# A COMPARATIVE APPROACH ON ENHANCING LIFETIME OF WIRELESS SENSOR NETWORKS

**Mohit Tiwari1, Shashi Gandhar 2*, S B Kumar3 , Arvind Rehalia 4 , Sunil Gupta 5**
1,2,3 Assistant Professor, Bharati Vidyapeeth's College of Engineering New Delhi, India
4Associate Professor, Bharati Vidyapeeth's College of Engineering New Delhi, India
5Associate Professor, Maharaja Surajmal Institute of Technology, New Delhi, India

**Abstract —** Wireless Sensor Networks are crucial elements that are employed to assess the environment, in addition, to utilizing the sensor information for additional computing including climate forecast, human medical-related forecasts, transportation management, and so on. Because of the significant operational expense of the system, the sensor network of the system is anticipated to run independently in the area for an extended length of time in these circumstances. As a consequence of this, the exhaustion of single sensor nodes may have an impact on the network's operations. As a result, in an attempt to extend the network lifespan, an energy-efficient alternative must be proposed. Wireless sensor network technologies have emerged in past decades as an evolving innovation for monitoring & recording ambient physical variables utilizing many sensors. For the organizing of gathered data, centralized sites are required. Multi-hop communication is used to transfer data to the sink nodes communications are needed. To eliminate undesired transmissions, the most well-known WSN approach known as information aggregating is utilized. It must gather information from various sensors & transmit it to the ground station. The procedure of gathering information is repeated many times to maximize information effectiveness. This technology contributes to lower transmitting information power costs.

**Keywords —** Wireless Networks, Clustering, Information, Algorithm, Lifetime, Sensors, Data, Network, Nodes, Performance, Etc.

## I. INTRODUCTION

A wireless sensor network (WSN) is made consisting of a significant amount of reduced power multi-functional sensing systems that operate in an unsupervised environment & are capable of detecting, computing, or communicating. A sensing module, an ADC (Analog to Digital Converter), a CPU (Central Processing Unit), a power supply module, as well as a transmission system, are the main elements of a node. Sensor networks are micro-electromechanical devices (MEMS) that respond to changes in external conditions such as temperature or strain. Sensor networks detect or analyze bodily information from the observed region. A mixed-signal transformer digitizes the continuous analog signal detected by the detectors & sends it to control systems for additional analysis. Sensor networks are incredibly tiny, require very little power, function at excellent dimensional ratios, or are independent & adaptable to their surroundings [1]. In the outdoors, the geographical concentration of the sensor network could reach 20 nodes/m3. Because wireless sensor networks are often tiny electrical equipment, these can only have a restricted-energy supply. Every sensor network has a definite region of coverage for which it may consistently & precisely provide the amount under observation. Power usage in sense is caused by many factors, including (a) signal collection or transformation of signals transmitted to electronic pulses, (b) transmission filtering, & (c) analog-to-digital translation [2].

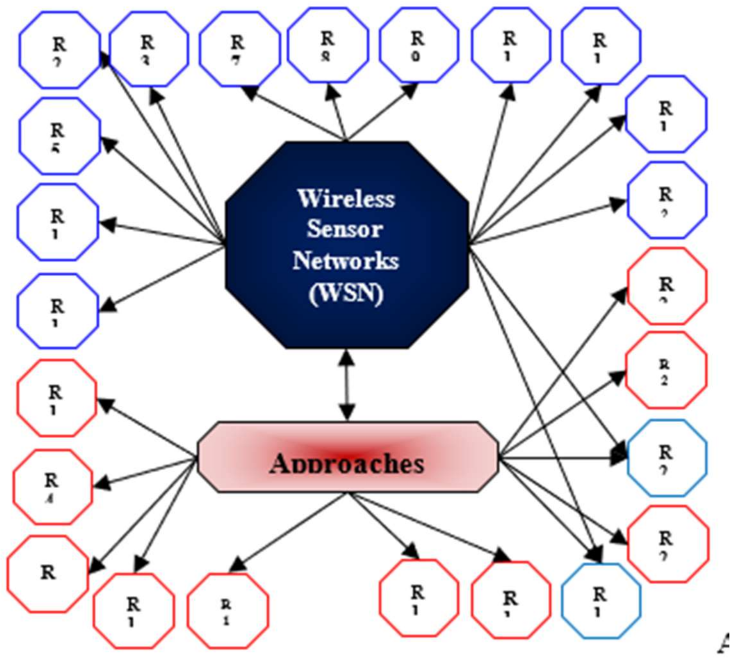


Figure 1. SEM of a Comparative Approach on Enhancing Lifetime of Wireless Sensor Networks

**Sensor networks are classified into three types:**

Neutral, Omni Position Sensors: Passive sensing nodes detect their surroundings without actively exploring them [3]. In this situation, vitality is simply required to magnify their analog signals. In gauging the surroundings, there's no concept of "directional."

Neutral, narrow-beam sensors: While monitoring the surroundings, these detectors are focused on the directions.

**Effective Sensors: These detectors constantly investigate their surroundings.**

Due to the limitations of detecting & computing capacity, transmission efficiency, or capacity of a sensor network, a significant amount of detecting gadgets are scattered throughout a topic of focus to gather data (temperature, humidity, motion detection, etc.). Such components may connect between themselves immediately or via additional intermediary nodes to transmit or receive data, forming networks; hence, every component in a sensing network serves as a gateway within the system. Every sensor node connects immediately with a controlling center termed Base Station (BS) and delivers acquired data through straight contact transport algorithms (single hop). The base station is stationary or situated a long distance distant from detectors. The base station may connect together with the end customer natively or via the currently connected networks. The sensing network's architecture varies regularly. Nodes may lack universal identity [4]. In the instance of direct connection, the sensor networks use power fast due to the considerable distances separating them and the base station. One way (multi-hop) routes information to the ground station through adjacent nodes, saving transmitting module power. A networking protocol is a standard that describes how routers interact with one another, distributing information that enables them to identify routes between any 2 network components, with networking methods determining the path. Every router knows just the networks that are immediately connected to it. This data is shared by a routing algorithm above all close neighbors, then across the network. Gateways learn about network architecture in this manner. There are primarily two kinds of networking processes: statically networking and adaptive networking.

Adaptive networking serves the identical purpose as traditional networking, but it is more resilient. Dynamic networking enables processing databases in individual controllers to be configured in a constant way to define network paths for messages. If a router along the path fails, the endpoint could become inaccessible. Adaptive networking enables router connectivity databases to adapt as potential paths vary. Since components in wireless sensor networks regularly shift location or perish anywhere at a time, variable networking is used.

## II. OBJECTIVE

**The study seeks to accomplish the essential objectives:**

- To explain Wireless Sensor Network (WSN).
- Explaining the Benefits and Drawbacks of WSN.
- Discussing the Application of wireless sensor networks.
- To explain the Problems in Sensor Network Architectural & Layout
- Elaborating about the Networking Approach in Use.
- Explaining the Comparative Study.

## III. METHODOLOGY

Wireless Sensor Networks assess sensor data for climate estimates, health record forecasts, transportation management, etc. Due to high running expenses, network sensors & actuators may operate autonomously for an extended period of duration. An exhausted sensor node potentially disrupts network functioning. Energy-efficient solutions must be offered to prolong the network lifetime. Multiple wireless sensors gather environmental data. Centralized data Inter info transfer to sink node. Accumulating data reduces needless transfers. It delivers detecting information to the AP. Databases efficiency involves data collection. This lowers internet prices.

## IV. WIRELESS SENSOR NETWORK (WSN)

A wireless sensor network (WSN) is regarded as an intelligent & low-cost efficient solution for improving the competence or dependability of different commercial systems such as security monitoring, residential control, smart grid, etc. Monitoring systems are composed of a significant amount of sensor networks that need little electricity to operate and thus are relatively compact. These deployed sensor networks can function as self-governing devices. The sensors may be placed in a variety of locations [5]. However, there are several challenges to using the WSN in genuine activities. The idea of energy usage in the system was a crucial topic considered when building WSN. In many implementations, a sensor network is supplied by limited electricity supplies such as batteries and supremely capacitors, limiting the network's lifespan. Alternative power options, including especially solar energy, have indeed been studied and are actively collaborating with sensors to ensure the network's lifetime. Nonetheless, the intermittent aspect of the power provider has a distinct influence on total networking efficiency [6]. As a result, network energy usage is a crucial aspect that must be addressed while constructing a networking architecture. The notion of clustering has been presented & proved to be highly respectable for meeting this criterion of power-saving networking architecture. The clustering procedure is a necessary phenomenon to carry out.

Below are the primary elements engaged in the clustering algorithm:

- Sensor Node: A sensor node is a network component that can perceive information as a detector, save material as a storage medium, and transport packages by engaging in the networking processing, or procedure information [7].
- Clusters: Cluster is defined as a grouping or gathering of networks that share characteristics. Because of the complex structure of the sensor nodes, it is necessary to divide them into portions in addition to facilitating activities such as information exchange.
- Cluster Head: A cluster-representing node. In many other terms, it serves as the gathering's head node [8].
- Base Station: A base station is a network device that serves as a drain node in transmission. This occurs at the top of the WSN chain. It serves as a data channel between the sensor nodes & the client. Different cluster techniques are used to carry out the clustering operation. Low Energy Effective Clustering (LEACH), Power-Efficient Gathering in Sensor Information Systems (PEGASIS), Distributed Energy Efficient Clustering (DEEC), Hybrid Energy Efficient Distributed (HEED), Threshold sensitive Energy Efficient sensor Network (TEEN), and other well-known spatial energy productive forwarding procedures These standards make it possible for activities to be very power saving.
- Restricted Energy: The restricted quantity of power in sensor networks must be considered as an appropriate clustering to lower the channel's total power usage.
- Network Lifespan: The restricted quantity of power in networks causes a reduction in connection lifespan [9].
- Restricted Skills: The tiny physical dimension & restricted quantity of saved power in a sensor node limits the networks' information analysis & information communication skills.

- App Reliance: For an effective clustering technique, implementation resilience must be considered whenever creating clustering algorithms [10].

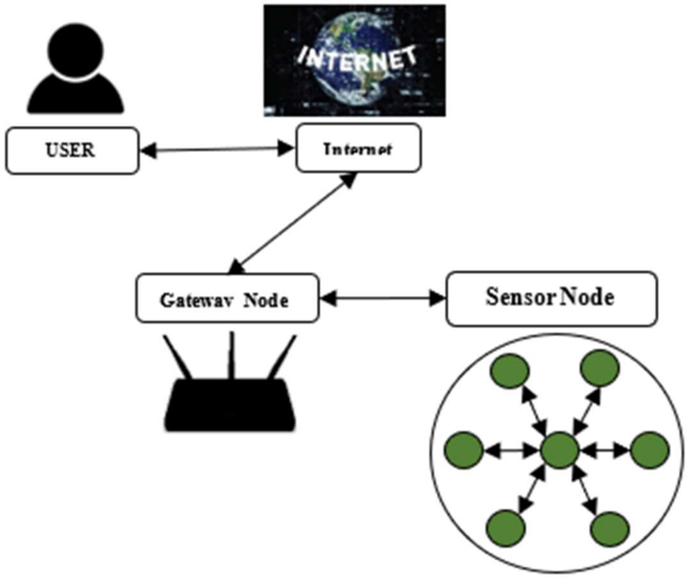


Figure 2. Wireless Sensor Network (WSN)

## V. BENEFITS AND DRAWBACKS OF WIRELESS SENSOR NETWORKS

The following table 1. summarizes the benefits and drawbacks of wireless sensor networks [11]:

| Benefits | Drawbacks |
| --- | --- |
| Network configurations are possible without the need for established equipment. | Lower safe because cybercriminals may get in contact with the entry node & obtain all of the data. |
| If an extra workspace is necessary on an ad hoc basis, be adaptable. | Extremely difficult to set up than a wired connection. |
| The cost of deployment is low. | Significantly influenced by the environment (walls, microwaves, long ranges owing to transmission loss, and so forth). |
| Suitable for inaccessible locations including such over sea, mountains, remote regions, or thick woods. | When compared to a wired connection, the performance is slower. |

## VI. APPLICATIONS OF WSN

WSN uses include tracking, analyzing, & regulating. WSNs are mostly used to observe habitats, identify objects, manage nuclear reactors, identify fires, or monitor transportation. Frequent use of WSNs is zone surveillance, in which the WSN is placed across a zone where an occurrence is to be tracked. Rather than employing landmines, a huge number of sensor nodes might be distributed across a battleground to identify hostile infiltration [12]. When the detectors identify the monitoring occurrence (temperature, pressure, noise, lighting, electromagnetic fields, vibrations, and so on), the occurrence must be relayed to another of the base stations, which may then take the necessary response. Wireless sensor networks are widely employed in the water and wastewater sectors. Commercial wireless I/O gadgets or sensor modules driven by solar modules and battery packages may be used to monitor operations that are not connected for current/information transfer. Wireless sensor networks may utilize a variety of sensors for detecting the existence of cars. Wireless sensor networks are indeed utilized to regulate the temperatures & moisture in business greenhouses [13]. Whenever the temperatures or moisture fall under certain limits, the greenhouse management may be warned through e-mail or SMS, or hosting equipment can activate sprinkling devices, open ports, switch on fans, or regulate a broad range of system reactions. While definite wireless sensor networks are easy to install, they are indeed simple to move as the system's needs alter.

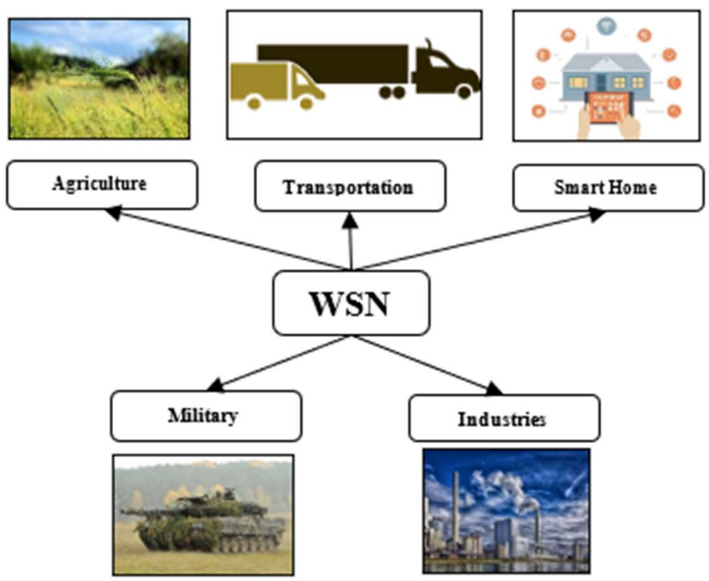


Figure 3. Applications of Wireless Sensor Network (WSN)

## VII. PROBLEMS IN SENSOR NETWORK ARCHITECTURAL & LAYOUT

The primary architectural aim of wireless sensor networks is to convey information while enhancing network lifespan and adopting power efficiency navigation methods. Various architecture & models were utilized in sensor networks based on the requirements. Similarly, the effectiveness of a transport method is determined by the network's structure & design, hence network structure or layout are critical elements of WSNs [14]. Several tough aspects influence wireless sensor network architecture, which should be solved before optimal networking can be established in WSNs. The next part attempts to outline the technical concerns & difficulties associated with WSNs.

- **Network dynamism:**

Because nodes in WSNs might be fixed or dynamical, network flexibility is a difficult problem. Usually, routing systems presume that sensor nodes & base stations are permanent, i.e., static, however, in the event of variable BS or nodes, pathways from one node to someone else should be provided within the networking regularly so that all endpoints may send information through the notified route. The detected occurrence might be dynamic or static, according to the applications [15]. The incident is continuous in object sensing systems, for instance, but forestry surveillance for advanced fire management is an instance of a static occurrence. Observing ambient occurrences is done responsively. Lively occurrences, in contrast, side, operate proactively.

- **Transmission of information:**

WSN information transfer is context-specific. It could be an ongoing, occurrence-based, search query, and mixed. Sensor nodes deliver information to the home stations regularly in the event of continuous information communication. Whenever an incident happens or a particular request is created by the base stations, information is sent to the base station in incident-triggered or query-based communication [16]. Because hybrid transmission combines continual, occurrence, or query-based communication, data transfer is a critical challenge for WSN structure & layout.

- **Merging of Information:**

Information merging is the technique of merging information from several origins based on some functionality. Signals manipulation approaches are used to accomplish this. Many networking systems employ this strategy to improve power conservation or information transmission performance [17]. Because sensor nodes receive information from several nodes, identical sequences may be merged, resulting in duplicate information. To prevent this duplicate information in the information fusing or information aggregating procedure, understanding is required.

- **Scalability:**

A WSN is made up of countless numbers of sensing networks. Forwarding methods should be capable to manage many of the sensing node's characteristics for the network's lifespan to be consistent with such a large number of components [18].

## VIII. NETWORKING APPROACH IN USE

### A. LEACH (Low Energy Adaptive Clustering Hierarchy)

LEACH is a clustered mechanism that self-organizes and adapts [19]. It distributes the power demand throughout the network's sensors via randomized. The LEACH methodology makes the following presumptions:

- Each node has the sufficient processing capability to handle several MAC schemes.
- Information from nodes near to one another is coupled.
- All nodes are capable of transmitting with sufficient energy to approach the foundation stations.

### B. TEEN (Threshold sensitive Energy Efficient sensor Network)

TEEN is a LEACH-based cluster-based hierarchy networking technology. This standard is designed for time-sensitive situations. It is based on 2 principles.

- The BS may immediately send information to all network nodes.
- The BS & sensor network both have identical beginning power.

### C. APTEEN (Adaptive Threshold TEEN)

APTEEN is an enhanced variation of TEEN that includes all of the TEEN's capabilities [20]. It was designed for mixed networking that collects simultaneously regular information as well as response to time-critical occurrences. APTEEN allows questions like as:

- A summary of the existing network perspective.
- Long-term surveillance of an occurrence.
- Previous information valuation assessment

### D. PEGASIS (Power efficient Gathering Sensor Information System)

PEGASIS is a near-optimal chain-based energy efficiency technique centered on LEACH. Based on this method, all nodes know approximately every others & may send material straight to the base station. PEGASIS implies that almost all sensing networks contain a similar amount of power & will probably expire at a similar moment [21]. Because all nodes are stationary and also have worldwide information about the networking, the chains could be simply formed using a pessimistic approach.

### E. SPIN (Sensor Protocols for Information via Negotiation)

SPIN is a group of adapting methods that employ information negotiations & resource-adaptive techniques. SPIN is an information transportation system. It is presupposed that:

- Information from nearby nodes is comparable.
- The show's endpoints are all base stations.

### F. DD (Directed Diffusion)

Directed diffusion seems to be a data-centric (DC) and enterprise application approach wherein sensing networks data is specified by ascribing pairs. It is made up of 4 components: passions, information transmissions, variations, or reinforcing [22].

### G. RR (Rumor Routing)

Rumor routing is a form of controlled dispersion that is employed in cases where geographical transportation is not possible. It mixes query flooding & incident drowning techniques randomly. It is predicated on the following suppositions:

- Only reversible linkages depart.
- It has a permanent architecture.

• Only relatively brief broadcasts are permitted.
• The network is made up of tightly spaced nodes.

### H. Geographic and Energy-Aware Routing (GEAR)

To determine the range connecting any 2 sensory nodes, location-based networking methods for sensor networks require position data from all sensor modules. GEAR is a location-based routing technology that employs GIS (Geographical Information System) to locate sensor components in a network [23].

### I. Geographic Adaptive Fidelity (GAF)

GAF is an excess power position route optimization technology. This procedure was designed for smartphone ad hoc channels, but it can also be used in sensing devices. GAF can be used for all these non-mobile as well as cell phone modules. Even though GAF is a proximity procedure, it can also be accomplished as a centralized procedure with clusters predicated on spatial position.

## IX. COMPARABLE RESEARCH

At this point, we are going to evaluate the routing protocols based on their achievement concerning a variety of variables [24]. The similarity is presented in Table 2.

The following table 2 provides a comparison of transit algorithms based on several factors.

| *Algorithms* | *Movement* | *Energy administration* | *The lifespan of a network* | *Scalability* | *Understanding of resources* | *Category* | *Information collection* | *Depending on a query* | *Technique* |
|---|---|---|---|---|---|---|---|---|---|
| ***LEACH*** | Fixed BS | Maximum | Very good | Good | Yes | Clustering | No | No | No |
| ***TEEN*** | Fixed BS | Maximum | Very good | Good | Yes | Reactive / Clustering | Yes | No | No |
| ***APTEEN*** | Fixed BS | Maximum | Very good | Good | Yes | Hybrid | Yes | No | No |
| ***PEGASIS*** | Fixed BS | Maximum | Very good | Good | Yes | Reactive / Clustering | Yes | No | No |
| ***SPIN*** | Supported | Limited | Good | Limited | Yes | Proactive/flat | Yes | Yes | Yes |
| ***DD*** | Limited | Limited | Good | Limited | Yes | Proactive/flat | Yes | Yes | Yes |
| ***RR*** | Very limited | Not support | Very good | Good | Yes | Hybrid/flat | Yes | Yes | No |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***GEAR*** | Limited | Limited | Good | Limited | Yes | Location | No | No | No |
| ***GAF*** | Limited | Limited | Good | Limited | Yes | Location | No | No | No |

**CONCLUSION**

In contrast to the typical method of information passing used in wired networks, the last several decades have seen a considerable focus placed on the transit of wireless sensor networks, which has created some new & interesting issues. The process of routing data in sensing nodes is a relatively recent topic of study. Because sensing nodes are developed for particular purposes, developing effective routing algorithms for sensor networking is of utmost significance. At the beginning of our research, we performed an exhaustive analysis of the various routing strategies that may be used in wireless sensor networks. Just on basis of the overall method of operation as well as the kinds of purposes they are designed to serve, the routing strategies may be divided into three categories: proactively, responsive, & mixed. In addition, these techniques may either be straight communications, flat procedures, or clustered procedures, depending on the type of engaging nodes. Similarly, according to the architecture of the system, they are classified as structured, information, or location-based, respectively.

**REFERENCES**

[1] V. Panwar, D.K. Sharma, K.V.P.Kumar, A. Jain & C. Thakar, (2021), “Experimental Investigations And Optimization Of Surface Roughness In Turning Of EN 36 Alloy Steel Using Response Surface Methodology And Genetic Algorithm” Materials Today: Proceedings, https://Doi.Org/10.1016/J.Matpr.2021.03.642

[2] M. Mansouri, "Optimal sensor and path selection for target tracking in wireless sensor networks", Wireless Communications and Mobile Computing, vol. 14, no. 1, pp. 128-144, 2012. Available: 10.1002/wcm.1241.

[3] Y. TANG and F. HU, "Theft detection based on Omni-directional vision sensors", Journal of Computer Applications, vol. 30, no. 1, pp. 36-40, 2010. Available: 10.3724/sp.j.1087.2010.00036.

[4] A. Jain, A. K. Pandey, (2019), “Modeling And Optimizing Of Different Quality Characteristics In Electrical Discharge Drilling Of Titanium Alloy (Grade-5) Sheet” Material Today Proceedings, 18, 182-191 https://doi.org/10.1016/j.matpr.2019.06.292

[5] D. GEORGOULAS and K. BLOW, "Wireless Sensor Network Management and Functionality: An Overview", Wireless Sensor Network, vol. 01, no. 04, pp. 257-267, 2009. Available: 10.4236/wsn.2009.14032.

[6] A. Jain, A.K.Yadav & Y. Shrivastava (2019), “Modelling and Optimization of Different Quality Characteristics In Electric Discharge Drilling of Titanium Alloy Sheet” Material Today Proceedings, 21, 1680-1684 https://doi.org/10.1016/j.matpr.2019.12.010

[7] K. Sakib, "Asynchronous failed sensor node detection method for sensor networks", International Journal of Network Management, vol. 22, no. 1, pp. 27-49, 2011. Available: 10.1002/nem.782.

[8] D. R, "Cluster Head Election in Wireless Sensor Network", Journal of Advanced Research in Dynamical and Control Systems, vol. 12, no. 7, pp. 586-592, 2020. Available: 10.5373/jardcs/v12sp7/20202144.
[9] A. Ghosal and S. Halder, "Lifespan prolonging location-wise predetermined deployment strategy for visual sensor networks", Journal of Network and Computer Applications, vol. 63, pp. 86-97, 2016. Available: 10.1016/j.jnca.2015.12.017.
[10] A. Jain, A. K. Pandey, (2019), "Modeling And Optimizing Of Different Quality Characteristics In Electrical Discharge Drilling Of Titanium Alloy (Grade-5) Sheet" Material Today Proceedings, 18, 182-191 https://doi.org/10.1016/j.matpr.2019.06.292
[11] L. Lombardo, "Distributed Measurement Systems: Advantages and Challenges of Wireless Sensor Networks", IEEE Instrumentation & Measurement Magazine, vol. 25, no. 4, pp. 21-28, 2022. Available: 10.1109/mim.2022.9777775.
[12] V. Panwar, D.K. Sharma, K.V.P.Kumar, A. Jain & C. Thakar, (2021), "Experimental Investigations And Optimization Of Surface Roughness In Turning Of EN 36 Alloy Steel Using Response Surface Methodology And Genetic Algorithm" Materials Today: Proceedings, https://Doi.Org/10.1016/J.Matpr.2021.03.642
[13] Y. TAO, X. ZENG and W. LUO, "Study and improvement on coverage control algorithm in WSN", Journal of Computer Applications, vol. 30, no. 6, pp. 1459-1462, 2010. Available: 10.3724/sp.j.1087.
[14] Monika, Mamta, and N. Goyal, "Architectural Analysis of Wireless Sensor Network and Underwater Wireless Sensor Network with Issues and Challenges", Journal of Computational and Theoretical Nanoscience, vol. 17, no. 6, pp. 2706-2712, 2020. Available: 10.1166/jctn.2020.9109.
[15] L. Cai, "Research of Optimizing Computer Network Based on Dynamism Theory", Applied Mechanics and Materials, vol. 556-562, pp. 5356-5358, 2014. Available: 10.4028/www.scientific.net/amm.556-562.5356.
[16] A. Jain, A. K. Pandey, (2019), "Multiple Quality Optimizations In Electrical Discharge Drilling Of Mild Steel Sheet" Material Today Proceedings, 8, 7252-7261 https://doi.org/10.1016/j.matpr.2017.07.054
[17] J. Kim, H. Kwon, D. Shin, and S. Hong, "A WSN(Wireless Sensor Network) Building Scheme using Clustering and Location information", Journal of Information and Security, vol. 20, no. 3, pp. 13-20, 2020. Available: 10.33778/kcsa.2020.20.3.013.
[18] A. Jain, C. S. Kumar, Y. Shrivastava, (2021), "Fabrication and Machining of Fiber Matrix Composite through Electric Discharge Machining: A short review" Material Today Proceedings https://doi.org/10.1016/j.matpr.2021.07.288
[19] D. . and A. Sangwan, "Review on LEACH (Low Energy Adaptive Clustering Hierarchy) Protocol for Enhancing Energy Efficiency of WSN", International Journal of Computer Sciences and Engineering, vol. 7, no. 4, pp. 41-43, 2019. Available: 10.26438/ijcse/v7i4.4143.
[20] B. Parmar and J. Munjani, "Analysis and Improvement of Routing Protocol LEACH using TEEN, APTEEN and Adaptive Threshold in WSN", International Journal of Computer

Applications, vol. 95, no. 22, pp. 5-9, 2014. Available: 10.5120/16724-6790.
[21] N. Meghanathan, "Use of Tree Traversal Algorithms for Chain Formation in the PEGASIS Data Gathering Protocol for Wireless Sensor Networks", KSII Transactions on Internet and Information Systems, 2009. Available: 10.3837/tiis.2009.06.003.
[22] S. DU, "Application of passive clustering in directed diffusion algorithm", Journal of Computer Applications, vol. 28, no. 2, pp. 402-405, 2008. Available: 10.3724/sp.j.1087.2008.00402.
[23] H. Huang, G. Hu and F. Yu, "Energy-aware geographic routing in wireless sensor networks with anchor nodes", International Journal of Communication Systems, vol. 26, no. 1, pp. 100-113, 2011. Available: 10.1002/dac.1335.
[24] "A comparative study on energy-efficient clustering based on metaheuristic algorithms for WSN", International Journal of Advanced Technology and Engineering Exploration, vol. 9, no. 86, 2022. Available: 10.19101/ijatee.2021.874823.