

WSN: QoS Analysis Using Machine Learning Techniques

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Abstract: In nature, a wireless sensor network circulates, is self-directed, and distributed. A wireless sensor network (WSN) is a type of network that consists of several nodes that are wireless sensors connected to a base station. WSN has been popular in recent years for sensing crucial information and communicating it to the destination via the base station. It is vital to use the most efficient path and make proper use of the available resources in this transmission. In general, nodes in a WSN have energy restrictions; in the absence of an efficient way, the network lifetime is extended, resulting in severe consequences. The widespread adoption of WSN and its importance in practical applications has heightened interest in the research field. Several traditional methodologies were developed for WSN with the goal of conserving energy. The majority of present options are reactive, centrally managed, one-size-fits-all solutions. However, in terms of cost-effectiveness and optimization, these are insufficient for fulfilling and serving future complex networks. Hierarchical routing techniques are hence effective in terms of energy efficiency. These hierarchical protocols collect and disseminate data using a clustering approach. This technique is still in development because to the necessity for large amounts of data to be processed on WSN both sending and receiving. Bandwidth, sensor energy use, and time consumption are all significant factors to consider during the WSN process. To address these challenges, an effective ML (machine learning)-based method must be developed in order to improve the WSN characteristic in every way. The major goal of this review paper is to show that machine learning is a feasible solution to solving WSN difficulties, particularly in terms of energy efficient routing.

Keywords: *Wireless sensor network, Artificial intelligence, machine learning, neural network, routing, evolutionary algorithm*

1. INTRODUCTION

Wireless sensor networks are made up of nodes, which are a collection of diverse dispersed sensors. By way of a wireless link, this network of devices is well connected to one another. It is mostly used for communication, sending and receiving data from a source to a destination. Because it is wireless, it chooses the closest neighbor node and sends the data till it reaches its destination. These WSNs are frequently used for two purposes: monitoring and tracking [13]. WSN is primarily utilized in tracking applications to track animals, enemies, humans, traffic, cars/buses, and other objects. Sensor nodes are responsible for monitoring animal/patient movement, security detection, and the environment in monitoring applications. The WSN structure is depicted in detail in Fig 1.

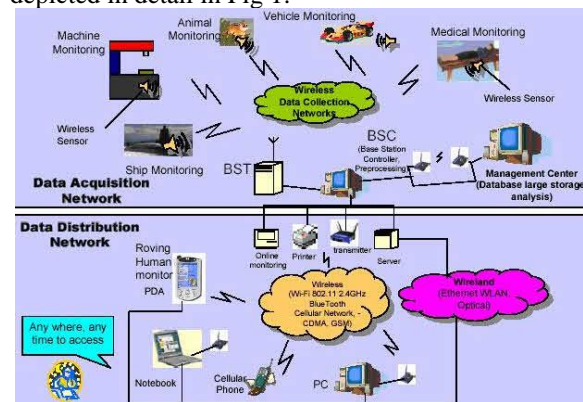


Fig1: Wireless sensor network

The communication in a WSN is handled by transmitting and receiving data between the nodes. In order to complete this procedure properly, a well-known routing protocol is required for determining the appropriate routing path. Topology can be used to create a network connection. Star, tree, and mesh topologies are the most common WSN topologies. The topology for communications is chosen based on the process's reliance. The environment of a WSN determines whether the network will be installed underwater, underground, on land, and so on. The following is a list of WSN types:

- Terrestrial WSNs
- Underground WSNs
- Underwater WSNs
- Multimedia WSNs
- Mobile WSNs

WSN Architecture:

Five levels and three cross layers completes the WSN architecture. These five layers are extremely significant in sensor networks: application, transport, network, data connection, and physical layer. The three cross planes of the WSN are power management, mobility management, and task management. The WSN architecture is detailed in detail below.

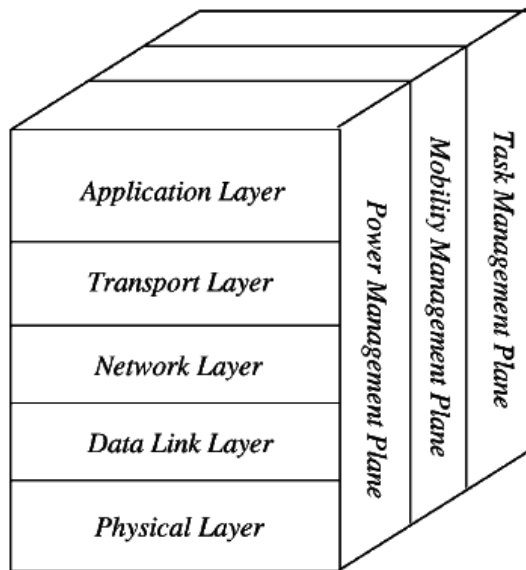


Fig 2: Wireless Sensor Network Architecture

Application layer:This layer manages traffic and allows many applications to send data in a clear style so that good information may be found.

Transport layer:This layer keeps track of the network's connection plans. It operates on the basis of a protocol that determines where data should be sent and received. The data is divided into two categories: packet-driven and event-driven. STCP (Sensor Transmission Control Protocol), PORT (Price-Oriented Reliable Transport Protocol), and PSFQ (Price-Oriented Reliable Transport Protocol) are three common transport layer protocols (pump slow fetch quick).

Network layer:This layer's main responsibility is to conduct routing, which includes a variety of functions. This layer is responsible for power conservation, partial memory, buffers, and sensor self-organization, among other things.

Data link layer:This layer is in charge of preserving point–point (or) point–multipoint reliability, as well as multiplexing data frames, data streams, MAC, and error control.

Physical layer:Frequency selection, signal detection, modulation, and data encryption are all performed in this layer, which has an impact on WSN cost, power consumption, and density in order to extend battery life.

Minimal computational and memory requirements, energy efficiency, traffic patterns, automaticity, self-organization, scalability, and network support are the primary variables that influence the development of a significant routing protocol. Furthermore, limited battery capacity and exchangeability energy are crucial factors that affect routing. In a WSN, Energy Efficient Routing (EER) is critical for maximizing lifetime performance. The routing protocol achieves this by utilizing clusters, and popular cluster-based energy efficient protocols include LEACH, PEGASIS, and TEEN.

- Common limitations in WSN:
- Possess very little storage capacity
- Possess modest processing power
- Processing in short communication range – consumes a lot of power
- Requires minimal energy – constrains protocols
- Have batteries with a finite lifetime
- Passive devices provide little energy

The following is a summary of the paper's structure: We discussed related work and EER in WSN in section 2. The various EER algorithms in WSN are presented in Section 3. Section 4 discusses numerous factors that affect EER protocols, as well as tables that show an overview of existing methods, algorithms, and characteristics, and section 5 concludes.

2. RELATED WORKS:

Mingzhe Chen et presented a comprehensive research of QOS in next-generation wireless networks at [1. According to the author, artificial intelligence (AI) and machine learning can be used to improve service quality as the number of IoT devices grows in real time. The author presents numerous key ideas of machine learning and artificial neural networks (ANNs) in his study, particularly in wireless network applications. His paper succinctly outlines the basic architecture and training technique of neural networks, as well as the obstacles and opportunities that come with them. The author concludes that ANN (Artificial neural network) will be a finite solution for a range of wireless communication problems.

[2] X. Cheng et presented his study on a new domain known as MBD (Mobile Big data). The author's

research focuses on the massive amounts of data created by diverse mobile sources such as sensors, IoT, and smartphones. The author discusses the problems of scalability, cost-effectiveness, reliability, analytics, and security in the mobile context. The author proposed using a thematic taxonomy approach to categories MBD based on data type, source, characteristics, applications, analytics, and security.

A comprehensive survey on machine learning for networking was presented by RaoufBoutaba and colleagues [3]. The author claims that ML (machine learning) can solve real-time challenges in WSN while also enabling automation. The author provides a quick outline of complicated difficulties that arise in network operation and administration in his survey. A defined learning paradigm, as well as machine learning techniques, are required to address fundamental issues such as QoS and QoE management, resource and fault management, traffic prediction, routing and classification, congestion control, and network security.

2.1 Energy Efficient Routing:

Computing a valid transmission path is critical in a WSN. Routing protocol performance is largely determined by the network's architecture and design. The lack of a dependable protocol has a significant impact on the amount of energy consumed on data transmission. Restricted resource constraints, poor storage capacity, limited communication bandwidth, low processor speed, and limited battery power are all common issues that WSN devices face in real time.

The major three tactics in routing protocol, proactive, reactive, and hybrid, were presented by K. Akkaya et al [4]. The proactive technique uses the routing table of all sensor nodes in the network to explain the routing information. The reactive approach is an on-demand method in which a protocol counts the shortest hop from the target node sending the packet to the destination. The hybrid strategy incorporates the best aspects of both proactive and reactive techniques. The hybrid strategy can be utilized both within and across clusters.

Sensing, Processing, and Communication are all essential factors in WSN energy usage, according to Daniel Minoli et al. [5]. The energy used by the node in sensing node actions such as periodic, awake/sleep, and so on is referred to as sensing energy consumption. The amount of processing energy used during sensor control, protocol transmission, and data processing. Sleep, idle, and run are the three major stages of energy processing.

The energy required for data transmission from source to destination is referred to as the communication process. L. Junhai et al. [6] presented their work on WSN based on Machine Learning techniques. The author focused on two primary issues: network-related problems and application-related problems. Optimal node placement, localization, security, energy-aware routing and clustering, QoS, resource allocation, data aggregation and fusion, and scheduling are all network-related concerns. Information processing, event classification and target class identification, and target tracking are examples of application-related issues. A fuzzy-based hybrid EER method was presented by Zohre and Arabi et al [7]. Fuzzification, inference engine, and defuzzification are the three key operations that make up a fuzzy logic system. For data dissemination and cluster head selection, the author uses two algorithms: EF-Tree (Earliest-First Tree) and SID (Source-Initiated Dissemination). The cluster head is in charge of the path using fuzzy variables in routing. The SID, EF-Tree, and Fuzzy techniques are in charge of route switching based on the conditions. The major goal of this project is to improve energy efficiency and network longevity.

ToleenJaradat et al. [8] offered a cross-layer approach to an energy sensitive routing method. Her work's main goal is to reduce total energy consumption while also extending network longevity. The author used the transmission power of the nodes in the local communication range to estimate the next hop relay node to reach the target in this study. To measure the fluctuating parameters, the author uses a self-adaptive technique based on a fuzzy control algorithm. The author also discusses her work on scalability, self-learning, and the overall network's durability. Neeraj Kumar et al. [9] developed a methodology for overcoming EER difficulties using NN. In order to increase the network lifetime, the author mixes NN (neural network) with the cluster. He solves the problem by using linear programming with some constraints. Adaptive learning is in charge of the cluster head in the neural network, which is where routing and data transmission takes place.

Wenhui Zhao et al. [10] introduced an advanced self-organizing NN in a WSN that optimises the routing process based on the energy and compute power of each node. The author proposed a Hop Field Neural Network for determining the convergicast path with the least amount of power in this paper. On high-speed sensor networks, this convergicast routing algorithm is particularly effective.

3. CONCLUSION

- **Node Deployment:** This is an application-based process that has a randomized or deterministic effect on routing.
- **Node-Link Heterogeneity:** The set of sensors in a heterogeneous system poses a number of technological challenges in terms of data routing.
- **Data Reporting Model:** Time-driven, event-driven, query-driven, and hybrid data reporting are all options. Only measurement, data sensing, and reporting will be done according to the application, which adds to the time complexity.
- **Energy Consumption without Dropping Accuracy:** Complicate the process of energy-saving processing and data communication systems.
- **Scalability:** With a large number of sensor nodes, the routing takes longer to respond to events.
- **Network Dynamics:** Sensor mobility is especially important for scenarios in which most network topologies assume sensor nodes are immobile.
- **Fault Tolerance:** Sensor node failure causes a delay in the overall WSN operation.
- **Connectivity:** Sensor node connection is determined by the random distribution of sensor nodes in a sensor network.
- **Transmission Media:** The network connection in a multi-hop WSN is made over a wireless medium. It suffers network interoperability issues, similar to IEEE 802.11.
- **Coverage:** The network environment in which the sensor nodes are connected is limited in both precision and range, and can only cover a partial range.
- **Quality of Service:** Transmission time, in which the transmission must be completed within a certain amount of time. In terms of application variance, the network longevity is influenced by the quality of the data sent, as well as the maintenance of energy.
- **Data Aggregation:** Data aggregate is the process of combining data from many sources in order to complete a specific aggregation task.

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