ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, Vol 9(32), DOI: 10.17485/ijst/2016/v9i32/76215, August 2016 ISSN (Online) : 0974-5645

A Review of Hierarchical Routing Protocol for Wireless Sensor Network

C. Jothikumar* and Revathi Venkataraman

Computer Science and Engineering, SRM University, Chennai - 603203, Tamil Nadu, India; jothikumar.c@ktr.srmuniv.ac.in, revathi.n@ktr.srmuniv.ac.in

Abstract

Objectives: To minimize the energy utilized for transmitting and receiving the data in wireless sensor network. The goal is to find out the best routing protocol to increase the network lifespan. This paper dealt with the detailed review of hierarchical routing protocol of wireless sensor network and compared depends on few characteristics. **Methods:** Minimum spanning tree approach for finding the shortest path in the network to reach the sink. Energy Optimization is an important key used to increase the lifespan of the node. A different classification approach is introduced on routing the message based on the number of hops the packets takes to reach the destination. **Findings:** The transmission energy was a major factor in draining the sensor node. To minimize the transmission energy, we suggest a novel approach by varying the transmission power based on the distance from the node to the cluster head. **Improvements:** The survey will help to develop an adaptive routing protocol suitable for real-time application. Achieving the energy efficient routing protocol will have a downfall with the delay.

Keywords: Clustering based Routing, Data Aggregation, Energy Efficiency, Wireless Sensor Networks

1. Introduction

Wireless sensor networks is a group of nodes which are connected to a wireless network with the lesser energy capability that may be ad-hoc or mobile and are placed randomly in a dynamically changing environment. Each sensor node communicates over short distances through the radio transmission and collaborates to perform a common task. Wireless Sensor Networks deploy in military surveillance, home health care, and environmental science. Figure 1 shows the sensor network architecture.

In a wireless sensor network, the sensor can communicate with each other or directly to the base station. The network layer is responsible for data delivery by implementing an addressing scheme to accomplish the task. Routing is the major issue in wireless sensor network as they have limited capability concerning energy level, processing, and communication. The paper focus on the technique to route the messages with low energy consumption by which we can extend the lifetime of the network. The routing protocols in sensor networks are flat based, hierarchical based, localization based and QoS based routing protocol. In flat based routing technique, flooding is a traditional method to disseminate the data in the network without the need for routing algorithm. A technique called gossiping overcomes the drawbacks of flooding like implosion overlaps and resource blindness. In gossiping, the received node relays data to randomly selected nodes. The merit of this routing protocol is less energy consumption, and the demerit is the transmission delay. Another type of flat based routing protocol called SPIN (Sensor Protocols for Information via Navigation) assigns a high level name that completely describes the collected data and provides more energy saving than flooding. The drawback of the SPIN is no guaranteed delivery of data. In directed diffusion, the information from the sensor is received based on interest and not applied to the application involved in environmental monitoring.

*Author for correspondence

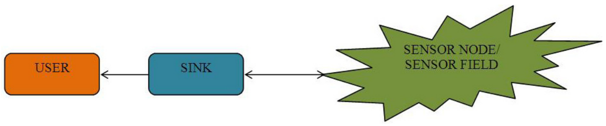

Figure 1. Wireless Sensor Network Architecture.

In hierarchical routing, LEACH is the first cluster-based protocol introduced where numbers of sensor nodes are grouped together with the cluster head. The Cluster Head (CH) gathers the data from each sensor which is in its range. The similar process takes place in LEACH-C where the base station decides the CH. PEGASIS is a chain based routing protocol that reduces the transmission distances of the node. Further comparisons with flat based and hierarchical based routing protocol collision overhead are more significant in flat based network than in hierarchical routing. In flat based nodes on multipath aggregates the incoming data, in hierarchical routing aggregates by clustering. In a flat based network, routing formed only in the region that has data for transmission, whereas in hierarchical routing there was an overhead of the cluster all through the network. Location based routing; we assume that all the nodes know its neighboring node position and the source node are assumed to be informed about the destination position. The DREAM protocol maintains the table that contains the location of all the node in a network. This protocol achieves by sharing location packets with the neighbor nodes. The downfall of this algorithm is the efficiency relies on the even distribution of nodes and occurrence of traffic.

In Quality of Service based routing, the network as to follow important metric for QoS such as delay, throughput, response time and bandwidth. Sequential Assignment Routing (SAR) is QoS based routing depends on energy, the priority level of each packet QoS on each path. To avoid the routing failure multipath approach was introduced. Here, hierarchical routing outperforms flat based routing. The drawback of hierarchical routing is the clustering overhead on the entire system. Many applications go for cluster based routing protocol than the flat based routing because it enhances the lifetime of the network by reducing the transmission distance between the neighbors. This study discusses the hierarchical routing protocol and their classification. This survey mainly aims at focusing on summarizing clustered routing algorithms based on comparing the attribute and performance. This survey is an attempt towards a comprehensive review and evaluation of hierarchical routing protocols developed for WSNs.

2. Hierarchical Networks Routing Protocol

The routing protocol is developed based on application needs. We need to consider the factors to develop the routing protocol. The key factor is energy efficiency of the sensor that affects the lifetime of the network. Hierarchical routing is the cluster based routing protocol[1]. The sensor nodes combine to form a cluster and the cluster has its own CH. The CH handles data aggregation and forwarding the data. Figure 2 shows the representation of hierarchical routing protocol.

The various classifications of hierarchical routing protocols are single-hop clustered routing, multi-hop clustered routing, multi-hop chain routing, and multi-hop grid-based routing techniques. The two types of single hop clustered routing include LEACH and LEACH-C. Multi- hop clustered routing classifications consist of TEEN, APTEEN, BCDCP, HEED, EEUC, ELCH, and SHPER. The multi - hop chain routing includes PEGASIS, SLEEP/WAKE SCHEDULING, PEDAP and GSTEB. The multi- hop grid- based routing includes VGA, TTDD and GBDD.

2.1 Single - Hop Clustered Routing

In single- hop clustered routing, the CHs communicates the data to the base station directly. Clustering is reducing the energy on transmission. The dynamic clustering was employed. Figure 3 shows the representation of single-hop clustered routing protocol.

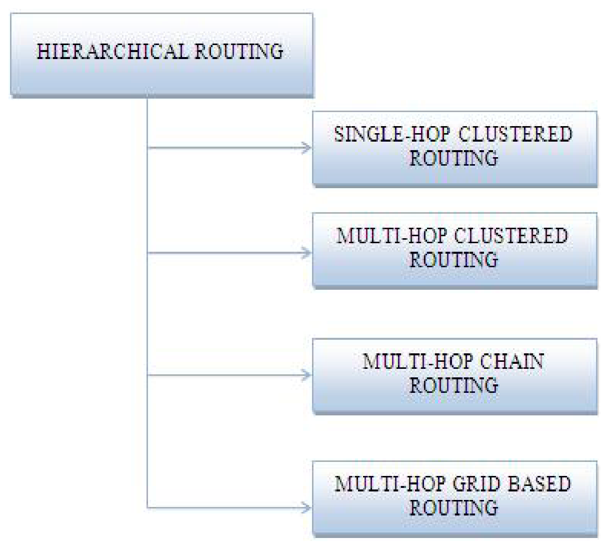

Figure 2. Representation of Hierarchical Routing Protocol.

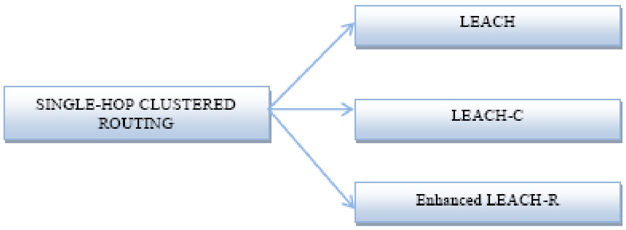

Figure 3. Single-hop Clustered Routing Classification.

2.2 Low-Energy Adaptive Clustering Hierarchy (LEACH)

The LEACH is an adaptive clustering protocol that employs distributed cluster formation and randomized rotation among the CHs to achieve even energy consumption[2,3]. The LEACH protocol consists of two phases: Low energy transmission phase (Setup phase): This phase sees the construction of clusters and selection of CHs. Here each node has data to send. On receiving the data from the nodes in its range, the CHs fuse, compress and address this data to the base station. Minimum energy should be consumed by the sensor nodes when it communicates with other nodes in the process of finding the CH. Every node uses a random probability distribution to determine whether it is the CH. The least frequently used CHs are candidates for the role of cluster heads. Since a random rotation of cluster heads is adopted, balanced energy consumption and a prolonged network lifetime can be observed. High energy transmission phase (Steady state phase): This phase represents the data transmission between CHs and the sink. To save energy, cluster member in the cluster will utilize the minimum energy required to transmit power to reach the CH and turn off the wireless radio. On the other side, the CH must be awake all the time to receive sensor data from its cluster member and communicate the data to the base station. The advantage of LEACH defeat the flat based routing techniques, concerning power consumption, and network lifetime by employing a clustering approach. The disadvantage is dynamic clustering may result in extra overhead.

2.3 Low-Energy Adaptive Clustering Hierarchy-Centralized (LEACH-C)

In LEACH-C the sink participates in the election of cluster head[4]. During the primary phase, the base station collects information indicating the energy levels and locations of all nodes deployed in the region. The base station finds the cluster using a simulated annealing algorithm. The similar and improved form of LEACH is LEACH-Centralized. LEACH-C depends on the sink to determine the CH. During the cluster formation, all the sensor nodes transmit its energy level and location to the Base Station (BS). The BS computes the CH and sends its ID to all the nodes. If the ID matches with the particular node, then that node will be the CH.

2.4 Enhanced LEACH-R

The protocol differs from LEACH based on CH selection using residual energy. It has two phases; cluster setup phase and steady state phase. In cluster setup phase, the protocol deals with the residual energy of the node[5]. For the first round random selection of CH using random probability distribution and on the next rounds based on a residual energy of the node. If the energy of the node is high compared to other nodes, then the node elects as the CH. In each round, an ad-hoc CH is employed. In steady state phase, the CH announced their status to other nodes and the nodes were communicating with the CH in TDMA approach. The CH further address the data to the sink. Table 1 shows the comparison between the single-hop clustered routing protocols.

2.5 Multi - Hop Clustered Routing

In multi-hop clustered routing, the CH communicates with the other CH to reduce the transmission energy to reach the data to the base station. It is similar to that of single-hop, but it communicates with multiple nodes to transmit the data to base station. Figure 4 shows the representation of multi-hop clustered routing protocol.

2.6 Threshold sensitive Energy Efficient Sensor Network (TEEN)

The TEEN protocol developed for critical applications in reactive networks[6]. This protocol employs for a time-critical application like industrial monitoring. TEEN architecture relies on hierarchical clustering in which nodes in the vicinity to each other form clusters. The cluster formation continues till it reaches the sink node. Primarily, the CH directs the Hard Threshold (H_{Th}) and the Soft Threshold (S_{Th}) values to its members. On exceeding the H_{Th} value, the sensing node switches its transmitter on and reports the same to the respective CH. Whereas, the S_{Th} is a minute change in the sensed attribute value that causes the node to perform data transmission through the transceiver. When the attribute value gets through the

Table 1. Single-Hop Clustered Routing

Protocol	Advantages	Drawbacks	Load Balancing	Scalability	Delivery delay	Mobility	Data Aggregation
LEACH	Low energy, evenly sharing the load, collision avoidance by TDMA	It is not applicable for large regions and the dynamic clustering brings extra overhead	Medium	Low	Very Small	Fixed BS	Yes
LEACH- C	The energy for data transmission is less than LEACH	Occurrences of Overhead	Medium	Low	Very Small	Fixed BS	Yes
Enhanced LEACH-R	Less transmission energy.	Dynamic Clustering gives overhead.	Medium	Low	Very Small	Fixed BS	Yes

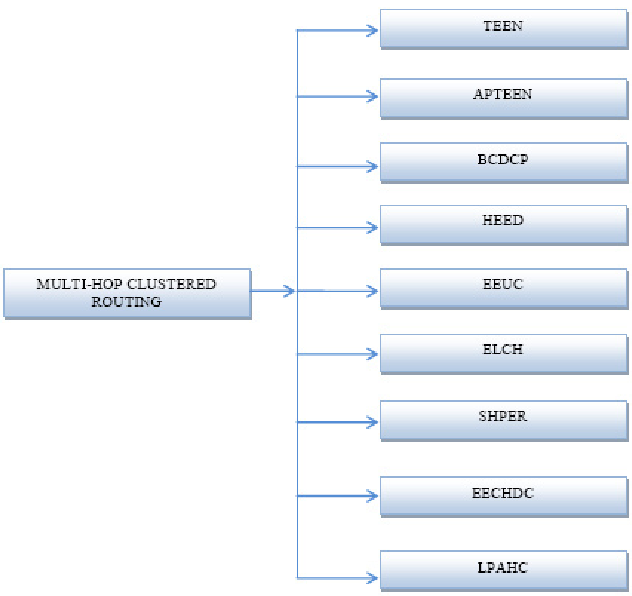

Figure 4. Multi-hop Clustered Routing Classification.

hard threshold, the transmitter is enabled by the node to send further the data received. This value is stored in a central variable known as sensed value (sv). TEEN proves beneficial when employed in critical real-time applications to address ad hoc changes in the attributes which are sensed (such as pressure, temperature).

2.7 Adaptive Threshold sensitive Energy Efficient Sensor Network (APTEEN)

The enhanced TEEN is ATEEN protocol that concentrates on both, encapsulation of periodic data aggregations and reacting to sensitive events[7]. Once the base station develops the clusters, the CHs send the threshold values and the transmission schedule to their respective cluster member. Ultimately, the CHs employ data aggregation to reduce the overall energy consumption. Evidently, the nodes consume less power in APTEEN when compared to TEEN, except the fact that complexity in APTEEN results in longer delays.

2.8 Base-Station Controlled Dynamic Clustering Protocol (BCDCP)

The BCDCP protocol is distinct in which clusters are formed considering the issue of balancing the energy level[8]. When the base station obtains the information about the current energy levels of all nodes in the network, it evaluates and generates an average energy level for all these nodes. Eventually, it analyses nodes whose energy levels exceed the average energy level (threshold limit). Each cluster is allocated with an equal number of cluster members to avoid the problem of overhead in CH. This protocol employs a distribution technique which places the sensor nodes uniformly all over the sensor field while utilizing a multi-hop clustered routing mechanism to perform a unit of data transmitted to the sink. Additionally, the sink is assumed to be the most optimal node in BCDCP, exhibiting maximum energy levels and throughput.

2.9 Hybrid Energy Efficient Distributed Clustering (HEED)

The HEED is a routing protocol, which brings clustering approach to enhance the lifetime of the network. The election algorithm for choosing CH differs from LEACH. HEED selects the CHs periodically by considering residual energy and reach the uniform CH throughout the network[9]. The node communicates with the CH with the minimum degree to balance the CH load. Here, the cluster member transmits the unit of data to the CH. The Dynamic Source Routing technique can be employed to forward data between the clusters to reach the sink.

2.10 Energy Efficient Uneven Clustering (EEUC)

It is a multi-hop routing protocol using clustering approach. Normally, CH rotation did periodically to balance the energy of the nodes[10,11]. The CH cooperates with CH to forward the data to base station. The CH closer to the base station will need to have more energy to transmit the data packet. EEUC is a mechanism that gathers the data periodically in wireless sensor network. It distributes the node into clusters of unequal size. The CH closer to the base station has a smaller size than the other which is farther away. The CH selection depends on the random number generated by each node. If the number is greater than the threshold will act as a CH.

2.11 Extending Lifetime of Cluster Head (ELCH)

In ELCH CHs are chosen based on the neighbor node votes. This protocol has the self- configuration capability and hierarchical routing properties that achieve to utilize minimum energy and thus to extend the network lifetime, that includes clustering approach and multi-hop routing[12]. During the first phase, clusters are generated and CHs are selected from every cluster. The CH selection takes place through a voting mechanism between nodes and their neighbor sensors. Finally, the sensor node with the maximum number of votes acts as the CH. During the second phase, the nodes in the cluster forward data to the CH, which transmits the data to the sink. After the cluster formation, every cluster comprises a cluster-head and its individual cluster members. These clusters are formed based on the degree of the node. After this, a time scheduling mechanism is introduced by the individual cluster members in every round. Every CH manages a table indicating the maximum power of each of its cluster members which updates at the end of every selection round. The data are transmitted directly from the cluster members to CH, which is further forward to the base station. This technique can result in minimum energy dissipation while maintaining a more balanced energy efficient network.

2.12 Scaling Hierarchical Power Efficient Routing (SHPER)

The SHPER protocol mainly aims for less energy consumption[13]. SHPER follows a random placement of nodes across the network area. The sink is located outside the network, and the sensor nodes and sink are fixed. Since the base station illustrates uninterrupted power supply, it can efficiently transmit data to all the sensor nodes. All the nodes are grouped together form clusters, and each cluster has its CH. The CH located close to the sink is capable of transmitting the data directly, called as an upper-level CH. The CHs located far away from the base station and communicate the data through upper-level CH to send data to sink. The election of the CH deals with the residual energy of the cluster member. SHPER avoids randomized rotation or selection of CHs to achieve enhanced throughput ensuring minimum energy dissipation. The data routing employs the route selection policy which performs by considering the residual energy of the sensor nodes and the communication costs associated with the every network path.

2.13 Energy-Efficient Cluster Head Selection and Data Convergence (EECHDC)

The selection of the CH deals with neighbor nodes, residual energy and distance of the node from the middle of the CH[14]. The node nearer to the existing CH should not take as CH for the next round. In CH selection phase, the algorithm proposed to elect the cluster head based on the parameter like residual energy, the density of the node, capability and the degree of the node. The residual energy and the degree of the node are high then the node will become the CH. In data collection and transmission phase, after CH selection the announcement was given to the cluster members. The CH receives and aggregates the data. These aggregated data transmits from CHs to the BS.

2.14 Least Power Adaptive Hierarchy Cluster (LPAHC)

The LPAHC performance includes two parts. The first part is the channelization design and the other part is CH selection and data transmission[15]. The FDM channelization helps to find unused frequency bands for allocation that reduces the energy cost. The nodes are organized into clusters of different size. The CH election depends on nodes residual energy. The data aggregation performs in CH by Channel State Information (CSI) channelization technique further improves the network lifetime. The CHs are evenly placed in a symmetric manner. The communication among the nodes with CH is based on RSSI. Then the CH sends the aggregated data to the base station. Table 2 shows the comparison between the multi-hop clustered routing protocols.

Table 2. Multi-Hop Clustered Routing

Protocol	Advantages	Drawbacks	Load Balancing	Scalability	Delivery delay	Mobility	Data Aggregation
TEEN	Suitable for time critical application like temperature	Not suitable for periodic discrete application	Good	Good	Small	Fixed BS	Yes
APTEEN	Low energy consumption. Suitable for both proactive and reactive applications	Long delay	Medium	Good	Small	Fixed BS	Yes
BCDCP	The network consuming less energy	Performance gain decreases as the sensor field area becomes smaller	Good	Low	Small	No	Yes
HEED	Low energy consumption	Clustering overhead occurs	Good	Good	Medium	No	Yes
EEUC	Energy balances by clustering	Latency occurs	Medium	Low	Medium	No	Yes
ELCH	Ensures minimum energy consumption while enhancing the network lifespan.	It is not applicable for larger region or negative effect in case of adding nodes	Medium	Low	Medium	Fixed BS	Yes
SHPER	Energy balance of the network	It does not support mobility	Good	Good	Medium	Fixed BS	Yes
EECHDC	Low energy consumption.	End-to-End delay occurs	Medium	Low	Medium	Fixed BS	Yes
LPAHC	Balancing the energy by clustering	Clustering overhead occurs	Good	Low	Medium	Fixed BS	Yes

2.15 Multi-Hop Chain Routing

In multi-hop chain routing, the nodes form a chain to communicate with other nodes to transmit data to the base station that reduces energy on transmission. Each node aggregates the data on its route and forwards the data to the next node. Figure 5 shows the representation of multi-hop chain routing protocol.

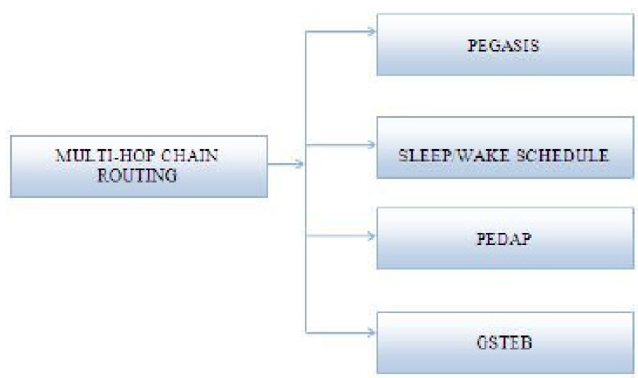

Figure 5. Multi-hop Chain Routing Classification.

2.16 Power-Efficient Gathering in Sensor Information Systems (PEGASIS)

The PEGASIS is an enhanced variant of the LEACH protocol, which employs a chain-based mechanism for data communication[16]. In PEGASIS, communications take place only between the nodes which are in the vicinity to each other. The nodes keep transmitting data to its neighbor nodes until it reaches the BS. In this process, a linear chain is formed for data transmission through the sensor nodes, by applying the greedy approach. The chain structure begins at the farthest node from the network and continues till the ones closer to the base station[17,18]. Consider the energy * delay matrix that attempts to balance the energy cost and delay for data gathering from the sensor network. The delay is encountered as the time taken for transmitting the data. Nonetheless, the PEGASIS protocol may cause redundancy in data transmission from any of the nodes in the constructed chain. The disadvantage is large networks which may induce higher transmission delay.

2.17 Sleep/Wake Scheduling Protocol

The protocol is designed to operate with minimum energy consumption. This process is accomplished by switching the communication signal to sleep mode when the node is idle condition and to wake mode once the message transmission/reception takes place[19]. This protocol mainly focuses on the accuracy of data synchronization between the sender and receiver. So that they can switch themselves between sleep and wake modes simultaneously to communicate with each other. The sleep/wake algorithm is developed in such a way that the effect of synchronization errors is addressed correctly. In this process, the current synchronism schemes achieve synchronization instantly on the reciprocation of synchronization messages between the sender and the receiver ends. It enhances the data capture probability threshold that minimizes energy consumption. The sleep/wake scheduling protocol is a multipath communication protocol, organized as a hierarchy of clusters with each cluster having a CH and many cluster members.

2.18 Power Efficient Data Gathering And Aggregation Protocol (PEDAP)

In PEDAP, the neighbor have organized themselves and form a group of the node where one node will act as a parent and other nodes are child node that was considered based on the residual energy of the nodes[20]. The parents further communicate the data packets to the root where it fuses the data and forwards to the sink. The leading concern in PEDAP is the algorithm employs a Prim's minimum spanning tree approach from source to reach the sink. The transmission distance was reduced, so the algorithm consumes less energy and increases the lifetime of the node.

2.19 General Self-Organized Tree-Based Energy-Balanced Routing Protocol (GSTEB)

GSTEB Protocol is to achieve a longer lifetime of the network. At every periodic interval, BS changes the root node based on residual energy and broadcast its ID and its coordinates to all sensor nodes. GSTEB employs a dynamic root node with short delay[21]. Simultaneously each node selects its parents based on itself and its neighbor's information like energy level of each node. Data fusion takes place in the root nodes, and the fused data are forward from root node to the sink. The node which has high energy is named as root node. Each node selects its parents by taking its energy level and its neighbor's energy level. The nodes with the largest energy level can act as a relay node that communicates with the root node. The data moves from the parent node to root node based on a time slot. To avoid interference between the child nodes FHSS was introduced. After building the routing tree, the energy utilization of each node can be measured by the sink. This information helps to calculate the topology for the next round. Table 3 shows the comparison between the multi-hop chain routing protocols.

Table 3. Multi-Hop Chain Routing

Protocol	Advantages	Drawbacks	Load Balancing	Scalability	Delivery delay	Mobility	Data Aggregation
PEGASIS	It decreases data transmission distance	Not suitable for large network and large delay	Low	Good	Very Large	Fixed BS	No
Sleep/ Wake	Minimum energy consumption. Energy efficient network	Synchronization and scheduling will both affect the overall system performance	Medium	Good	Large	No	Yes
PEDAP	Low energy consumption through near optimal path	Load balancing is less	Medium	Low	Medium	No	Yes
GSTEB	Minimizing the total energy consumption and balancing workload	It needs a BS to compute topography which leads to increase the energy waste and longer delay	Good	Good	Medium	No	Yes

2.20. Multi - Hop Grid based Routing

In multi-hop grid-based routing, node forms grid construction inside the sensor region to transmit the data to the sink where dissemination of data takes place throughout the network. Figure 6 shows the representation of multi-hop grid-based routing.

2.21 Virtual Grid Architecture Routing (VGA)

This protocol employs a mixture of data gathering and in-network handling in pursuance of maximum energy and network lifetime[22]. The overall process divides into phases, namely, clustering and data routing. During the clustering phase, the nodes are assumed to be deployed in a fixed topography. Each cluster has its CH. The CH which aggregates the data is termed as the Local Aggregator(LA). A set of this Local Aggregators (LA) is chosen to perform inter-cluster aggregation, and its members are termed as the Master Aggregators (MA). The routing energy cost includes routing from LAs to MAs and relaying the aggregated data over the shortest paths from MAs to BS. Some strategies can be adopted in the data aggregation phase to acquire a simple, efficient and near-optimal solution. VGA proves beneficial in attaining maximum energy efficiency and network lifetime with minimum delays. Nevertheless, the issue of the lesser number of the local aggregator as the master aggregator is a complex issue.

2.22 Two-Tier Data Dissemination (TTDD)

In this protocol the nodes are fixed and sinks can switch their locale dynamically[23]. On receiving an event, one of the sensor becomes the origin which will then generate data reports that are required by the base station. A virtual grid architecture is constructed where the source node acts as the initiator and is chosen as the starting point of transmission in the network. This source broadcasts an acknowledgment message to its adjoining

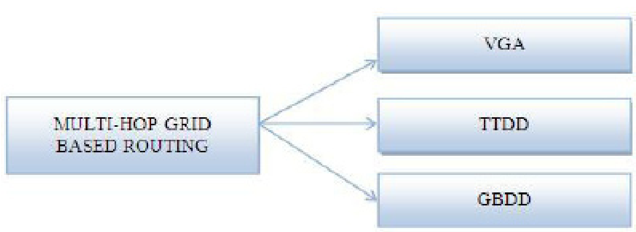

Figure 6. Multi-hop Grid Based Routing Classification.

crossing points based on the greedy approach for data forwarding. The data transmission ends when it reaches the crossing point of the grid. This step will continue till the message reaches the sink. This protocol can be utilized efficiently within a field of stationary sensor nodes, which are required to communicate with multiple mobile sink nodes. The major pitfall of TTDD is each node may construct the grid on its own, which may consist more dissemination points that forward the message to the mobile sink.

2.23 Grid-Based Data Dissemination (GBDD)

Is a grid-based routing protocol used to enhance the lifetime of sensor networks by consuming less energy[24]. In GBDD, the sink node is the start cross point of the grid, and the grid size is determined by the radio range of both the active nodes. R_h and R_l are considered to be the transmission ranges that represent high power and low power radio mode of the sensor node. Every cell in the grid takes up the form of a square shape, and every end is of size ‘m’ constructed using transmission energy. The disadvantage is the consumption of energy is high during data transmission. Table 4 shows the comparison between the multi-hop grid- based routing.

From all the study, we found that the transmission energy was a major factor in draining the sensor node. Hence, to minimize the transmission energy a novel approach is suggested by varying the transmission power based on the distance from the node to the CH. There by optimizing the transmission power. In the proposed system, the clusters have been formed using the cluster splitting algorithm. The CH was selected using neighbor information. Each node shares their energy and distance of the node to other neighbors. The node which has high energy will act as a cluster head. Since the distance between the nodes was known to the CH, it uses the signal strength which is needed to send ADV message to the farthest node in the cluster. While sending the data, all the nodes have power control to varying their transmission power based on the distance between their CH. The CH then forms multi-hop routing path by employing a minimum spanning tree algorithm to route the data to the base station. Thus, this mechanism reduces the transmission power and minimizes the energy consumption in the network. Figure 7 shows the architecture of the proposed system.

Table 4. Multi-Hop Grid Based Routing

Protocol	Advantages	Drawbacks	Load Balancing	Scalability	Delivery delay	Mobility	Data Aggregation
VGA	Energy efficiency and maximize the lifetime of the network	The optimal selection of local aggregators as master aggregators is NP- hard problem	Medium	Good	Medium	No	Yes
TTDD	Can be employed in the sensor field of stationary nodes, which is incorporated with mobile sinks.	The node builds a virtual gird(source node) structure of dissemination points to supply data to mobile sinks	Low	Low	Very Large	No	No
GBDD	It ensures continuous data delivery from source node to sink	It consumes more energy at high speed	Low	Good	Large	Limited	No

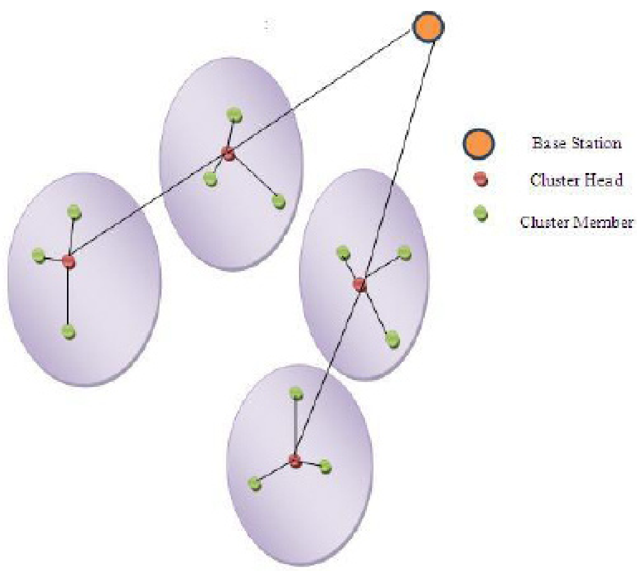

Figure 7. Topological representation of Proposed System.

3. Conclusion

In the survey of the several routing algorithms the merits and demerits of the protocols are identified based on some of the characteristics such as load balancing, scalability, latency, Mobility, data delivery model and data aggregation. With this comparison, the main issue identified was the reduced lifetime of the network due to consumption of more energy during data transmission. Transmission energy is the energy required to transmit the data successfully. All these protocols focus on increasing the network lifetime. Only a few like focused on the transmitter and receiver energy of the node. The complexity of the protocol needs to be analyzed. We need to have more mature models that consume less power during transmission. Adaptive power control in data communication is one of the future research areas to be explored and employing the shortest path algorithm for routing. This increase, node lifespan and indirectly reduces the energy consumption.

4. References

1. Sasirekha S, Swamynathan S. A comparative study and analysis and data aggregation technique in wireless sensor network. Indian Journal of Science and Technology. 2015; 8(26).
2. Heinzelman W, Chandrakaran A, Balakrishnan H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks. Proceedings 33rd Hawaii International Conference on System Sciences, HI, USA. 2000; 8. p. 110.
3. Handy MJ, Haase M, Timmermann D. Low Energy Adaptive Clustering Hierarchy with Deterministic Cluster-Head Selection. Proceedings 4th International Workshop on Mobile and Wireless Communications Network, USA. 2002; 1(4):368–72.
4. Heinzelman W, Chandrakaran A, Balakrishnan H. An Application- Specific Protocol Architecture for Wireless Microsensor Networks. IEEE Trans Wireless Communication. 2002; 1(4):60–70.
5. kaur J, Gaba GS, Miglani R, Pasricha R. Energy Efficient and Reliable WSN based on Improved Leach-R Clustering Techniques. Indian Journal of Science and Technology. 2015 Jul; 8(16).
6. Manjeshwar A, Agrawal D. Teen: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks. Proceedings 15th International Parallel and Distributed Processing Symposium (IPDPS'01) Workshops, USA, California. 2001; 2009-2015.

7. Manjeshwar A, Agrawal D. APTEEN: A Hybrid Protocol for Efficient Routing and Comprehensive Information Retrieval in Wireless Sensor Networks. Proceedings International Parallel and Distributed Processing Symposium, Florida. 2002. p. 195–202.
8. Muruganathan S, Ma D, Bhasin R, Fapojuwo A. A Centralized Energy-Efficient Routing Protocol for Wireless Sensor Networks. IEEE Communication Mag. 2005; 43(3):8–13.
9. Younis O, Fahmy S. HEED: A hybrid energy efficient distributed clustering approach for adhoc sensor networks. IEEE Tran Mobile Computing. 2004 Dec; 3(4):366–79.
10. Li CF, Ye M, Chen GH, Wu J. An Energy Efficient Unequal Clustering Mechanism for Wireless Sensor Networks. Proceedings of the 2nd IEEE International Conference on MASS, Washington, DC. 2005 Nov 7-10. P. 596–604.
11. Vijayan K, Raaza A. A Novel Cluster Arrangement Energy Efficient Routing Protocol for Wireless Sensor Network. Indian Journal of Science and Technology. 2016 Jan; 9(2).
12. Lotf J, Bonab M, Khorsandi S. A Novel Cluster-based Routing Protocol with Extending Lifetime for Wireless Sensor Networks. Proceeding 5th IFIP International Conference on Wireless and Optical Communications Networks (WOCN08), East Java Indonesia, Surabaya. 2006; 1–5.
13. Kandris D, Tsioumas P, Tzes A, Nikolakopoulos G, Vergados DD. Power Conservation Through Energy Efficient Routing in Wireless Sensor Networks. Sensors. 2009; 9(9):7320–42.
14. Thenmozhi E, Audithan S. Energy Efficient Cluster Head Selection and Data Convening in Wireless Sensor Networks. Indian Journal of Science and Technology. 2016 Apr; 9(15).
15. Munusamy K, Parvathi RMS, Chandramohan K. Least Power Adaptive Hierarchy Cluster Framework for Wireless Sensor Network using Frequency Division Multiplexing channelization. Indian Journal of Science and Technology. 2016 Feb; 9(6).
16. Lindsey S, Raghavendra C. PEGASIS: Power-Efficient GAthering in Sensor Information Systems. Proceedings IEEE Aerospace Conference, USA, Montana. 2002; 3:1125–30.
17. Jung S, Han Y, Chung T. The Concentric Clustering Scheme for Efficient Energy Consumption in the PEGASIS. Proceedings 9th International Conference on Advanced Communication Technology, Gangwon-Do. 2007; 1. p. 260–5.
18. Almazaydeh L, Abdelfattah E, Al-Bzoor M, Al-Rahayfeh A. Performance Evaluation of Routing Protocols in Wireless Sensor Networks. Computer Science and Information Technology. 2010; 2(2): 64–73.
19. Wu Y, Fahmy S, Shroff N. Energy Efficient Sleep/Wake Scheduling for Multi-Hop Sensor Networks: non-Convexity and Approximation Algorithm. Proceedings 26th Annual IEEE Conference on Computer Communications (INFOCOM 2007), Anchorage, Alaska. 2007. p. 1568–76.
20. Tan HO, Korpeoglu I. Power efficient data gathering and aggregation in wireless sensor networks. ACM SIGMOD Rec. 2003 Dec; 32(4):66–71.
21. Zhao S, Wu J, Zhang J, Liu L, Tian K. A General Self-Organized Tree-Based Energy-Balance Routing Protocol for Wireless Sensor Network. IEEE Transactions on Nuclear Science. 2014 Apr; 61(2):732–40.
22. Al-Karaki JN, Mustafa R, Kamal A. Data Aggregation in Wireless Sensor Networks Exact and Approximate Algorithms. Proceedings IEEE Workshop High Performance Switching and Routing 2004, Phoenix, AZ. 2004; 241–5.
23. Luo H, Ye F, Cheng J, Lu S, Zhang L. TTDD: Two-Tier Data Dissemination in Large-Scale Wireless Sensor Networks. Wireless Networks, Springer Netherlands. 2005; 11(1):161–75.
24. Sharma TP, Joshi RC, Misra M. GBDD: Grid Based Data Dissemination in Wireless Sensor Networks. Proceedings 16th International Conference on Advanced Computing and Communications (ADCOM 2008), Chennai, India. 2008; 234–40.