A Review of MANET Routing Protocols and Machine Learning Techniques

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ABSTRACT - A wireless, temporary network known as a mobile ad hoc network (MANET) is one in which nodes exchange radio or microwave signals with one another. Decentralized control, changeable topology, and the absence of infrastructure are characteristics of MANET. Routing is a difficult task in MANET due to the high node mobility. There may be occasions when a path failure minimal the network's performance. In this work, we reviewed the routing protocols that are widely applied in MANET. We also covered performances including throughput, end-to-end delay, routing overhead, packet losses, and packet delivery ratio, as well as machine learning methods like regression, classification, clustering, and correlations.

KEYWORDS- MANET, supervised Learning, unsupervised Learning, reactive Routing, proactive Routing, hybrid Routing

I. INTRODUCTION

Wireless networks are computer networks that utilize radio or microwave waves to communicate between network devices. The two different kinds of wireless networks are infrastructure established networks and infrastructure-less networks that are shown in Figure 1. The wireless networks having infrastructure (like GSM and WLAN networks), the access points act as a conduit for communication between the nodes. Nodes in infrastructure-less or ad-hoc networks can connect with each other using wireless links. There are several forms of ad-hoc networks, including MANET, WSN (Wireless Sensor Network), WMN (Wireless Mesh Network), and VANET (Vehicular Ad-hoc Network) [12].

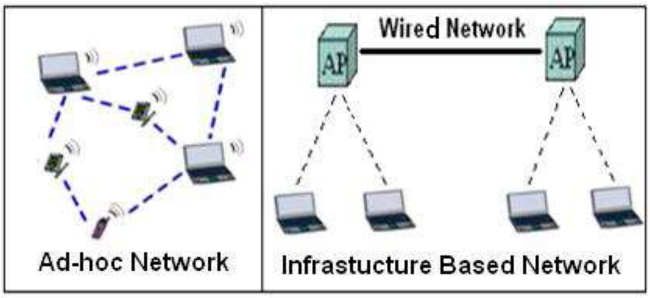

Figure 1: Types of Wireless Networks: Ad-hoc & Infrastructure based

Less infrastructure, decentralized control, changeable topology, and constrained bandwidth and storage are some characteristics of the MANET network. As they are constantly moving, the nodes in such a network can communicate with one another via wireless links. There are no specific base stations, wires, routers, servers, or access points. They can use an intermediary device or the devices that are inside their radio range to relay or forward communications to the devices outside of their range if they want to communicate with those that are farther away [13].

The major subjects of this study are the MANET routing protocols and machine learning algorithms. Routing in MANET is a difficult problem because of the movability of nodes, decentralized control, and dynamic topology. Routing protocols offer the path from the source to destination. The main goal of this study is to review routing protocols.

II. LITERATURE SURVEY

In our review of literature, we go through some earlier research that some researchers have done in the area of MANET routing protocols. The majority of researchers used machine learning techniques in MANET to detect intrusions and identify other security assaults. These methods can also be applied to dynamic routing.

Trivedi and Sharma [10] employed the Particle Swarm Optimization (PSO) strategy to assess the MANET's quality of service. Java is a computer language that is used to implement optimization strategies and evaluate AODV performance. Its output value is fed into the NS2.35 network simulator tool as an input. The PSO-based algorithm outperformed the simple AODV routing protocol in terms of average point-to-point delay, packet delivery ratio and a network routing load. Ayushree and Balaji used machine learning to determine the optimum route in MANET [9]. The NS2 simulator is integrated for an evaluation, and the AODV routing protocol is used for packet routing. Machine learning techniques are used to identify network assaults and look for the best route for sending packets from source to destination. The throughput and packet delivery ratio of routing protocols have both increased as a result of the suggested approach. Chatterjee and Saha [8] accurately predicted the magnitude of the weights required for non-identical network topologies in MANET using software. Artificial Neural Network guided this model. The trained ANN model assessed a number of inputs, including battery power, movability, packet drop rate, the total number of nodes and a degree of neighbours, in order to accurately estimate the right weight parameters in a variety of circumstances. The model accurately identified the best weight parameter that would provide systematic routing in MANET and shown favourable results in forecasting output values. By expanding the ring search mechanism (ERS) and Random early detection (RED) techniques, Durr-E-Nayab et al. [7] presented machine learning algorithms for choosing the proper routing parameters and protocol. The techniques for linear regression (LR), K-nearest neighbours (KNN), decision trees (DT), support vector machines (SVM) and artificial neural networks (ANN) are used to estimate the end-to-end delay, a packet delivery ratio, and throughput characteristics. KNN has the least level of error when compared to DT. SVM, LR, and ANN all generated results that were comparable. While ANN offered a better packet delivery ratio and LR showed the least amount of end-to-end latency, SVM and LR delivered better throughput outcomes. Kurkina et al. [6] contrasted the machine learning approaches with the help of MATLAB. The Naive Bayes Classifier (NBC), Classification Tree (C Tree), K-nearest Neighbours (KNN), Multinomial Logistic Regression (MLG), Artificial neural network (ANN), and Random Forest (R Forest) methods were tested using datasets on wine quality, wine, and the ionosphere. The results showed higher accuracy due to the Random Forest technique's low error probability and high F1 score precision and responsiveness values. Ramesh Babu et al. [5] provided descriptions of the three machine learning algorithms Naive Bayes (NB), Genetic Algorithm (GA) and Artificial Neural Network (ANN). for minimizing routing overhead in MANET using the MATLAB simulator. In comparison to ANN and NB, GA demonstrated greater network longevity and throughput. In comparison to GA and NB, ANN demonstrated lower latency. GA performed better than ANN and NB. Gandhi et al. [4] presented the Ant Colony Optimization technique and the Harmony Search technique in order to lower MANET energy usage. The ACO-HSA based network has greater residual energy than the ACO based network, according to the results of the NS2 simulator. Manohar P. M. [11] enhanced the efficiency of DYMO routing protocol in MANET by employing other machine learning techniques for linear regression. The machine learning-based strategy (ML-DYMO) was superior at delivering packets, enhancing throughput, lowering end-to-end delay, and decreasing routing overhead, according to the results of the NS2 simulator. Hadi et al. [2] evaluated the AODV, DSR and DSDV MANET routing protocols by combining the Cat and Particle Swarm Optimization algorithms. According to the outcomes of the NS2 simulator, the suggested CPSO-based solution reduced latency and packet loss while increasing packet delivery ratio. Li et al. [1] presented a deep reinforcement learning-based collaborative routing algorithm. The proposed algorithm was contrasted with the greedy and shortest-path algorithms. By adjusting the network load to minimize congestion, this technique demonstrated the least amount of end-to-end latency while also improving resource consumption.

III. MANET ROUTING PROTOCOLS

The routing protocol is a procedure for managing and transferring network traffic from one device to other. The two types of traditional routing algorithms used in wired networks are link-state and distance vector algorithms (DVA). In link-state routing, each node uses a flooding approach to regularly transmit the most recent network information to all other nodes. Numerous number routing systems have been offered as solutions to the issues with the link-state and distance-vector algorithms. Figure 2 illustrates how these routing techniques can be broadly divided into two groups: flat routing and hierarchical routing. Furthermore, both proactive and reactive routing are offered. In hybrid protocols based on hierarchical routing, proactive and reactive protocols are integrated. Table-driven routing and wireless packet transmission are equivalent. But on-demand routing protocols only find a path when a source node needs to connect to a destination node. [13].

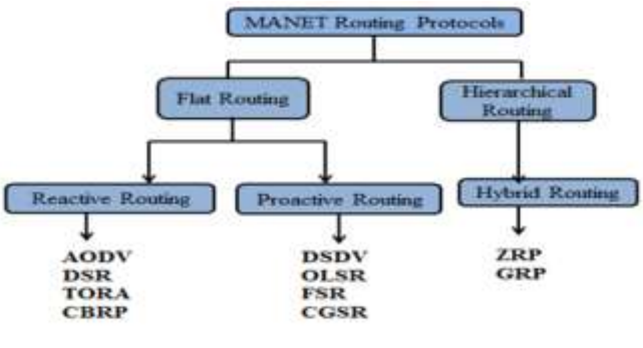

Figure 2: A Classification of MANET Routing Protocols

- **Reactive Routing Protocols:** These protocols only construct new routes when they are necessary. In other words, it initiates the route discovery process in preparation for transferring packets from one end to the other. The reactive routing protocols that are now in use are AODV, DSR, TORA, and CBRP [13].
- **Proactive Routing protocols:** These protocols require that every node in the network maintain routing tables containing contact information for other nodes. These protocols include DSDV, OLSR, FSR, and CGSR, among others [13].
- **Hybrid Routing Protocols:** These protocols include proactive and reactive elements. ZRP and GRP are two instances [14].

IV. MACHINE LEARNING TECHNIQUES

Machine learning, a fast-developing field of technology, enables computers to comprehend independently using current data. Numerous sorts of algorithms are employed to build mathematical models and generate projections based on historical data or information [15]. Several categories can be used to categorize machine learning algorithms, as shown in figure 3.

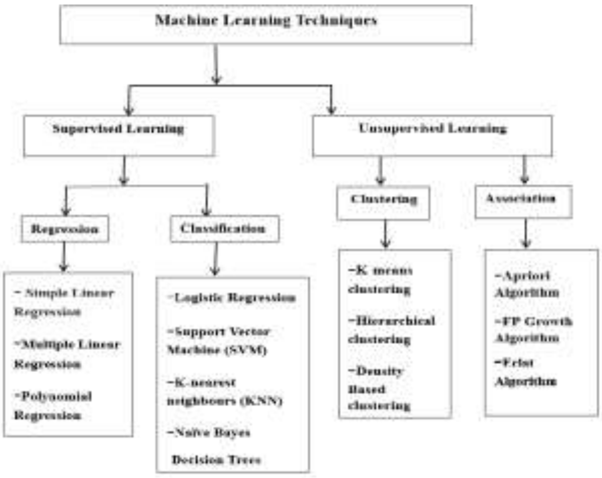

Figure 3. Machine learning methods using supervised and unsupervised learning

When a sizable amount of training data has already been analysed and is used as the basis for finishing a specific task, supervised learning techniques are used. Common supervised learning techniques consist of:

- **Linear regression:** The equation y = ax+b, where a and b are the variables, the model will try to evaluate and x is the input data, is used to represent the model in a linear regression.

- **Multiple Linear Regression:** It is a simple linear regression enhancement in which numerous independent factors are used to predict the feedback variable.

  y = A + B1x1 + B2x2 + B3x3 + B4x4 ...

  A is the estimated intercept, while B1, B2, B3, and B4 are the slopes or coefficients pertaining to these independent features [15].

- **Polynomial Regression:** It is a regression procedure that calculates the correlation as an nth degree polynomial between a dependent (y) and independent (x) variable. Below is a discussion of the polynomial regression equation [17]:

  $y= b_0+b_1x_1+ b_2x_1^2+ b_2x_1^3+...... b_nx_1^n$

- **Support Vector Machine:** The supervised machine learning method, SVM, is applied to best elaborate each observation from a given set. Routing, localization, fault detection, blockage and communication problems are just a few of the challenges that SVM is used to address in WSNs [18].

- **K-Nearest Neighbour:** The regression and classification issues are solved via the KNN technique. KNN is primarily responsible for explaining the difference between the provided and the model being measured. The readings are lowered, thus the lost samples from the highlighted rooms are discovered. Data gathering and inconsistency detection were used to show KNN in WSN applications [18].

- **Naive Bayesian Learning:** This mathematical method uses a variety of statistical methods to learn conditional dependency and then use that knowledge to find connections between the data. Numerous issues with routing, data placement, aggregation, fault prediction, connection, and coverage were found in WSNs using the Bayesian learning method [18].

- **Decision tree:** It is a flow diagram like schema that uses bifurcated method to emphasize each feasible end result of a choice. The tree's nodes represent conditional tests of certain variables, and each branch represents the results of those tests [19]. The benefits of decision trees include detailed decision-making analysis, transparency, and reduced complexity. These are utilised to address various WSN complications such as data aggregation connectivity.[18].

Unsupervised Learning Techniques: It examines untagged datasets and conducts independent relationship searches using learning approaches. These methods are employed to address issues like clustering and dimensionality reduction [19].

- **K-mean clustering:** Finding the k number of clusters in input space is done iteratively. A-priory is used to define the number k. In the feature space, the cluster centroid serves as a representation for each cluster. Since there is only one cluster that connects all of the data, the clusters are discontinuous and cover the whole feature space [20].
- **Density Based Algorithm:** Density-based method can recognize dense data areas. Density can refer to proximity of data point to the Gaussian mean or to the dense cluster of neighbouring data points. However, it won't function well if the groups are dispersed, overlapping moderately or have dramatically non-identical densities [21].
- **Apriori Algorithm:** It is used to locate all frequently occurring item sets in the database and is easy to execute. The technique does numerous database searches to identify common item sets that are utilized to construct k+1-itemsets from k-item sets. The minimum support criterion for each k-itemset can be more than or equal to the frequency [22].
- **FP-growth Algorithm:** It is the apriori algorithm's development. The FP-growth algorithm thus fixes the faults of this algorithm. It is a different approach that may be used to identify the data set that appears in a data “collection” the most frequently [23].
- **ECLAT Algorithm:** A data mining technique called ECLAT (Equivalence Class Clustering and Bottom-up Lattice Traversal) is utilized to discover common items and acquire access to element sets [24].

V. SUMMARY AND FUTURE PERSPECTIVE

This study provides a detailed explanation of MANET routing protocols, machine learning methods and the categorization of routing protocols that are flat and hierarchical based on routing approach. Additionally, we have discussed supervised and unsupervised machine learning methods. It is unclear whether routing protocol is optimal in all situations due to MANET characteristics including changeable topology, decentralized management, and lack of fixed infrastructure. The study of efficient and effective routing methods is expanding quickly. Future research will focus on a few problems, including security, scalability, traffic, and power. Using machine learning, we can make MANET more scalable, safe, and power-efficient.

VI. REFERENCES

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