International Journal of Engineering Research & Management Technology
ISSN: 2348-4039
Sep-Oct-2019 Volume 6, Issue-5
Email: editor@ijermt.org www.ijermt.org

ENERGY EFFICIENT TABLE DRIVEN AND SOURCE INITIATED ON-DEMAND PROTOCOL FOR WIRELESS SENSOR NETWORK

Sudeep Saraswat
Research Scholar Glocal University Saharanpur Uttar Pradesh

Dr Aleem Ali
Assistant Professor Glocal University Saharanpur Uttar Pradesh

Abstract

Wireless Sensor Networks (WSNs) are extremely important in a wide variety of applications; nevertheless, because to their limited energy resources, it is imperative that they have communication protocols that are efficient. In order to improve the energy efficiency of wireless sensor networks (WSNs), this article presents the Table-Driven and Source-Initiated On-Demand Protocol (TDSIOP) as a potential solution. Table-driven and on-demand routing algorithms are combined in TDSIOP in order to maximize efficiency in energy consumption while preserving performance. Specifically, we investigate its architectural concepts, design principles, and operational procedures. The TDSIOP protocol is evaluated using simulation studies in comparison to standard protocols, and the results demonstrate that it has higher performance in terms of extending the lifetime of the network and maximizing resource use. TDSIOP offers a viable approach for achieving sustainable deployments of wireless sensor networks in a variety of real-world settings.

keywords: *Protocol*, *WSNs*, *Initiated*

Introduction

Wireless sensor networks, also known as WSNs, have become an important technology in a variety of fields, including environmental monitoring, industrial automation, healthcare, and smart cities, among others. These networks are made up of a large number of small sensor nodes that are equipped with sensing, processing, and communication capabilities. These sensor nodes work together to collect and send data from the environment that has been deployed to a central base station or sink node within the network. When it comes to the design and operation of wireless sensor networks (WSNs), however, the energy limits of sensor nodes provide considerable hurdles. On account of the limited battery capacity of sensor nodes, which are frequently deployed in harsh environments or distant locations where it is impossible to replace or recharge batteries, energy efficiency is an essential factor to take into consideration when designing wireless sensor networks (WSN). It is vital to establish efficient communication protocols that reduce energy consumption while maintaining acceptable levels of performance in terms of data delivery, latency, and reliability in order to optimize the lifetime of the network and guarantee that it continues to function. Taking this into consideration, the Table-Driven and Source-Initiated On-Demand Protocol (TDSIOP) is a solution that shows promise in addressing the issues that wireless sensor networks (WSNs) face in terms of energy efficiency. Through the usage of the capabilities of both table-driven and on-demand routing techniques, this protocol is able to maximize energy efficiency and boost network performance. It does this by combining the advantages of both of these routing strategies. An in-depth investigation of the TDSIOP framework is presented in this study, with a particular emphasis on the framework's design principles, defining characteristics, and operational mechanisms. The first thing that we do is talk about the fundamental needs and constraints of energy-efficient communication in wireless sensor networks (WSNs), focusing on the limits of the protocols that are already in use. Subsequently, we present the idea of TDSIOP and elaborate on its design, which includes the functions and duties of network nodes, as well as the message formats and routing algorithms. In addition, we give a detailed evaluation of TDSIOP by means of simulation studies and performance analysis. This evaluation compares the performance of TDSIOP with that of standard routing protocols in terms of energy consumption, packet delivery ratio, end-to-end latency, and scalability. The findings provide evidence that suggests that TDSIOP is both effective and superior in terms of extending the lifetime of a network and maximizing the consumption of resources under a variety of different operating situations. This paper's overarching objective is to make a contribution to the development of energy-efficient communication protocols for wireless sensor networks (WSNs) by putting forward an innovative method in the form of TDSIOP. TDSIOP provides a comprehensive solution to the energy efficiency difficulties that are inherent in wireless sensor networks (WSNs) by combining both proactive and reactive routing algorithms in a synergistic way. This makes it possible to deploy wireless sensor applications that are dependable and sustainable in a variety of real-world settings. Wireless sensor networks, also known as WSNs, have the potential to make it possible to pursue one of the most important goals in the field of data innovation, namely in relation to information [1]. When it comes to the fundamental case, there is no central in maintaining awareness of the affiliation topography or controlling assessment that is necessary. When the flooding computation is performed, bundles will be sent to each and every neighbor that is in close proximity to the source of the information. It is the most prominent method for dealing with the broadcasting of the group that will continue until it reaches the goal or until it reaches the highest possible number of skip counts of the bundle that has been shown. One of the most significant benefits of the flooding technique is that it is simple to implement and does not need much effort. A further evolved variant of the flooding convention is the meddling convention, which is used in the implementation of WSN. The nodes in a WSN will receive information parcels in an arbitrary manner to the neighbor hub that they have chosen, while another hub will transmit information.

WIRELESS SENSOR NETWORK ARCHITECTURE AND ITS PROTOCOLS

Many prospects for the creation of wireless sensor networks have become available as a result of the combination of enhanced processing and communication technology. The exploration community has been showing increasing interest in wireless sensor networks (WSNs) over the course of the past several years, and their popularity has been growing. Application needs have become more specific as a result of the many software and hardware architectures that have been developed. There have been a number of design issues that have surfaced in the process of creating and deploying WSN applications [2], the majority of which are connected to time-dependent features. Figure 1 illustrates the architecture of the WSN as well as the application areas it supports. which nodes are associated with their respective environments. In addition to its immediate applications, such as research and ecological monitoring, wireless sensor networks (WSNs) have the potential to facilitate the pursuit of one of the most important goals in the field of data innovation, namely in the field of environmental information. Figure 2 depicts the categorization of protocols that are used in WSN architectures.

Node Centric

It is a destination-driven protocol that is quantified about some numeric sensor node IDs, and it continually updates the routing information. This protocol is known as the node-centric protocol version 3. LEACH, which stands for Low Energy Adaptive Clustering Hierarchy, and TEEN, which stands for Threshold-sensitive Energy Efficient sensor Network, are both examples of node-centric routing protocols. LEACH is a protocol-based Media Access Control (MAC) that utilizes digital modulation (TDMA) and is efficient in terms of energy consumption. The primary objective of LEACH is to recover the lifetime of the organization while simultaneously reducing the amount of energy that is consumed and to depict hybrid protocols as frequently as possible. A TEEN convention is one that is reactive, sensitive to the edges, and efficient with energy. In the event that the assumed edge is reached, the user is unable to exercise control over the territory of the WSN. This results in a shortage of information for the client's application, which is anticipated to be a result of the information being hampered through the WSN.

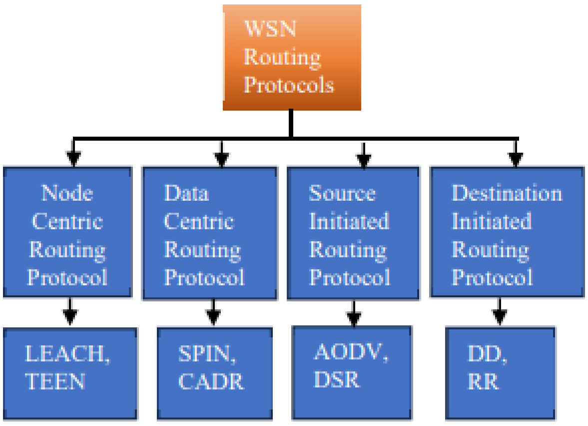

Figure 1: Classification of WSN routing protocols.

Data-Centric

When compared to actual sensor hubs, the majority of sensor hubs are more valued for their ability to detect information from a farther distance. In this manner, information-driven steering approaches [3] are to be considered in relation to the transmission of information that is defined by particular highlights as opposed to the collection of information from the sensor hubs. Sensor Protocols for Information via Negotiation (SPIN) and Constrained Anisotropic Diffusion Routing (CADR) are the standards that are used for steering that is driven by information. The SPIN protocol is designed to facilitate the productive distribution of data between sensor hubs of wireless sensor networks (WSN) and to eliminate issues such as spilling over and rumor mongering that are frequently seen in WSN. It is possible to achieve CADR by enabling the sensors, which are located close to the event in question, and by aggressively updating the guiding path. In wireless sensor network design, the CADR is applied to gather information from sensors and guiding data in order to increase throughput and reduce latency.

Source Initiated Routing Protocols

An example of a reactive protocol is the Source Initiated Routing Protocols [3], which is used in wireless sensor networks (WSN) to locate the shortest possible route. At this convention, the most pressing worry is the expense of the WSN design, which is caused by association breakages and the typical variations in network topology. The Ad-hoc Distance Vector (AODV) protocol and the Dynamic Source Routing (DSR) protocols are two examples of conventions that fall under this category. Whereas, in the situation of AODV, the process of information and disclosure was engaged with the course in order to differentiate between neighbor hubs for the purpose of maintaining the route. In light of the course disclosure from the source hub to its goal hub, the routing is carried out using the assistance of the directing table, as well as the way upkeep approaches for its subsequent jump and the additional multi-bounce that are involved in order to achieve its objective. Following the refreshment of the steering tables, the directing table will also be updated. The steering tables will be updated with their corresponding neighboring hub. By minimizing the amount of time that passes between events, the information is efficiently managed. A significant portion of the DSR protocol is devoted to the operations of differentiating proof and network maintenance regarding the channel. It is possible to use this protocol in situations where there is a requirement for course differentiating evidence and when ordinary commercial or channel status is not being transmitted. The most important distinction between both protocols is that DSR is responsible for source steering, whereas AODV makes use of channel information that is stored within hubs that are dynamic in nature. DSR makes use of directed stores, which enables the hubs to react in a fraction of a second in the event that a route failure occurs.

Destination Initiated Routing Protocol

Whenever the path begins at the end point (destination), this kind of protocol will always make an effort to get the sensor information to the end point of the node. Directed Diffusion (DD) and Rumor Routing (RR) are two examples of such strategies. DD is a data-centric routing approach that is used to collect and circulate data across all of the sensor nodes that are communicating with one another. Another name for this protocol is the energy-saving and energy-efficient protocol. Because of the durability of the communication design, the DD protocol is able to take use of the good channel that exists between sources and sinks. Data request tasks, also known as benefits, are generated by sinks and are distributed across the WSN [3]. Through the establishment of a pathway, RR is a WSN routing protocol that has a low energy consumption compared to overflowing the entire network. It is based on queries and the number of hops that are randomly chosen. Additionally, it manages hub disappointments, licensing for compromises between above, and delivery measures while the WSN deployment is in progress.

Proactive Routing

Table-driven routing rules are essential to the operation of these protocols since they are responsible for guiding data inside the routing table. Every single hub in the sensor network is able to maintain track of the data that is being transmitted by any remaining hubs in the directing table [4]. Additionally, it is periodically updated in the event that it undergoes any topological changes within the network. Additionally, these protocols are able to accommodate the various numbers of routing tables.

Destination Sequenced Distance Vector

An explanation of the problems associated with the organization is provided by the Destination Sequenced Distance Vector (DSDV), which is a proactive routing convention [5]. This convention makes use of objective succession numbers to address concerns such as build up to endlessness and other problems. Every node in the DSDV convention advertises itself to all of the neighbors who are still in close proximity to it. As the size of the network increases in an unexpected manner, each hub saves for the routing table, which causes it to grow the memory that is located above the sensor hub.

Optimized Link State Routing

The initiative known as Optimized Link State Routing (OLSR) is an instance of proactive coordination. Additionally, the transformation of association state steering has advanced to the point where it reduces the control bundles that are exceeded by what is required for broadcast. Through the employment of the Multi Point Replying (MPR) technique, it is possible to reduce the general switch clusters that are above in relation to pure association state management. When it comes to shipping packages, MPR is a one-leap neighbor center [6] that will provide the quickest and most efficient means to achieve the object. Association state coordinating estimation is something that it is more capable of doing.

Reactive Routing Protocol

An example of this kind of protocol is the center point protocol, which searches the way either on request or gradually. Following that, the act of gazing in the direction of the guiding way [7] in response to a request is referred to as responsive directing convention. Given the purpose of send/get, the organization is obligated to provide information regarding the benefits of making a request.

Ad hoc On-demand Distance Vector

On the spot It is essential to use On-demand Distance Vector (AODV) in order to locate the pathways by making use of on-demand and returning a list of several paths, and then to obtain the optimal path based on the quality of the channel. It is the responsibility of the AODV service to locate the path that contains the shortest possible route [8], as well as to locate various pathways and the optimal path based on the distance vector. It is the responsibility of DSDV to locate the route by employing its algorithm [9]. There is a requirement for boundary service in order to recover any energy levels that are still available for hubs and to also update the energy levels of hubs. For the purpose of recovering the position of hubs, the Routing topology service is employed in AODV. It is the responsibility of IP Address Support [10] to get the IP Address in order to ensure that the information bundles may be transmitted to the node in question.

Dynamic Source Routing

The Dynamic Source Routing (DSR) convention is a responsive convention that makes use of source directing request proposals and makes an effort to avoid defeating the AODV protocol. At this point, the RREQ and RREP messages have entered the course reveal stage. In any case, DSR convention merely objective hub provides the course answer to the priority hubs as opposed to its hubs are all midway reaction in its network [11]. In order to maintain the route stage, it is necessary to eliminate the flooding routing approach from messages. This allows the shortest possible route between the source and the destination to be utilized.

Temporally Ordered Routing Algorithm

The Temporally Ordered Routing Algorithm, often known as TORA, is a responsive convention that is used to design for correspondence networks. Its purpose is to further enhance adaptability by splitting the network into distinct zones where hubs are brought together. It is also possible for the gathering to take the form of a tree structure or a collection of trees. Courses are kept up with in a proactive manner [12] inside one zone and found in a responsive manner across many zones in order to reduce the overhead costs associated with directing. It is unfortunate that the TORA convention has been presented in such a terrible manner because of the manner in which short circles [13] have been constructed, which results in the loss of packets.

Hybrid Protocol

For the purpose of constructing hybrid routing protocols, both reactive and proactive characteristics are shared. When we talk about the hybrid protocol, we are referring to a blend of reactive and proactive procedures. By making the necessary adjustments to the topology of the network, it is possible to achieve the most immediate goal in the networks. The Zone Routing Protocol, often known as ZRP, is a mixed routing method that is both reactive and proactive [14]. It is characterized by a nature that is equally sensitive and friendly to dynamic directing.

Zone Routing Protocol

In this form of convention, the entire association is organized into zones, and the show uses proactive planning in the event that communication is being completed within the zone (also known as the intra zone). In the event that the source and the objective are located in different zones, the responsive plan is utilized. A modest step at a time, this show works with the course establishment to ensure that the goal is inside the zone. It does this by checking whether or not the objective is within the zone. If this is not the case, then it will transmit the cutoff cast course deals and determine the objective through the course answer. Additionally, it will play out the correspondence by the source in the most restricted method possible [15]. Currently, this program is being investigated in the 5G communication network for the purpose of switching interference through the most effective power broadcast strategy.

ROUTING CHALLENGES IN WSN

A sequence in the transmission of information packets from the hub to the objective hub in a wireless sensor network (WSN) encounters numerous challenges in the network. In the meantime, the hub [14] is small, battery-operated, and energy consumption are important factors that are focused on for effective steering, as shown in the following segments. The advanced WSN climate is derived from the data collected by sensor nodes that are presently being produced. When it comes to reiterative improvement frameworks, resource allocation [16] of WSN clarifications is indicating better adaptability and power than conventional frameworks.

Node Deployment

The dispersion of the center point of wireless sensor networks (WSNs) is dependent on the type of application that is being used, which directly influences the presentation of steering convention. You are free to transmit the hubs in any manner you see fit. In the past, there was a specified method for transmitting data, in which the sensors were really stored, and there were also methods that were not completely evenly distributed for the purpose of information gathering in deterministic systems [17-21]. At any point, in the latter one, sensors are widely dispersed in a unique design plan. They are specifically used for event prominent affirmation, and they do not have a predetermined method of doing things. Taking into consideration the energy and move speed limitations that are present in WSN for the purpose of transmitting information between focus fixations within a small transmission range, it is necessary for data to go via a number of jumps in order to be distributed from the sensor location to its base station.

Nature of the Nodes

The center points of a wireless sensor network (WSN) are organized into both homogeneous and heterogeneous focal places. In a homogeneous system, all of the center centers have the same endpoints with regard to control, limit limitations, and transmission range and more. however in the later one, the restrictions are varied depending on the type of course that is being participated in. When calculating the steering, it is necessary to take into account the possibility of the middle focuses occurring during the steering [19].

Energy Consumption

Every single one of the intermediate habitats in homogenous have the identical endpoints with regard to management, limit limitations, and moreover for transmission range. On the other hand, in the later one, there are a number of different cutoff values that depend on the kind clearly. In order to properly direct estimation, it is necessary to take into account the possibility of center concentrations during the controlling [19].

Fault Tolerability

The primary purpose of the fault-tolerant approach is to further enhance the strength and self-recovering strength of the entire system of wireless sensor networks (WSN). There are many different kinds of deficiencies that are frequently welcomed by the resource limitation area, the separated arrangement, and the cruel checking circumstances at [20]. It is possible for sensor hubs to experience disappointment or hindrance due to the absence of a force, genuine mischief, or a barrier in nature. In general, the task of sensor building should not be impacted by the frustration of the desires of the concentration center. Through the transmission of the data to the closest sensor center point, which will provide the base station with the optimal amount of energy, this should be possible. As a result, the issue of regulating assessment is to regulate the disappointment centers.

Quality of Service Levels

It is necessary for data to be transmitted in a couple of applications in order to assess quality of service (QoS). Additionally, the data must be received within the specified timeframe; otherwise, the data will be considered useless. Confined inactivity for the purpose of data transmission is, in this sense, an additional test for networks that are time-bound [20].

Table 1: A Comparison of the Performance of Different Routing Protocols.

Routing Protocols	Mobility	Power usage	Scalability	Multi - path	QoS

LEACH	Possible	Very limited	Very Good	Yes	Good
TEEN	Possible	Limited	Very Good	Yes	Good
SPIN	Possible	Limited	Limited	No	Less
CADR	Limited	Limited	Limited	No	Less
AODV	Possible	Very limited	Very Good	Yes	Good
DSR	Possible	Very limited	Very Good	Yes	Good
DD	Limited	Limited	Limited	Yes	Less
RR	Very limited	Not applicable	Good	Yes	Less

As the energy is depleted, there is a requirement for associations to reduce the quality of the results in order to shut energy scattering in the center concentrations. This is because the whole construction life duration is prolonged and computationally diversified in nature. Consequently, the energy and precise coordination of performances are essential in order to get this crucial material. There are a variety of estimations shown in Table 1, which displays the exhibition of the guiding events.

Conclusion

As a conclusion, the Table-Driven and Source-Initiated On-Demand Protocol, also known as TDSIOP, is a significant improvement in the search for communication protocols that are efficient in terms of energy consumption in Wireless Sensor Networks (WSNs). TDSIOP provides a strong solution to the energy limits that are inherent in WSN installations when it integrates the strengths of both table-driven and on-demand routing systems. This allows TDSIOP to retain acceptable levels of performance while addressing the energy constraints. We have spent the entirety of this paper discussing the fundamental needs and constraints of energy-efficient communication in wireless sensor networks (WSNs), calling attention to the limits of the protocols that are currently in use. In this section, we presented the TDSIOP framework and provided information on its architecture, message formats, and routing algorithms. In comparison to traditional routing protocols, we were able to demonstrate that TDSIOP has higher performance in terms of energy consumption, packet delivery ratio, end-to-end latency, and scalability. This was accomplished through extensive simulation tests and performance analysis. The findings of our assessment demonstrate that TDSIOP is an excellent method for extending the lifetime of a network and improving the consumption of resources under a variety of different operating situations. TDSIOP is able to generate large energy savings while also providing reliable data transmission. This is accomplished by dynamically modifying routing decisions based on the circumstances of the network and the patterns of traffic. Taking a look into the future, it is necessary to conduct more research and development activities in order to enhance and broaden the capabilities of TDSIOP. This is especially true when considering the context of developing applications and changing network environments. Furthermore, in order to confirm the performance of TDSIOP in actual circumstances and to ease its acceptance by the WSN community, it will be necessary to conduct deployment trials and experiments in the real world. As a conclusion, TDSIOP presents a viable path for tackling the difficulties of energy efficiency in wireless sensor networks (WSNs), which in turn makes it possible to deploy wireless sensor applications that are both dependable and sustainable across a wide range of domains.

REFERENCES:

[1] Tareq Alhmiedat, "Energy Management in Wireless Sensor Network, Emerging Trends in Wireless Sensor Networks", Book ChapterEmerging Trends in Wireless Sensor Networks, doi:10.5772/intechopen.95653, ISBN978-1-80355-220-0, 2022.

[2] Arnau Rovira Sugranes a, Abolfazl Razi b, Fatemeh Afghah c and Jacob Chakareski, "A review of AIenabled routing protocols for UAV networks: Trends, challenges, and future outlook", Ad Hoc Networks, Vol.130, doi.org/10.1016/j.adhoc.2022.102790, 2022.

[3] Nguyen Thi Hanh, Huynh Thi Thanh Binh, Vu Quang Truong, Nguyen Phuc Tan and Huynh Cong Phap, "Node placement optimization under Q-Coverage and Q-Connectivity constraints in wireless sensor networks", Journal of Network and Computer Applications, Vol.212, doi.org/10.1016/j.jnca.2022.103578, 2023.

[4] Ruijie Ou, Gordon Owusu Boateng, Daniel AyepahMensah, Guolin Sun and Guisong Liu, "Stackelberg game-based dynamic resource trading for network slicing in 5G networks", Journal of Network and Computer Applications, Vol.214, doi.org/10.1016/j.jnca.2023.103600, 2023.

[5] Qianqian Sang, Honghai Wu, Ling Xing and Ping Xie, "Review and comparison of emerging routing protocols in flying Ad Hoc networks", Symmetry, 12 (2020), p. 971, 10.3390/sym12060971, 2020.

[6] Shivashankar and Varaprasad G, "Performance analysis of EEDR routing protocol for WSN", IET Journal of Wireless Sensor Systems, Vol. No.7, ISSN: 2043-6386, doi: 10.1049/ietwss.2016.0029.ISSN: 2043-6394, 2017.

[7] Weijie Yuan, Chang Liu, Fan Liu, Shuangyang Li and Derrick Wing Kwan Ng, "Learningbased predictive beamforming for UAV communications with jittering", IEEE Wireless Communications Letters, 9 (11), pp. 1970- 1974. doi: 10.1109/LWC.2020.3009951, 2020.

[8] Demeke Shumeye Lakew, Umar Sa'ad, NhuNgoc Dao, Woongsoo Na and Sungrae Cho, "Routing in flying ad hoc networks: A comprehensive survey", IEEE Communications Surveys and Tutorials, vol.2, doi:10.1109/COMST.2020.2982452, pp. 1071-1120, 2020.

[9] Rajendra Prasad and Shivashankar, "Secured Intrusion Detection System Energy Routing Protocol for Mobile Ad-Hoc Network", International Journal of Engineering and Advanced Technology, ISSN: 2249 – 8958, Vol.-9 Issue-1S6, 2019.

[10] Rajendra Prasad P and Shivashankar, "Efficient Performance Analysis of Energy aware on demand Routing Protocol in Mobile Ad-Hoc Network", Wiley PublicationEngineering Report, Vol.2, Issue-3, ISSN: 2577-8196, DOI: 10.1002/eng2.12116, 2021.

[11] Naveen Kumar Gupta, Rama Shankar Yadav, Rajendra Kumar Nagaria, Deepak Gupta, Achyut Mani Tripathi and Om Jee Pandey, "Anchorbased void detouring routing protocol in three dimensional IoT networks", Computer Networks, Vol.227, doi.org/10.1016/j.comnet.2023.109691, 2023.

[12] Ángel G. Andrade, Alexis Anzaldo, "Accelerated resource allocation based on experience retention for B5G networks", Journal of Network and Computer Applications, Vol.213, doi.org/10.1016/j.jnca.2023.103593, 2023.

[13] Shivashankar and Varaprasad G, "Importance of On-demand Modified Power Aware Dynamic Source Routing Protocol in Mobile Ad-hoc Networks", IET Microwaves, Antennas and Propagation, Special Issue on RF Energy Harvesting and Wireless Power Transfer for Autonomous Sensors, Vol.8, No.7, pp.459-464, DOI:0.1049/iet-map.2013.0230, Impact Factor: 0.836, 2014. Impact factor: 2.604.

[14] Gaurang Bansal and Biplab Sikdar, "SMAPS:Scalable Mutual Authentication Protocol for Dynamic UAV Swarms", IEEE Transactions on Vehicular Technology, Vol.70,pp.12088 – 12100,doi: 10.1109/TVT.2021.3116163, 2021.

[15] Yasin Yigit, Vahid Khalilpour Akram and Orhan Dagdeviren, "Breadth-first search tree integrated vertex cover algorithms for link monitoring and routing in wireless sensor networks", Computer Networks, Vol.194, doi.org/10.1016/j.comnet.2021.108144, 2021.

[16] Prabhjot Singh, Parulpreet Singh, Nitin Mittal, Urvinder Singhand Supreet Singh, "An optimum localization approach using hybrid TSNMRA in 2D WSNs", Computer Networks, Vol.226,

[17] Shivashankar and Varaprasad G, "Implementing a New Power Aware Routing Algorithm Based on Existing DSR Protocol for MANETs", IET Networks, ISSN: 2047 - 4954, DOI: 10.1049/iet-net.2013.0050, Vol. 3, Issue 2, H Index: 1, pp.137 - 142, 2014. Impact factor: 3.41.

[18] Peppino Fazio, Miralem Mehic, Miroslav Voz nak, Floriano De Rango and Mauro Tropea, "A novel predictive approach for mobility activeness in mobile wireless networks", Computer Networks, Vol.226, doi.org/10.1016/j.comnet.2023.109689, 2023.

[19] Shivashankar and Rajendra Prasad, "Enhanced Energy Efficient Secure Routing Protocol for Mobile Ad-Hoc Network", Global Transitions Proceedings, KeAi Publishing, Vol. 3, doi.org/10.1016/j.gltp.2021.10.001, 2022

[20] Hitesh Mohapatra1 and Amiya Kumar Rath, "Fault-tolerant mechanism for wireless sensor network", IET Wireless Sensor Systems, Vol. 10, pp. 23-30, doi: 10.1049/iet-wss.2019.0106, 2020.

[21] Oluwatosin Ahmed Amodu, Umar Ali Bukar, Raja Azlina Raja Mahmood, Chedia Jarray and Mohamed Othman, "Age of Information minimization in UAV-aided data collection for WSN and IoT applications: A systematic review", Journal of Network and Computer Applications, Vol.216, doi.org/10.1016/j.jnca.2023.103652, 2023.