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A Survey: Recent Energy Efficient Clustered Routing Techniques used in WSN

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***Abstract*— Wireless sensor network (WSN) has developed as essential addition to the modernized wireless transmission system. Optimum choice of the route for information transmission leads to saving of the power consumed that improves the network lifetime of WSN. Different routing, energy conservation, information distribution have been basically established for WSN in which power awareness is crucial design aspect. Routing protocol in WSN mainly depends on the applications and system structure because still there is no agreement on static transmission stack for wireless sensor system. To fulfill the need of abundant and persistent computing, new routing protocols are required. In this paper, classified routing protocols in different stages i.e. security aspects, characteristics, protocols, and challenges. In addition, routing protocols are considered on the basis of the similarity and differentiability of the sensor hops monitored by method of the grouped and non-grouped between them. Moreover, different protocols are explained in detailed approach.**

***Index Terms*— Wireless sensor network, Information transmission, Routing protocols and Security aspects.**

I. INTRODUCTION

With the popularity of the wireless sensor network, there has been tremendous growth in wireless sensor network [1]. Hence, sensor network has become an immense requirement of social beings. The sensor system is the method of gathering data, processing and sending by the sensor device to another sensor and then associated logically to the social beings [2]. Wireless sensor network consists of maximum amount of the sensor hops that are densely populated in biological environment and nearest to it. Sensors in wireless system are small devices that investigate different situations such as high temperature, pressure and humidity and so forth [3] [4]. The capability of the sensor device to connect to controller or between the sensor hops. Every hop needs energy resource which is high to improve the lifetime of the system [5]. The self-organization of the sensor hop presents various issues for the scientists in establishment of the system protocols. The structure of the wireless sensor network as given in fig. 1 contains sensor hops which are distributed in system and every hop able to collect and route information back to sink. The hardware structure contains four elements like as sense element, process, trans-receiver and energy component. [6] The method has the capacity to search, generating energy, and movement based on presentations. The main apprehension for inventers and scholars is the control element. However, required energy resource should be implemented to optimize the lifetime of the hop, conventions and protocols [7] [8].

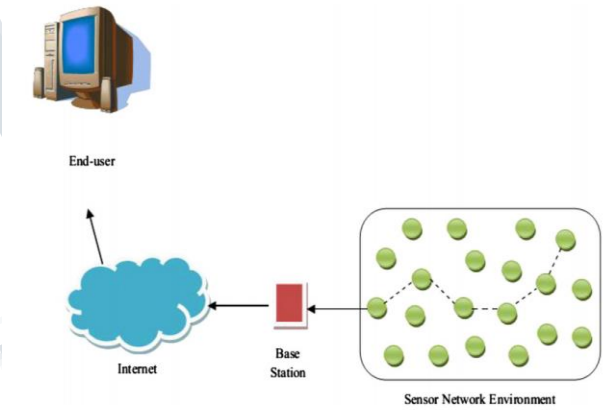

Fig.1 Wireless sensor network [21]

Some of the applications of wireless sensor network, [10]:

- Healthcare monitoring scheme.
- In security application.
- Defence services, surveillance, inspecting and targeting scheme.
- Recognition of the environmental conditions
- Transportation and traffic control scheme.
- Industrial applications.

Advantages of WSN [11] [12]:

Wireless sensor network have some of the advantages which are described as,

- Fewer prices as compared to global positioning system modem.
- Less power consumption.

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- Easy to modify coverage area.
- Prevents cabling due to wireless connection
- Provide stability to novel sensor device.
- Centralised monitoring scheme.
- Some disadvantages are as follows:

Less speed than wired system

- Minimum security.
- Influenced by external devices and Bluetooth.
- Easily accessed by intruders.

Challenges of WSN [13]

1. Power: The different operations to be performed needs energy by the sensors. Power is used up in collecting, handling and communicating information. In case the hop elements are empty, some types of the operation needs are required to consume energy. Energy plays an essential role to recharge and modify battery due to demographic situations. The main challenge for wireless sensor system is to implement and grow power efficient hardware and software protocols for sensor system.
2. Self-Preservation: The nodes are deployed in absence of any human intervention. The system configuration, reliability, management and repairing must be done by system itself.
3. S/W and H/W Problem: Sensor system contains the maximum number of the hops. If hop is less expensive then only it is preferred. Memory is advisable to be utilized due to its less cost. The CPU unit of sensor hop recognizes power consumption and calculation inability of hop.
4. Security: WSN is also used for investigation, building observing, intruder alarms and in dangerous schemes like as airports and hospitals. Hence, the information transferred from sensor to controller needs security and it may lead to overhearing on transmission of data. It is important for every sensor hop and controller to identify that the information achieved was forwarded by confidential party and not by opponent. False information may be predicted that alters the route of the network. Various types of attacks are spoofing and it modifies the route data, sink hole and Sybil threat, DOS and jamming threat.
5. QOS (Quality of Service): WSN is utilized in different application services so it is essential to have better QOS. However, it is not easy due to change of topology frequently and accessible data condition for routing is integrally inaccurate. Sensor system requires to be delivered with large number of bandwidth so it is capable to get negligible QOS value. Data traffic is unstable in sensor system though data is collected from different hops to sink hop. QOS method must be developed for unstable restrained QOS traffic. Different routing in sensor system required to expense power reliability to meet the distribution needs. Though multiple node decrease the number of power expended for collecting information the overhead must decrease the delivery of the packet. [14]

II. LITERATURE SURVEY

Kumari, R. and Nand, P et al., 2016[15] analyzed the presentation of different protocols of WSN in body area system and sensor network. This research compared the presentation of the similar and diverse system using metrics like as packet delivery ratio, throughput and latency rate and so forth. In addition, this research determines that a wireless convention requires updating method in body area system. Also, the protocols used are AODV, DSDV, DSR and the AOMDV. It was observed AODMDV performed better as compared to other protocols. The comparison analysis was done to recognize the presentation of the protocols in body sensor system and the outcomes AODMDV protocol get decreased. Still, this protocol performs better in all prospective.

Singh, O., Rishiwal, V and Yadav, M et al., 2016 [16] recognized three protocols which are LEACH, SEP and FAIR on the basis of the energy in different environment. Differentially in random power attributes was taken by the sensor hops. Various metrics were utilized for the selection of the measured protocols of H-wireless sensor system. Experimental analysis was done by comparing different protocols. It was noted that FAIR protocol gives reliable results as compared to LEACH and SEP because failed hops may reduce in each cycle and data packet transmission value to controller and CH increases.

Sreevidya, B and Rajesh, M et al.,2017[17] proposed research on power efficient routing method. The technique measured is sensor network that is the gathering of the clusters and information transferred using CH instead of the collective strength of each hop in the system. In WSN based on clusters, it was beneficial to get routing convention that utilizes clusters to select the routing data. This research proposed a new cluster dependent routing convention in WSN that optimized the power consumption on information transference and improved the lifespan of the system. It was concluded to get beneficial results by comparing AODV and CBRP protocols.

Karthikeyann, A., Arunachalam, V. P., Karthik, S and Dhivya, P et al., 2018[18] developed diverse methods for energy management for influential communication. The main goal of this research was to handling and keeping the appeared and transferring the sensed information to the controller. Different protocol was utilized for power

reliable transmission. In this research, organize and unorganized low information accumulation and routing like as EEDA and MECA for achieving better transmission that provides best outcome when comparison was done with other protocols.

Saini, P. and Bhatia, D et al., 2018 [19] researched on routing method such as hierarchical formation routing with the conventions such as LEACH, TEEN, SEP and EAMMH. This proposed a novel declaration concept remote invention. The data shared between allocated path to achieve the reliable and accurate selection. In this research, Wireless token ring convention was taken as remote-LAN practice through IEEE802.4 token bus protocol. This protocol updates the capability by removing the amount of the re-communication as selection of the output result. In this research, MATLAB was used as regeneration code to reflect the information interchange criteria between motions in ring for already defined time period.

Jiang, S et al.,2018 [20] utilized ant colony (ACO) and swarm optimization (PSO) method to optimize the LEACH convention that were mainly utilized in WSN routing convention , to decrease the power consumed in WSN during communication. During the clustering method of LEACH convention ,CH are selected in absence of the measured power consumption occurs due to some facts like as position , analysis of information, leads to selection of the CH . Hence, swarm optimization was used to optimize the LEACH convention as to achieve the globalized optimum transmission presenting CH. During communication in LEACH, a single path was simple for CH to consume power, so, round per system get decreased. To solve the issue, an inter cluster transmission route was developed in single path and multiple route approach. PSO algorithm was utilized to interact with the modernized method to get rid of the local optimum output and accelerate its achievement of globalized transmission route in LEACH protocol. Experimental analysis was done to get the final outcome. It was observed that LEACH protocol in artificial intelligence get improved. Also, inequality among the information communication and system power consumption was resolved by join combined invention technique in artificial intelligence approach.

III. SECURITY PROSPECTIVE IN WSN

Security is the main challenging approach in establishment of the routing protocols in WSN. To determine the security structure, security goals and threats is required to describe routing method.

3.1 Security goal: It is main aspect that mainly effect on the performance of the system and interconnection among the network. Hence, security attributes are considered at the time of the establishment of the routing protocols in WSN. Generally, network is more prone to attacks due to the presence of the specific features in WSN like as wireless connection, dynamic structure, source restrained capacity [21]. For example, a broadcasting behavior of wireless connection permits the opponents to interrupt easily, and modified the transferred data. However, security challenges are required to clear before the deployment of the hops in the system. Security plays an essential role in forwarding of data packet from sender to receiver hop and it required to be prevented from the intruders followed by its routes.

Sensor system is more prone to various kinds of the threats so an essential goal for the security is (i) Verification (ii) Privacy, (iii) Reliability and (iv) Accessibility.

i) Verification: The intruder nodes may change and adjust information during the communication in specific location. Though sensor hops in WSN connects through wireless network, every transferred data packet required to be secured to recognize data packet with mischievous intent.

ii) Privacy: This method ensures that the data transferred should ensure data may not be modified by the intruders during the communication. In case the data is inaccurate, it may affect the whole routing procedure.

iii) Reliability: It is related to the loss of information, and error at the time of the transmission. Reliability ensures that the data may not be affected by the intruders at the time of transmission from sender to receiver.

iv) Accessibility: Mainly, WSN are organized with maximum dimension of the hop idleness to allow such disappointments in route method. However, accessibility is essential to promise the attendance of wireless sensor system process even in case of the failure of the hops or threats. In addition, it is necessary to fulfill the needs of the self-recovery method.

The given all security goals is recommendations to scientist to determine the security needs also the type of the threats. In wireless sensor network the security needs are required to be fulfilled by accepting the security methods like as cryptographic method, symmetric key and confidential scheme.

IV. ROUTING PROTOCOLS IN WSN

Routing is the method of different form predictable routing in static system in different manner. There is no structure, wireless connections are unpredictable, sensor hops may fail and routing protocols run into power saving needs. Various approaches were established for wireless system. The main goal of routing is to find the finest route between

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the sensor node and controller and interconnect from source to destination. The architecture of routing protocol in WSN must determine the power and issues of system node, possibility of the loss of information. Some of the routing protocols are described as [22],

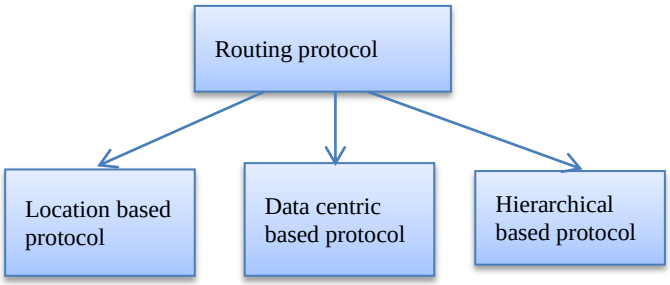

Fig. 2 Routing protocols in WSN

3.1 Location-based Protocols

This protocol is determined by the location and data for sensor hops is necessary for sensor system by various routing protocols to compute the distance among specific hops so that the power consumption can be valued. It is dependent on the location regardless of the hop identity as the target of the information packet. The nodes are placed in the area that is acceptable as receiver node and that can acquire and process the data. However, there are no addressing criteria for sensor system like as IP address and located information can be utilized in routing data in efficient way [23]. The examples of this routing protocol are GAF and GEAR.

1. Geographic Adaptive Fidelity (GAF): This protocol is used for the preservation of power in WSN and the architecture of GAF is encouraged by the energy which reflects energy consumption due to sending and forwarding of data packet and empty when sensor hops determine the availability of the data packets. The sensor field is dispersed into grid square and every square use located information which can be determined by global positioning system and location scheme to interconnect with specific grid where it is placed. GAF is based on three stages which is inquiry, active and sleep state. When sensor hop is in sleep state then saves energy during the communication. In discovery phase, sensor hop interconnect the investigated information to recognize other sensor in same grid. Sensor hop sends the investigated information to identify the parallel sensor about the situation in each of the state that can be used in the application on different factors such as requirement and sensor movement. It drives to improve lifetime of the network while accomplishing a phase in which every grid consists one active sensor that depends on rank rule. The rank of the sensor is based on the remained energy level. Sensor with highest rank is capable to deal with the routing of the dependent grids.

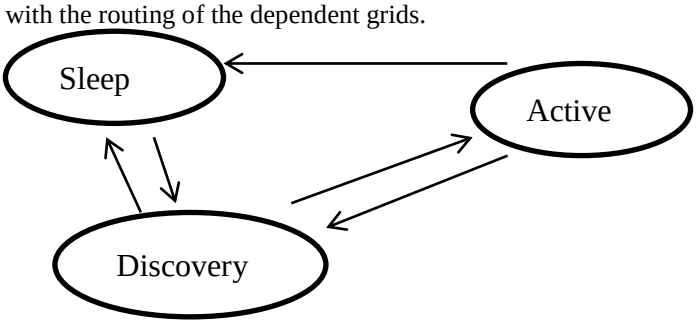

Fig.3 Location based structure in GAF [23]

2. Geographical and energy aware routing (GEAR): This routing needs a path to target sensor area. Sensors are imaginary to achieve the location prepared hardware, for example, GPS is capable to recognize available positions. Moreover, sensors are observant about the remained energy and also the location nearest hops. It is dependent on the geographical information to select sensor device to route data packet in direction of received information. I t is dependent on the geographical information to select the sensor device to route data packet in position of the received information [24].

3.2 Data centric protocol: It is different from the out-dated address centric protocol in which data is forwarded from sender to sink node [25]. At the starting, sensor hop have the appropriate data responds by forwarding the data to sink node which is not reliant on sensor device. The intermediate sensor device achieves some accumulated data generated from multiple sources and sends gathered data towards the sink hop. The technique indicates data saving because of less transmission which is important to forward data from sender to sink node. Data centric protocol are described below:

1. Sensor Protocols for Information via Negotiation (SPIN): The protocol is reliable and adaptive about the resource. The sensor device arranges the protocol which is able to compute energy consumption that is required to calculate, forward and acquire data over the system. The protocol is based on the two techniques which is negotiation and resource variation. It makes the availability of the sensor to negotiate with other before any information dissemination occurs to overwhelm announcing unavailable information in the scheme. It uses multiple data as descriptor that the sensor device requires to disseminate [26]. It uses diverse data as descriptor that sensor requires to allocate. The method of the diverse information avoids overlapping specified sensors. The

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linked sensor data must be more than dimension of the diverse information.

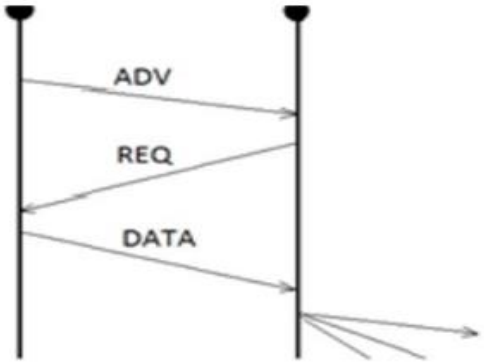

Fig. 4 Stages in SPIN protocol

2. Directed Diffusion (DD): It is routing protocol for sensor request and special consideration. It came across the main requirements of the sensor system as energy efficiency, toughness and scalability. It is dependent on different elements such as data mining, propagated information. Sensing employment is determined by the class of the linked features. Sink node determine less data for achieved operation at the time of the direct diffusion. Moreover, sink node maintains specified sensor to send maximum data by forwarding exact information with minimum interval. The nearest sensor hops concerned about the information and examines the source with related to huge data which best gradient value.

3. Energy aware data centric routing: It is novel disseminated routing protocol developed by the active sensors which is responsible for input scheme data processing and relay. The scheme is recognized by broadcasting tree in which every sensor device in system and static at gateway node. Generally, it establishes a forwarding tree which guess optimum span tree. It is energy ware and has a tendency to improve the lifetime of the network [27]. The gateway node works as data resource in which every sensor plays a role of data sink.

3.3 Hierarchical Protocol: This protocol is dependent on cluster method. It is used by sensor to record sensed data to sink node [28]. The layered protocol contains different clusters. Every cluster attained through specified node, so it is known as cluster head.
This protocol helps in managing the energy consumed of sensor node by linking various node communications in

Specified cluster and decrease the rate of information to controller.

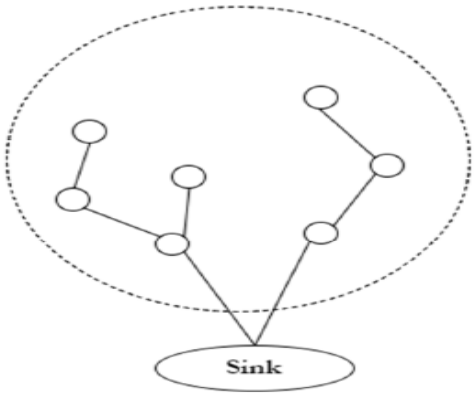

Fig.5 Hierarchical Arrangement [23]

The creation of the cluster that is dependent on the reservation of energy and locality of cluster to cluster head (CH). Some of the examples of this protocol are LEACH, TEEN, APTEEN and PEGASIS.

1. LEACH (Low Energy Adaptive Clustering Hierarchy): This protocol is supportive in improving the lifetime of the system. It is cluster based protocol that is dependent on three steps which is generating cluster head; generate cluster and communication among clusters [28]. The protocol contains the clusters group and stable data transmission. The collections of clusters are performed in random and dispersed manner. However, it improves the life span of the network. The execution taker place in regular basis and each cycle contains the growth of the clusters. It is method which is structured to collect forwarded data to controller.
The chief objective of LEACH is:

- Improve the lifetime of the network
- Decrease energy ingestion.
- Gathered data reduce the number of data communication.
- Decrease the number of the transferred data packets through linked data.

In order to achieve the objective, LEACH monitors a categorized arrangement to organize the network in class of the nodes. Each group is managed by selecting the cluster head. CH achieves performs different task to function in system. Mainly, consistent collection of data is done.

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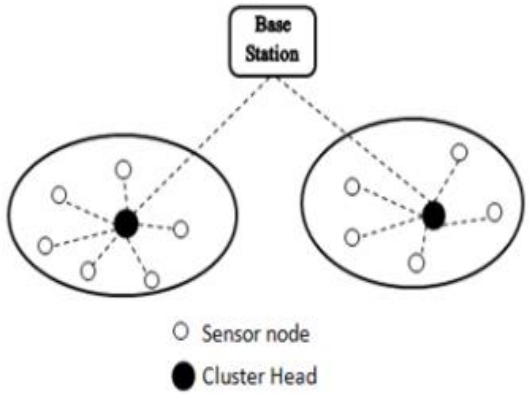

Fig.6 LEACH [28]

2. PEGASIS (Power-Efficient gathering in Sensor Information Systems): It is routing protocol which follows the chain based rule. In this protocol, the chain starts from the last hop and forwards to all other hops to form a chain structure. It is dependent on the standard that every hop will transfer and receive data from the nearest neighbors. A main head in the chain is accountable for transferring of the linked information to the sink hop. The header of the hop gets changed in which power is distributed between the hops. The power dissemination and maximum level energy leads to improvement of the lifespan of the system. It supports to decrease the delay which achieved the route towards the controller. The main goal in this protocol is that every hop for each hop gets and transfer data to nearest hop and then again works as header for connecting to the controller. This method distributes the power load even between the sensor hops in the system. In the beginning, hops are placed randomly and arranged to form a chain structure [29]. This method follows a greedy algorithm. The connection of the sensor hops in this protocol is given in figure as,

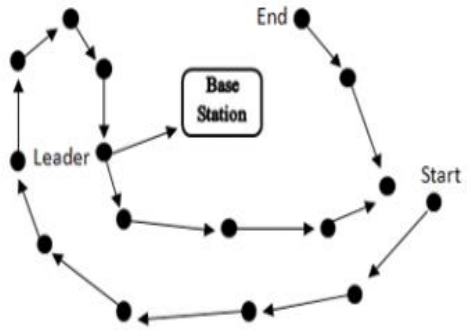

Fig. 7 PEGASIS routing chain based protocol [28]

CONCLUSION AND FUTURE SCOPE

Routing protocols in WSN are specified application, data centric, and enable to collect information and optimize consumed power. The main features of the protocols in WSN are ease, power awareness, flexibility and scalability because of the restricted power supply, inadequate calculation energy, inappropriate storage and bandwidth in wireless sensor system. Generally, wireless sensor networks improved the lifetime of the system. WSN is used in different applications areas. In addition, different routing protocols in WSN are also described. Routing in sensor system has great concern in recent years and presented some challenges, applications and advantages and disadvantages. Then, summarized about the different routing protocols in sensor system and classified different routing protocols namely data-centric, hierarchical and location-based and motion based protocol.

In upcoming work will implement a novel routing protocol for data transmission and route calculation. Routing protocol will improve the network performance and parameters such as PDR and End to end delay.

REFERENCES

[1] Chen, Y. and Zhao, Q. (2005). On the lifetime of wireless sensor networks. IEEE Communications letters, vol.9(11), pp.976-978.

[2] Shaikh, R. A., Jameel, H., d'Auriol, B. J., Lee, H., Lee, S., and Song, Y. J. (2008). Group-based trust management scheme for clustered wireless sensor networks. IEEE transactions on parallel and distributed systems, vol.20(11), pp.1698-1712.

[3] Romer, K., & Mattern, F. (2004). The design space of wireless sensor networks. IEEE wireless communications, vol.11(6), pp.54-61.

[4] Huang, C. F., and Tseng, Y. C. (2005). The coverage problem in a wireless sensor network. Mobile networks and Applications,vol. 10(4),pp. 519-528.

[5] Bhardwaj, M., & Chandrakasan, A. P. (2002). Bounding the lifetime of sensor networks via optimal role assignments. In Proceedings. Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies ,Vol. 3, pp. 1587-1596,. IEEE.

[6] Luo, J., & Hubaux, J. P. (2005). Joint mobility and routing for lifetime elongation in wireless sensor networks. In Proceedings IEEE 24th Annual Joint Conference of the IEEE Computer and Communications Societies. ,Vol. 3, pp. 1735-1746, IEEE.

[7] Mehregany, M., Gabriel, K. J., and Trimmer, W. S. (1988). Integrated fabrication of polysilicon mechanisms.

IEEE Transactions on Electron Devices, vol.35(6), pp.719-723.

[8] Xie, L., Shi, Y., Hou, Y. T.and Sherali, H. D. (2012). Making sensor networks immortal: An energy-renewal approach with wireless power transfer. IEEE/ACM Transactions on networking, vol. 20(6),pp. 1748-1761.

[9] Xie, L., Shi, Y., Hou, Y. T. and Lou, A. (2013). Wireless power transfer and applications to sensor networks. IEEE Wireless Communications,vol. 20(4), pp.140-145.

[10] Abbasi, A. Z., Islam, N., and Shaikh, Z. A. (2014). A review of wireless sensors and networks' applications in agriculture. Computer Standards & Interfaces,vol. 36(2),pp. 263-270.

[11] Demirkol, I., Ersoy, C. and Alagoz, F. (2006). MAC protocols for wireless sensor networks: a survey. IEEE Communications Magazine,vol. 44(4), pp.115-121.

[12] Maraiya, K., Kant, K.,and Gupta, N. (2011). Wireless sensor network: a review on data aggregation. International Journal of Scientific & Engineering Research, vol.2(4), pp.1-6.

[13] Wang, F and Liu, J. (2010). Networked wireless sensor data collection: issues, challenges, and approaches. IEEE Communications Surveys & Tutorials, vol.13(4),pp 673-687.

[14] Suo, H., Wan, J., Huang, L., and Zou, C. (2012). Issues and challenges of wireless sensor networks localization in emerging applications. In 2012 International Conference on Computer Science and Electronics Engineering ,Vol. 3, pp. 447-451, IEEE.

[15] Kumari, R. and Nand, P. (2016). Performance Comparison of various Routing Protocols in WSN and WBAN. In 2016 International Conference on Computing, Communication and Automation (ICCCA) , vol 2(1),pp. 427-431,IEEE.

[16] Singh, O., Rishiwal, V. and Yadav, M. (2016). Energy trends of routing protocols for H-WSN. In 2016 2nd International Conference on Advances in Computing, Communication, & Automation (ICACCA)(Fall) , vol 2(2), pp. 1-4. IEEE.

[17] Sreevidya, B. and Rajesh, M. (2017). Enhanced energy optimized cluster based on demand routing protocol for wireless sensor networks. In 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI) ,pp. 2016-2019, IEEE.

[18] Karthikeyann, A., Arunachalam, V. P., Karthik, S. and Dhivya, P. (2018). Energy Efficient Structure Free and Location Based Routing Protocol in WSN. In 2018 International Conference on Soft-computing and Network Security (ICSNS) , vol 2(1),pp. 1-5, IEEE.

[19] Saini, P., & Bhatia, D. (2018). Energy Efficient Relative Investigation of Routing Protocols in Wireless Sensor Network (WSN). In 2018 International Conference on Inventive Research in Computing Applications (ICIRCA) , vol 2(2),pp. 139-143, IEEE.

[20] Jiang, S. (2018). LEACH Protocol Analysis and Optimization of Wireless Sensor Networks Based on PSO and AC. In 2018 10th International Conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC) ,Vol. 2, pp. 246-250, IEEE.

[21] Zin, S. M., Anuar, N. B., Kiah, M. L. M. and Pathan, A. S. K. (2014). Routing protocol design for secure WSN: Review and open research issues. Journal of Network and Computer Applications, vol. 41, pp.517-530.

[22] Singh, S. K., Singh, M. P. and Singh, D. K. (2010). Routing protocols in wireless sensor networks–A survey. International Journal of Computer Science & Engineering Survey (IJCSES), vol.1(2),pp. 63-83.

[23] Raja, B., Rajakumar, R., Dhavachelvan, P., & Vengattaraman, T. (2016, December). A survey on classification of network structure routing protocols in wireless sensor networks. In 2016 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC) , vol 3(2),pp. 1-5. IEEE.

[24] Priyadarshi, R., Soni, S. K., & Sharma, P. (2019). An enhanced GEAR protocol for wireless sensor networks. In Nanoelectronics, Circuits and Communication Systems (pp. 289-297). Springer, Singapore.

[25] Akkaya, K. and Younis, M. (2005). A survey on routing protocols for wireless sensor networks. Ad hoc networks, vol. 3(3), pp.325-349.

[26] Xiao, D., Wei, M. and Zhou, Y. (2006). Secure-spin: Secure sensor protocol for information via negotiation for wireless sensor networks. In 2006 1ST IEEE Conference on Industrial Electronics and Applications , vol 2(2),pp. 1-4, IEEE.

[27] Shah, R. C. and Rabaey, J. M. (2002). Energy aware routing for low energy ad hoc sensor networks. In 2002 IEEE Wireless Communications and Networking Conference Record. WCNC 2002 (Cat. No. 02TH8609) ,Vol. 1, pp. 350-355, IEEE.

[28] Bansal, P., Kundu, P. and Kaur, P. (2014). Comparison of LEACH and PEGASIS hierarchical routing protocols in wireless sensor networks. International Journal on Recent Trends in Engineering & Technology, vol. 11(1), pp.139.

[29] Lindsey, S., & Raghavendra, C. S. (2002). PEGASIS: Power-efficient gathering in sensor information systems. In Proceedings, IEEE aerospace conference ,Vol. 3, pp. 3-3,IEEE.