sensor node will be elected to remain up for a certain amount of time before going to sleep. On behalf of the other nodes in the zone, this node is in charge of monitoring and reporting data to the BS. As a result, GAF saves energy by shutting off unused network nodes without compromising routing integrity. As each node has a GPS position, it may be linked to a virtual grid point.
- **Geographic and Energy Aware Routing (GEAR):** Since data searches typically involve geographic qualities, Yu and colleagues [12] described how to distribute the inquiries to the relevant locations by using geographic information. In order to get a packet to its intended location, the Geographic and Energy Aware Routing (GEAR) protocol employs heuristics that are both energy conscious and geographically knowledgeable. Directed diffusion is all about limiting the quantity of interests to a certain area rather than delivering the interests to the whole network. GEAR is

able to save more energy than directed diffusion by accomplishing this.

- **The Greedy Other Adaptive Face Routing (GOAFR):**Geometric routing algorithms that combine face and greedy routing have been suggested in [15]. In this part, we'll take a quick look at the most important aspects of GOAFR. GOAFR's greedy algorithm always selects the nearest neighbour as the next node for routing. If a node's neighbours are all further away than the present node, it might get stuck at some local minimum. Routing the face in a different way is referred to as "other face routing" (OFR) (FR). FR is the first algorithm that assures success if the source and destination are linked.
- **SPAN:** Some nodes are chosen as coordinators via SPAN [13], a positional method. As a network backbone, coordinators are employed to distribute messages. If two neighbours of a non-coordinator node cannot contact each other directly or through one or two coordinators, the node should become a coordinator. Because the sophisticated SPAN algorithm necessitates maintaining two or three hop neighbours in both new and current coordinators, the system is less energy efficient.

3.2 Protocols Routing

- **Negotiation based routing protocols:** In order to reduce duplicate data transfers, these protocols use high-level data descriptors. Communication choices are also made depending on the resources that are accessible. As previously mentioned, negotiation-based routing protocols, such as those in the SPIN family [17] and the protocols in, may be found. Due to the implosion and overlap caused by flooding, nodes will get several copies of the same information, which is why this is being implemented.
- **Multipath routing protocols:** In order to improve the network's performance, we'll look at routing methods that take use of several pathways rather than just one. When the main route between a source and a destination fails, the protocol's fault tolerance (resilience) is evaluated based on the probability that an alternative way exists. When several pathways are maintained between the source and the destination, energy consumption and traffic production rise.
- **Query Based Directed Protocols:** directed diffusion was proposed for WSNs by C. al. as a popular method of data aggregation. Data-centric (DC) and application aware, directed diffusion is a method for disseminating information. Attribute-value pairs are used to identify all data produced by sensor nodes in this system. The DC technique is based on the notion of aggregating data from several sources in order to eliminate duplication, reduce the number of transmissions, and so save network energy and extend network lifespan.
- **QoS-based routing:** Energy usage and data quality must be balanced in QoS-based routing methods. When sending data to the BS, the network must meet specified quality of service (QoS) measures, such as latency, energy, bandwidth, and so on. SAR, developed in [11], is one of the first routing protocols for WSNs that incorporates the concept of Quality of Service (QoS) into the routing choices. SAR relies on three criteria to make routing decisions: energy resources, quality of service (QoS) along each route, and the priority of each packet.
- **Coherent and non-coherent processing:** Wireless sensor networks run on a foundation of data processing. As a result, routing methods use a variety of data processing methods. As data floods the network, sensor nodes will often work together to process it. Coherent and non-coherent data processing-based routing are two examples of data processing approaches suggested in WSNs. The raw data is processed locally by nodes in non-coherent data processing routing[11] before being forwarded to other nodes for further processing. In computing, the aggregators are the nodes that conduct additional processing steps.

4. Vanet Protocols

In the beginning, VANET routing protocols like Ad-hoc on Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR)[16] were used in MANET networks. The dynamic nature of vehicular ad-hoc network nodes makes it difficult to discover and maintain routes. Diverse routing protocols have been suggested for vehicular ad hoc networks, and they allow routing for various messages with different goals. Vehicular Ad-hoc networks have numerous routing techniques established depending on architecture and application or scenario demands.Topology,Positioning, Broadcasting, Clustering and Geocast routing

protocols are all forms of routing protocols in VANET. Area/application suitability is one of the defining characteristics of these protocols.

4.1 Topology based protocol: Data is transferred through Networks via Routing Protocols, which are defined by industry standards. Dynamic routing choices may be made using efficient routing protocols in the network. Proactive and Reactive Topology Based Routing Protocols are further subdivided. When compared to position-based routing protocols, topology-based routing techniques offer a lower level of performance [16]. Additional node topology information is often required by Topology-Based Routing methods throughout the routing decision-making process.

- **Proactive Routing Protocols:** The topology is represented in tables by the proactive routing protocols. Using these protocols, data is sent from one node to the next in real-time. It is also known as a table-driven protocol because of its nature. Due to broadcasting the update tables, proactive protocols include two forms of updating: periodic update and triggered update[16]. When more nodes are added to a network, the table size grows, which increases the network's burden. As a result, protocols like DSDV and FSR (Fish loop State Routing) have been developed. Routing table overhead makes proactive systems unsuitable for wide networks [16]. Shortest route algorithms are often used in these protocols.
- **Reactive/Ad-hoc based routing:** Reactive protocols are opposite to proactive protocols they cannot maintain tables when the topology changes. In these types of protocols, the query floods into the network when a source node want to transmit the data and discovered route is stored until other node is inaccessible.
- **Hybrid routing:** There are elements of both reactive and proactive protocol design used into Hybrid Routing. Both the reactive and proactive features are geared on protecting the most reliable information in the immediate area. Route maintenance and discovery are handled by various zones in hybrid routing systems. The Hybrid routing system reduces the overall routing protocol's overhead and improves performance in constantly changing environments. In terms of application, routing, power management, and so on, hybrid routing presents a number of issues.

There are a number of obstacles in using communication for collision warning, road obstacle warning, cooperative,driving,junction,collision,warning, and lane change assistance etc.

Routing Protocols	Classification	Power usage	Data aggregation	Multipath	Query based	Qos	Communication Overhead
SPIN	Flat	Ltd	Yes	Yes	Yes	No	No
MCFA	Flat	N/A	No	No	No	No	No
Rumor Routing	Flat	Low	Yes	No	Yes	No	No
GBR	Flat	Low	Yes	No	Yes	No	No
LEACH	Hierarchical	High	Yes	No	No	No	No
PEGASIS	Hierarchical	Max	No	No	No	No	No
TEEN and APTEEN	Hierarchical	High	Yes	No	No	No	No
SPAN	Location	N/A	No	No	No	No	No
GEAR	Location	Ltd	No	No	No	No	No
GAF	Location	Ltd	No	No	No	No	No

Table 1 : Classification and comparison of routing protocols in wireless sensor networks

5. CONCLUSION

With just a few published studies to date, sensor network routing is a relatively unexplored field of study. In this research, we conducted a systematic review of all previously published routing strategies for wireless sensor networks. Increasing the usable life of the sensor network without compromising data transmission is the overarching objective of all these initiatives. Routing techniques may be classified based on factors including network topology, communication models, topologies, and reliability. Here, the tradeoffs between energy and power consumption and communication overhead are outlined in terms of the advantages and drawbacks of each routing approach.

Reference:

[1] W. Heinzelman, A. Chandrakasan and H. Balakrishnan, ”Energy-Efficient Communication Protocol for Wireless Mi- crosensor Networks,” Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS ’00), January 2000.

[2] http://www.ieee802.org/15/.
[3] F. Ye, A. Chen, S. Liu, L. Zhang, "A scalable solution to minimum cost forwarding in large sensor networks", Proceedings of the tenth International Conference on Computer Communications and Networks (ICCCN), pp. 304-309, 2001.
[4] W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive Protocols for Information Dissemination in Wireless Sensor Networks," Proc. 5th ACM/IEEE Mobicom Conference (MobiCom '99), Seattle, WA, August, 1999. pp. 174-85.

[5] J. Kulik, W. R. Heinzelman, and H. Balakrishnan, "Negotiation-based protocols for disseminating information in wireless sensor networks," Wireless Networks, Volume: 8, pp. 169-185, 2002.

[6] Feng Zhao, Leonidas J. Guibas, in Wireless Sensor Networks, 2004.

[7] D. Braginsky and D. Estrin, "Rumor Routing Algorithm for Sensor Networks," in the Proceedings of the First Workshop on Sensor Networks and Applications (WSNA), Atlanta, GA, October 2002.

[8] C. Schurgers and M.B. Srivastava, "Energy efficient routing in wireless sensor networks", in the MILCOM Proceedings on Communications for Network-Centric Operations: Creating the Information Force, McLean, VA, 2001.

[9] W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Microsensor Networks," Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS '00), January 2000.

[10] S. Lindsey, C. Raghavendra, "PEGASIS: Power-Efficient Gathering in Sensor Information Systems", IEEE Aerospace Conference Proceedings, 2002, Vol. 3, 9-16 pp. 1125-1130.
[11] Y. Xu, J. Heidemann, D. Estrin, "Geography-informed Energy Conservation for Ad-hoc Routing," In Proceedings of the Seventh Annual ACM/IEEE International Conference on Mobile Computing and Networking 2001, pp. 70-84.

[12] Y. Yu, D. Estrin, and R. Govindan, "Geographical and Energy-Aware Routing: A Recursive Data Dissemination Protocol for Wireless Sensor Networks", UCLA Computer Science Department Technical Report, UCLA-CSD TR-01-0023, May 2001..

[13] Tomjanovich and X. Lin. "GEDIR: Loop-Free Location Based Routing in Wireless Networks", In International Confer- ence on Parallel and Distributed Computing and Systems, Boston, MA, USA, Nov. 3-6, 1999.

[14] B. Chen, K. Jamieson, H. Balakrishnan, R. Morris, "SPAN: an energy-efficient coordination algorithm for topology maintenance in ad hoc wireless networks", Wireless Networks, Vol. 8, No. 5, Page(s): 481-494,

[15] Jamal N. Al-Karaki Ahmed E. Kamal Routing Techniques in Wireless Sensor Networks: A Survey Dept. of Electrical and Computer Engineering Iowa State University, Ames, Iowa 50011.

[16] Topology based routing protocols for vanet and their comparison with manet 1 kashif Naseer qureshi, 2abdul hanan abdullah 1 Department of Communication, Faculty of Computing, University Technology Malaysia, Skudai, 81310, Johor Darul Takzim, Malaysia Affiliation.

[17] W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive Protocols for Information Dissemination in Wireless Sensor Networks," Proc. 5th ACM/IEEE Modicum Conference (MobiCom '99), Seattle, WA, August, 1999. pp. 174-85.