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Overview of Routing in MANET using Soft Computing Approaches

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Abstract: Mobile Ad-hoc Network is a collection of mobile nodes that dynamically create a wireless network amongst them without using any infrastructure. In such an environment, it may be necessary for one mobile host to enlist the aid of other hosts in forwarding a packet to its destination, due to the limited range of each mobile host's wireless transmissions. In any network, Quality of Service is the basic requirement and when we talk about the MANET this is the highly constraint requirement of the user. To improve QOS and send information to each and every node present in the network it requires different soft computing approaches. In this approaches, different soft computing protocols and algorithms need to be considered. There are various routing algorithms, protocols, parameters that need to be considered for reaching to the destination. In this paper, we provide a comprehensive review of existing work done on Routing in MANET using various soft computing approaches. Then to improve QOS and to send information to nodes which parameters, algorithms should be covered. Next, we discuss about the various algorithms and protocols through which Routing in MANET is carried out to reach to the destination.

Keywords: Mobile Ad-hoc Network, Fuzzy improved genetic approach, neural network, routing protocol, wireless mesh network.

I. INTRODUCTION

New implementations of wireless networking are increasing drastically in the modern society [1]. In modern communication networks, particularly in packet switched networks, routing is an important process that has a significant impact on the network's performance. Enabling Internet connection in rural area, or anywhere else where some physical obstacles exist, signal degradation, multiple fading effect, low coverage of mobile base station, poor infrastructure or similar, can be potentially solved by specific ad hoc networks implementations [2]. One of the most used one is a mobile ad-hoc network (MANET). Through this node all network traffic received by other network routes will be sent. Fluctuations in number of users have influence on a rapidly changing topology. These changes occur randomly and dynamically. To provide better QOS and other parameters there are various routing algorithms and various soft computing techniques are used:

1. Neural Network
2. Wireless Mesh Network
3. Fuzzy based Genetic approach

Above three soft computing techniques uses different soft computing technique protocols for establishing the link between the nodes in minimum time and to improve QOS. The integration of an ad-hoc network with a bigger network- such as the Internet-or wireless infrastructure network increases the coverage area and application domain of the ad-hoc network. Mobile

ad-hoc sensor networks are very beneficial in different scenarios. Wireless Ad Hoc Networks (MANETs for short) [8] are characterized by their mobility, ease of deployment, self-configuration without a centralized administration and ability of nodes to communicate with each other even in out-of-range conditions with intermediate nodes performing the routing functions. MANETs are also flexible enough to get connected to cellular as well as wired networks.

The efficiency of a routing protocol [14] (at the outermost level) is directly related to numerous factors such as node mobility, dynamic topology, the communication capabilities of the nodes, power consumption issues, bandwidth constraints, traffic congestion, security and a host of other related parameters, all of which have to be well orchestrated to achieve an optimal performance that is adequate at the minimum level.

There are other various approaches and various soft computing approaches for routing in MANET. In these approaches, various routing algorithms, protocols have been used to send packets to every node and to improve QoS. Section 2, introduces related work done on Routing in MANET using soft computing approaches. Section 3, illustrates the various soft computing approaches and their parameters. Section 4 discusses the routing algorithms and protocols used in above approaches. Section 5 concludes this paper with some suggestions for further improvement.

II. RELATED WORK

Many proposals and models addressed quality of service (QoS) among mobile nodes of the wireless networks and considered the link quality in their designs and architectures.

In the year 2012, author Parimal Kumar Giri has proposed the neural network based approach for MANET [14]. He found a number of attempts using neural networks, namely Hopfield Neural Networks (HNNs), were made to solve or provide an approximate solution to the Shortest Path problem faster than would be possible with any algorithmic solution, relying on the Neural Networks (NNs) parallel architecture.

In the year 2011, authors Siddesh.G.K et al. [17] have proposed routing in ad-hoc wireless network using soft computing techniques like neural networks, fuzzy logic and genetic algorithm. In this work, they have performed simulation using hyper net simulator for various existing protocols like proactive routing, reactive routing, power aware routing protocol, hybrid routing. Authors have concluded that it appears reasonable to assume that the essential ingredients of artificial neural network with Fuzzy Logic and Genetic Algorithms go a long way in improving the performance of protocol in very dramatic terms.

In the year 1989, authors Park and Choi have also proposed one algorithm [10][16] but it has limitation that algorithm fails to coverage too many times. It has poorer behavior with increasing no. of graph nodes. In the year 2010, authors Nenad S. Kojić et al. [12] have proposed neural network based approach to routing protocol for wireless mesh networks. In this work, authors have presented new algorithm for wireless network. Starting from characteristic of MANETs and especially based on WMNs, routing algorithm offers the new way of protocol organization and metric in use. In this paper, authors have realized routing protocol through two independent procedures. They have done lot of simulations for different types of network topology and network's parameters.

In year 2005, Rauch and Winarske authors have proposed an algorithm in the year 2005, but it has limitation that it needs to know the number of hops required for shortest path in advance [9][14].

In the year 2013, authors Sharad Sharma et al. [16] have presented routing in wireless mesh networks using two soft computing based approaches like *Biogeography Based Optimization (BBO) approach and Big Bang Big Crunch (BB-BC) approach*. They have proposed routing algorithms which find the optimal shortest path taking into account three most important parameters of network dynamics. They have also further observed that for the shortest path problem BB-BC outperforms BBO in terms of speed and percent error between the evaluated minimal path and the actual shortest path. Authors have established the superiority of BB-BC over BBO for finding the optimal path in a WMN.

Authors G. Ilanchezhiapandian et al.[3] have proposed one protocol to improve quality of service. They have proposed cross layer approach using AODV protocol. The proposed cross-layer mechanism utilizes Signal to Noise Ratio (SNR) measurements along the routing path and selects the path with high quality of service rather than the path with minimum number of hops. In this paper, authors have presented cross- layer Ad-hoc On-demand Distance Vector Routing protocol (CLAODV) to improve the performance of MANET routing protocol. They have modified the protocol to choose route according to the signal to noise ratio and eliminate the routes with the bad link which has the very low signal to noise ratio .Also they have concluded that (CLAODV) gives increased performance in terms of delivery ratio, delay and packet drop when compared to the existing AODV protocol.

Authors Jaspal Jindal et al.[6] in the year 2013 have proposed another soft computing approach i.e. Fuzzy Improved Genetic Approach for Route Optimization in MANET. In this work, the proposed routing algorithm was inspired from the genetic approach. Instead of using the shortest path authors have selected a genetic inspired path to avoid congestion over the network. In this work, the selection of the next cross over child path have identified on the basis of cyclic fuzzy logic. Authors have observed that the results obtained from genetic based approach in which fuzzy is applied at the crossover show better path optimization. The fuzzy improved genetic approach provides energy efficient path which is needed for route optimization in MANET.

III. SOFT COMPUTING APPROACH

In this paper, are providing a comprehensive review of three soft computing approaches to improve quality of service and route optimization in MANET.

1. Neural Network

An Artificial neural network is akin to a biological network, capable of thinking, reasoning, decision-making and a high degree of parallelism. It draws inferences from a vast storehouse of knowledge and experience gained over a period of time in solving problems. It can work with imprecise and ill-defined parameters in arriving at solutions. Fuzzy Logic and Genetic Algorithms are additional ingredients that can make an ANN more powerful and aggressive in solving unsolvable problems by analytical methods [17].

Basically, the most significant characteristic of NEURAL is the uniform distribution of the information around the node's location based on the current changes in its neighborhood. Inspired by the biological nervous system, Artificial Neural System (ANS) and neural networks are being applied to study a wide variety of problems in the areas of engineering and business [1][4][15]. In a ANS system, the information is propagated between neurons using electrical stimulation along dendrites. High stimulation signal produces an output to the other neighbor neurons and so the information takes the right way to the destination, where a reaction will occur. In this approach, [20] authors have proposed Kohonen Model [18] for Self-Organizing Systems. They have proposed a architecture for a NEURAL as illustrated in following figure 1.

The conjunction of three phases, which consider algorithms normally applied in the area of neural networks, provide robust and efficient tools to be implemented in NEURAL. The architecture in fig. 1 shows these modules as Pre-processing, Route Discovery and Learning. The Route Discovery module computes a self-organizing routing algorithm using the Kohonen model. Finally, the performance of a trust mechanism is carried up in the learning module.

Following figure 1 illustrates about the schematic architecture for NEURAL. It consists of two modules:

- 1) Preprocessing Module
- 2) Route discovery module

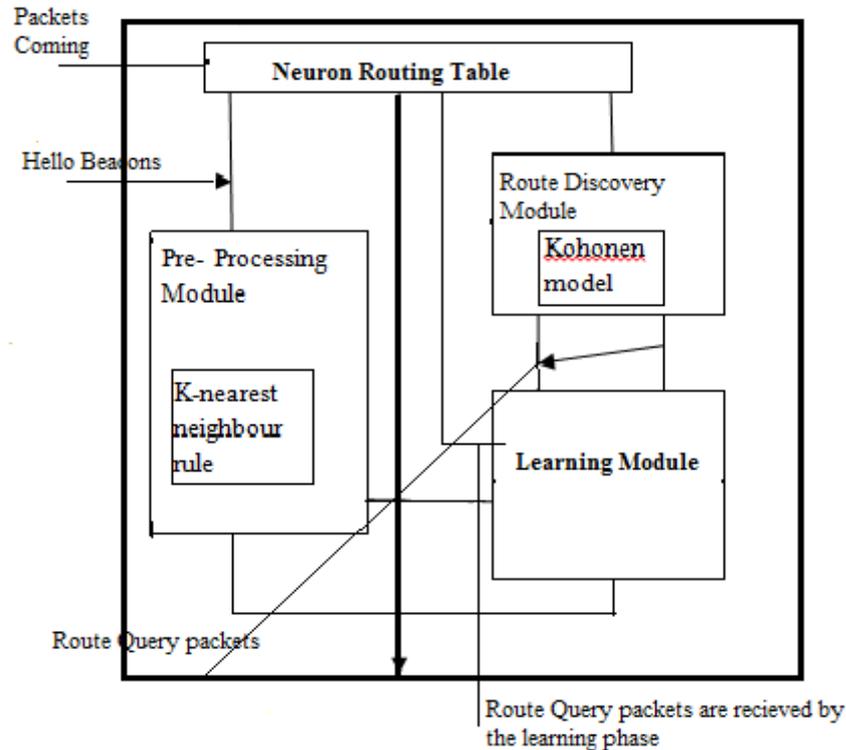


Fig1. Schematic Architecture for NEURAL

1. Preprocessing Module

Preprocessing module adapts the K-nearest neighbors' rule sensing the continuous topology changes of the network which is based on sending hello requests and reply packets during an interval of time.

2. Route Discovery Module

Kohonen model, which it is used to select the next route in the MANET network based on a competitive learning procedure. Route discovery phase is divided into three steps:

- Broadcasting
- Selection of the "winner"
- Adaptation

In this way, authors have designed architecture for NEURAL. In this paper, the design of a self-organizing routing algorithm called NEURAL is achieved using classification, adaptive and learning algorithms from the Artificial Neural System.

3. wireless mesh network

Specific modifications of MANET created a possibility to implement several new wireless networks. One of them is a wireless mesh network (WMN). Wireless Mesh Networks are rapidly deployable, dynamically self organizing; self configuring, self healing, self balancing and self aware multi hop networks. Over the last ten years, WMNs have gained more and more attention and are now considered as a convincing solution for providing better Internet access services for end users. In these networks each node (stationary or mobile) has the capability to join and create a network automatically by sensing nodes with a similar capability within its radio range.

In a WMN the performance parameters can be categorized as per flow; per node; per link; inter flow and network wide parameters. WMN is an emerging technology that offers a cost-effective and scalable method to connect wireless devices. In this paper [16], authors have proposed two soft computing based approaches in wireless mesh networks:

- BIG BANG BIG CRUNCH (BB-BC) approach

- BIOGEOGRAPHY BASED OPTIMIZATION (BBO) approach

Wireless Mesh Network (WMN) is a specific type of MANET. As in MANET, each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations. In this way wireless mesh technology is used to build cost-effective outdoor wireless networks for private or public sewn technology ensure secure, high-bandwidth, scalable access to fixed and mobile applications across metropolitan areas. Primary goal of every new user connected to wireless network is to make Internet connection.

4. fuzzy based genetic approach

This is also another soft computing technique for route optimization in MANET. In this work,[6] authors have proposed the selection of the next cross over child path will be identified based on cyclic fuzzy logic. The whole process will optimize the routing algorithm to improve the QOS. Authors have proposed genetic based approach to build the network path for the route construction in an optimize way. Finally mutation will be performed. . In this work, the selection of the next cross over child path will be identified based on fuzzy logic. The fuzzy logic will be implemented under the parameters of energy and the distance specification.

In this work, authors have concluded that fuzzy improved genetic approach gives better result in term of distance and path optimization which can be summarized as an efficient energy form.

IV. ROUTING ALGORITHMS AND PROTOCOLS CONSIDERED FOR ROUTE OPTIMIZATION

There are various routing algorithms and protocols used for various soft computing techniques are as follows:

1. Routing Algorithms

There are different algorithms used in **Neural Network** approach proposed by different authors. Following table 1 illustrates the comparative study of different algorithms based on Neural Network.

Table I
Evolution Of Neural Network Based Routing Algorithm Solutions

AUTHORS OF ALGORITHM	LIMITATIONS OF ALGORITHM PROPOSED	ADVANTAGE OF ALGORITHM PROPOSED
Rauch and Winarske [9]	Need to know the number of hops required for shortest path in advance.	First development towards the field of NN based routing solutions.
Park and Choi [10]	Fails to coverage too many times. Poorer behavior with increasing no. of graph nodes	Multi Destination routing problem. Single Destination routing version – Here extends the range of operation of former method.
Zhang and Thomopoulos [7]	Not adaptable to external conditions	Finds a path with as many as N hops

Above table illustrates the advantages and limitations of algorithm proposed by authors in neural network approach. This paper, highlight the different methods based on GA for solving the SP routing problem. One of the earliest GA-based shortest path routing algorithms. Fuzzy Logic and Genetic Algorithms are additional ingredients that can make an ANN more powerful and aggressive in solving unsolvable problems by analytical methods. Fuzzy Logic helps us to work with ill-defined parameters and Genetic Algorithms represent a powerful paradigm in searching for optimal solutions in a solution space.

In wireless mesh network, authors have proposed algorithm for packet routing based on the Hopfield neural network and with primary goal to find optimal path through dynamic network topology [15]. This information is used for routing packets into the WMN. For this purpose authors have used mobile agent technique in wireless mesh network technique. Mobile agent logic is realized by the Hopfield neural network, too. In this way updated messages are broadcasted all over the network via optimized flooding technique. In the algorithm proposed in this work, the procedure starts with the connection of a new user to a network. The WMN router detects the new device. (Three phases and two procedures):

First: Finding the shortest WMN routes (should be realized by software in mobile device),

Second: Enabling the physical connection with WMN router (which requires changing of the routing table data in the WMN router),

Third: Enabling the logical connection with one of the gateways for providing the connectivity to the distribution system over the end WMN router. In this way, algorithm based on the Hopfield neural network is used in WMNs for route optimization in MANET. In the paper [16], authors have also proposed BIG BANG BIG CRUNCH (BB-BC) AND BIOGEOGRAPHY BASED OPTIMIZATION (BBO) algorithms. The BB-BC theory believes that energy discharged by the initial explosion i.e., kinetic energy, is counterbalanced by the energy of bodies attraction known as gravitational pull. In the Big Bang phase, energy dissipation produces disorder and randomness as the main feature of this phase. In the Big Crunch phase, randomly distributed particles are drawn into an order. This theory of repeated big bang followed by big crunch phases forms the basis of an optimization algorithm called the Big Bang-Big Crunch optimization algorithm [13][19]. BBO is the study of how species are articulated on the landscape in space and time. Based upon the dynamical equilibrium theory Dan Simon proposed BBO algorithm. Since its first application, this meta-heuristic approach has been applied successfully to some engineering applications. Authors have applied this algorithm to evaluate minimal cost path.

In **Fuzzy improved genetic approach**, routing algorithm has used in which the selection of the next cross over child path will be identified based on cyclic fuzzy logic. In this work, the fuzzy-improved Genetic algorithm has been implemented for the route generation. In this work, while generating the path, the mobility of the node has also considered. The analysis has been driven in the form of energy consumed as well as the total path length. This work was about to perform the optimize path generation. The fuzzy improved genetic approach provides energy efficient path which is needed for route optimization in MANET. And authors have proposed that this algorithm is better than previous one.

2. Routing Protocols

There are various routing protocols used in **Neural network** like proactive routing, reactive routing, power aware routing protocol, hybrid routing. Using these protocols authors have observed Link establishment time for a maximum of 200 nodes using hyper net simulator and NS2 simulator. Also, in the paper [9] authors have proposed a routing protocol which is inspired by the synapses in the brain, in which neighbors neurons compete to propagate the signal. Authors have contributed with the design of a modular architecture for the NEURAL protocol. It is essential to develop efficient broadcast protocols that are optimized for energy consumption and low control overhead. Thus, the "Post-synapse" algorithm was introduced in this paper as a query mechanism to avoid flooding due to useless broadcast packets in the NEURAL protocol.

In **wireless mesh network**, [12] authors have used link quality source routing (**LQSR**) protocol. One of the routing protocols with various performance metrics which aims to select a routing path according to link quality metrics. Three performance metrics, i.e., the expected transmission count (ETX), per-hop RTT, and per-hop packet pair are implemented separately in LQSR.

In this way, authors have used a link quality source routing protocol in WMNS for route optimization in MANET. In this work, they have selected a routing path according to link quality metrics. In this work, a new performance metric, called the weighted cumulative expected transmission time (WCETT) was proposed for the routing protocol. WCETT takes into account

both link quality metric and the minimum hop-count. It can achieve good tradeoff between delay and throughput because it considers channels with good quality and channel diversity in the same routing protocol.

V. CONCLUSION

Routing in mobile ad-hoc network using various soft computing techniques have been done using various algorithms and routing protocols. Routing in MANET using soft computing technique is the solution to improve quality of service and route optimization in MANET. In all above techniques authors have proposed various parameters to improve quality of service and route optimization. In this paper, we have discussed existing work done on Soft computing technique for routing in MANET and parameters that should be considered. Next, we discuss various soft computing mechanisms through which routing in MANET can be carried out and also discussed about the various routing algorithms and protocols used in soft computing. Future work is to improve the parameters considered.

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