

An Improved Cluster Head Election Algorithm

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ABSTRACT

Mobile ad hoc network is one of the most frequent communication networks in research and development. In this network technology the mobility and the fluctuating connectivity is a major issue thus for improving the connectivity and performance of the network, clustering approaches are used. The main aim of clustering based network organization is to improve the scalability and performance. Thus in this presented work the mobile ad hoc network clustering is proposed for investigation.

The proposed network clustering technique is the basic technique which is inherited from the weighted clustering algorithm. The different network parameters are evaluated for finding the optimum node quality selection and according to these nodes quality parameters the weights are calculated. The estimated weights are providing guidelines for providing the efficient cluster head selection. In the proposed clustering scheme the PSNR, mobility, node speed, remain energy and connectivity are the quality parameters of node selection.

Keywords: MANET, Clustering Algorithm, Weight, Election.

1. INTRODUCTION

Mobile ad hoc network is one of the well-known technologies among wireless networks. Due to mobility and dynamic topology the network suffers from different security and performance issues. The clustering algorithms are implemented for improving the scalability and performance of the routing algorithms. The presented work demonstrates a mobile ad hoc network clustering algorithm and their design strategy. The overview of the proposed routing techniques is discussed in this chapter.

1.1 Overview

Mobile ad hoc networks are one of the most popular networks. The wireless connectivity and mobility of network devices enable it to work in a number of applications. The network is not containing a centralized control; therefore the topology control is responsibility of routing protocols. Thus the routing protocols are managing the topology development and also responsible for route discovery and route management. On the

Other hand, due to absence of centralized control, the network suffers from the issues of security and performance.

In this presented work, the main focus is given on the performance improvement of the mobile ad hoc network. A number of research articles are investigated where a number of recently developed techniques for improving the performance are available but most of them are increases either control message exchange or computationally expensive by which the end to end delay is affected. It is observed the clustering algorithms are capable to improve the routing and network performance. The clustering algorithm is selected for performance improvement.

The WCA (weighted clustering algorithm) is able to improve the network performance and scalability of network. This algorithm measures the node quality and according to the evaluation the efficient nodes are selected for data transmission. In this algorithm, nodes are categorized in two main roles; first, the cluster head by which the entire nodes are communicating with other nodes, secondly, the client nodes which consume the services distributed through the cluster heads. This section only provides the understanding of the proposed work. The overall objectives and design strategy is discussed in detail in further sections.

1.2 MOBILE AD-HOC NETWORKS

A Mobile Ad-hoc Network is a collection of wireless devices that can be set up instantly anywhere and anytime without the need of any pre-existing network communications.

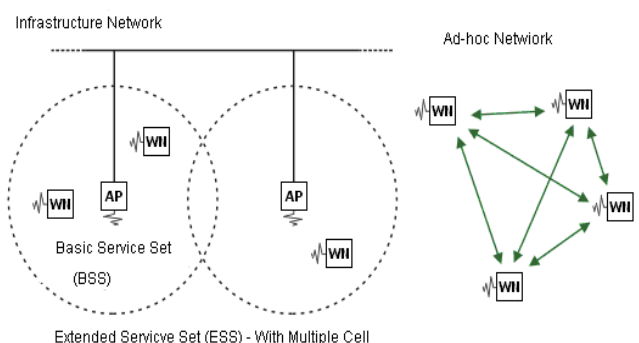


Fig.1.1 Example of Simple Ad-hoc Network with Participating Nodes

It is a self configured network infrastructure, in which mobile devices are connected with wireless links. These devices are free to move randomly and often act as host as well as router at the multi-hop forwarding, nodes can route their packets with the help of intermediate nodes. So, Ad-hoc networks are fully distributed in nature and can work at anyplace, anytime and anywhere without the aid of any network infrastructure or centralized administration [4]. These properties make these networks highly robust and more applicable in several areas. Another figure 1.2 shows the multi-hop forwarding between these communicating devices such as A, B, C, D, E, F and G. According to figure, for example, if nodes are mobile and node A want to send data packets to another node G, it can route its packets with the help of B and F which is shown in figure also.

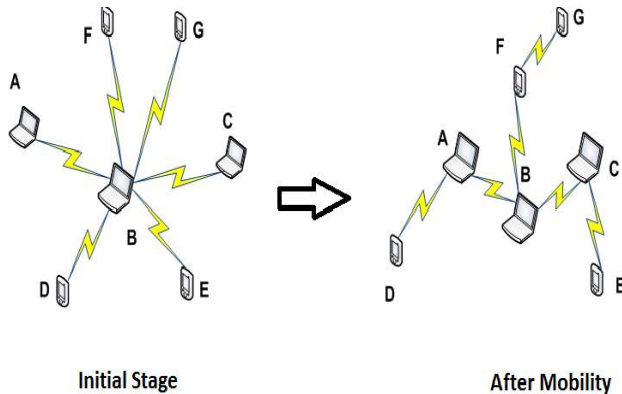


Fig.1.2 Multi-hop Ad-Hoc Network

1.3 Characteristics of MANET

Mobile ad hoc network supports diverse properties in network therefore required to implement a network with the following features [16]:

1. **Self-Autonomous Terminal:** MANET has a property that each of its mobile node acts as an autonomous node. The node can work as a host as well as router. Meaning that, every mobile node provides basic functionality as host as well as it can also work as mobile router. So it is very difficult to distinguish end nodes and switches in MANET [1].
2. **Distributed Nature:** An Ad-hoc mobile wireless network is a fully distributed network in nature and the use of basic centralized routing approaches in this network may consume a large amount of bandwidth or overheads [2].
3. **Multi-hop Forwarding:** An Ad-hoc network can either be single hopped or multi-hopped depending on the routing protocols, different attributes and the link layer. It is assumed that single hop MANET is better and simpler, when it comes to its architecture and implementations. But in multi-hop, the in-path routers and nodes can be used for forwarding the data packet, when source and destination are out of the wireless transmission range of each other [3].
4. **Dynamic Network Topology:** Ad-hoc network is also known as dynamic network topology. It is a reconfigurable type of network which can operate without the need of any fixed network infrastructure [4].
5. **Light-weight Terminals:** Basically, the MANET nodes are mobile devices like mobile phones, PDA, hand-held and wearable computers etc. which have less processing, memory size, and battery power etc. So, these devices need some

relevant algorithms and mechanism to implement the computing and communication functions between them [5].

1.4 Clustering in MANET

Current scenario of the cellular networks exclusively depends upon the wired backbone that connects all base stations denoting that the network is fixed to a geographical area and fixed boundary. This kind of network cannot be employed in emergency conditions, because of time consuming installations. For this reason, mobile multi-hop radio networks or ad hoc networks perform well in places where no backbone is available or poses a costly installation for example, law enforcement operations, communications on battle field, situations of disaster recovery, and so on. Such circumstances claim a network where even the base station is mobile, and flawless communication is supported.

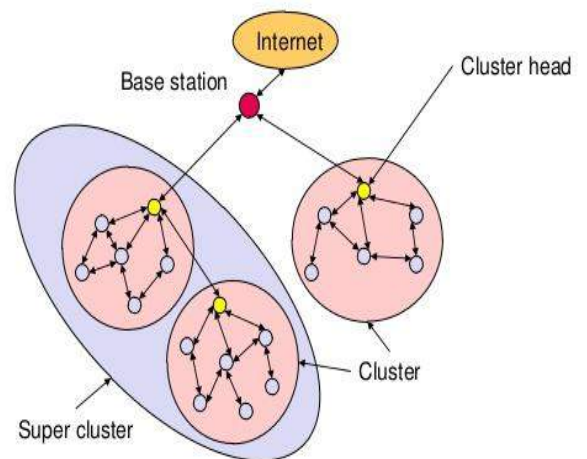


Fig. 1.3 Ad Hoc Network Clustering

Multi-cluster multi-hop radio wireless networks are required to be malleable towards varying network configurations. Cluster heads are responsible for the cluster formation. Cluster head is one amongst all the nodes, and cluster are formed comprising a number of nodes and preservation of the topology fathered work. A group of cluster heads is called as dominant set. Cluster head allots resources to all the nodes that belong to its cluster. Because of the self-motivated temperament, connection and disconnection of mobile nodes to and from the clusters agitates the network's stability and those configuration of cluster-heads is unavoidable. It is a crucial issue, since frequent cluster-head changes negatively affect the routine of other protocols like scheduling, routing and resource allocation that rely on it. Choosing best possible cluster-heads is an NP-hard problem. Therefore existing solutions to this problem are based on heuristic and greedy approaches [7].

2. EWCA- PROPOSED ALGORITHM

This section provides the detailed overview of the proposed mobile ad hoc network clustered routing technique i.e. EWCA. The cluster algorithms are able to scale and enhance the performance of the ad hoc networks.

2.1 Methodology

The proposed network clustering technique works on the three main phases. The different phases are given in figure 3.1.

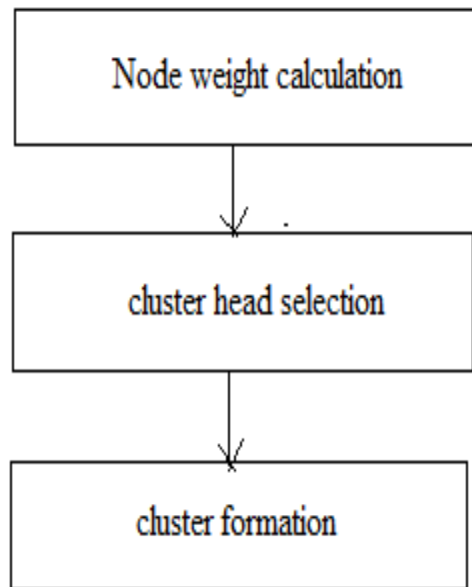


Figure 2.1 Clustering Phases- EWCA

According to the given diagram the proposed clustering scheme is taken place in three main phases. The detailed description of the proposed system is given as:

1. Node Weight Calculation

The mobile ad hoc network is a connected group of nodes which are connected with each other through the wireless links. Additionally as the network node performs functions the resources are consumed in similar manner. In order to manage the life time of network the efficient node selection and load normalization is primary aim of the clustering algorithm, by which the load on nodes are distributed in network and optimum resources are preserved. Thus in order to perform network clustering the following performance and resource parameters are considered.

Signal to noise ratio (SNR): That evaluates the level of a desired signal to the level of backdrop noise. It can be labelled as the fraction of signal power and the noise power, commonly expressed in decibels. The node sends a data packet to neighbour node and between both the signal strength the values are estimated using the given formula.

$$SNR = 10 \log_{10} \left(\frac{A_{signal}}{A_{noise}} \right)^2$$

Connectivity: In this network the nodes are said to connect which are in radio range of a node. Thus Maximum numbers of nodes connected through this node causes the more serving capability.

Remain Energy: The network devices in mobile ad hoc network are created with limited amount of energy. But if node losses its energy frequently then the node is not

functioning as required. Thus remain energy is an essential parameter for clustering, that will be computed using the below given formula.

$$E = \text{initialenergy} - \text{Consumedenergy}$$

Mobility: Another property of node in ad hoc network is mobility. Nodes are frequently moving from one place to other in this network randomly. The low mobile nodes are able to form more stable clusters. Thus node mobility can be computed using the following formula

$$M = \frac{1}{T} \sum_{i=1}^T \sqrt{(X_t - X_{t-1})^2 + (Y_t - Y_{t-1})^2}$$

2. Weight calculation:

The computed weights are help to find the optimum node in network. Thus a list of efficient nodes is created using the calculated weights.

$$W = w_1 * c + w_2 * E + w_3 * M + w_4 * SNR$$

3. Cluster Head Selection:

In the previous phase all node compute the weights of their neighbour nodes using a neighbour table. Thus after comparison of evaluated weights the cluster heads are elected for a cluster of nodes.

This section provides the detailed understanding of the network parameter calculations, In the next section the steps are summarized using an algorithm.

2.2 Proposed Algorithm

The above given methodology of the solution development can be summarized in steps. The summarized algorithm is reported in this section.

Weight Calculation Algorithm

1. Find the number of neighbours of each node, which can be expressed as connectivity c.
2. Find the energy remaining, e for each node.
3. Compute the mobility M for each node or average of the speed in anticipation of the current time t.

$$M = \frac{1}{T} \sum_{i=1}^T \sqrt{(X_t - X_{t-1})^2 + (Y_t - Y_{t-1})^2}$$

4. Compute the SNR of nodes.
5. Calculate the combined weight W as

$$W = w_1 * c + w_2 * e + w_3 * M + w_4 * SNR$$

Cluster-head Selection Algorithm

1. Each node finds its neighbours and builds its neighbourhood table.
2. Each node calculates its weight by calling the weight calculation algorithm given above.

3. Each node broadcasts its weight to its neighbours. If it has maximum weight among its neighbours, it sets the cl-head flag to true, otherwise, the cl-head flag is set to 0.
4. The node with maximum weight broadcasts cl-head messages to other nodes.

3. SIMULATION AND RESULT ANALYSIS

This chapter provides the understanding of implementation technique of the proposed routing algorithm and the evaluation of results. Therefore first the tools and techniques are discussed and then after simulation parameters and the simulation scenarios are explained. These scenarios are help to perform the experimentations and obtaining the performance of network.

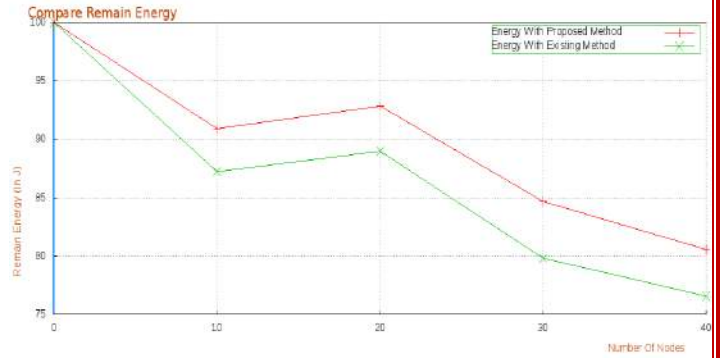


Figure 3.1 Energy Consumption.

3.2 Packet Delivery Ratio

Packet delivery ratio provides information about the performance of any routing protocols, where PDR is estimated using the formula given

$$\text{packetdeliveryratio} = \frac{\text{totaldeliveredpackets}}{\text{totalsentpackets}}$$

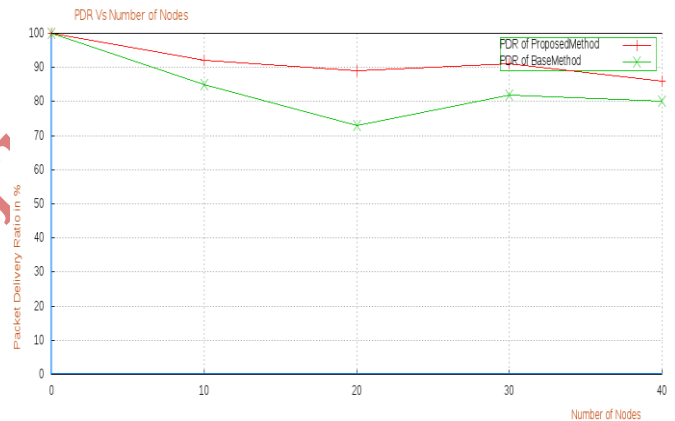


Figure3.2 Packet Delivery Ratio

3.3 Throughput

Network throughput is the usual rate of successful delivery of a message over a communication medium.

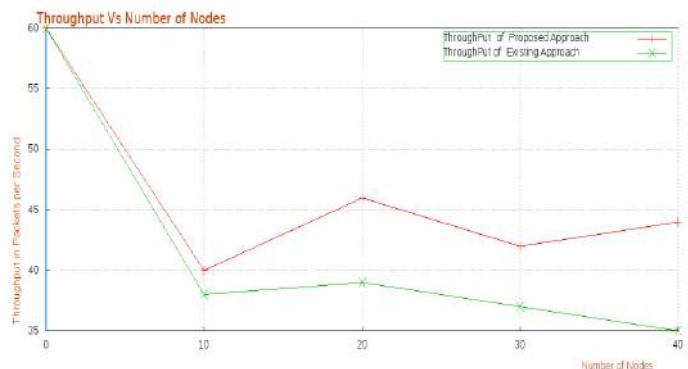


Figure 3.3 Throughput

Simulation properties	Values
Antenna model	Omni Antenna
Dimension	750 X 550
Radio-propagation	Two Ray Ground
Channel Type	Wireless Channel
No of Mobile Nodes	15
Routing protocol	AODV
Time of simulation	10.0 Sec.

Table 1 Simulation Setup

Experimental observations

After implementing the desired network configuration the following facts are found.

1. The performance of the traditional routing protocol is comparatively low as compared to the proposed weighted clustering scheme in terms of packet delivery ratio.
2. The performance of the proposed routing technique becomes much adoptable even the nodes are highly mobile.
3. The proposed clustering scheme helps to scale the network performance and data delivery ability.

3.1 Energy

During the communication scenarios for each event of mobile nodes, a specific amount of energy is consumed. The amount of energy is limited for each mobile nodes

4. CONCLUSION AND FUTURE WORK

Mobile ad hoc network is a dynamic infrastructure of communication. In this network the mobility and dynamic network topology is an essential property of network. recent years.

The presented work consider the ad hoc networks performance and scalability issues the investigated result and cluster based solution are presented. In the proposed clustering technique the network node's performance parameters are used as the quality of the nodes and based on the optimum node quality, the cluster head selection is performed.

clusters and is able to scale the performance of network successfully.

S. No.	Parameters	Proposed scheme	Traditional scheme
1	Throughput	High	Low
2	Packet delivery ratio	High	Low
3	Remaining energy	High	Low

Table.2 Performance summary

4.1 Future work

The proposed cluster head selection algorithm is designed and implemented successfully and the performance of the proposed technique is compared with the traditional cluster head selection technique. Among them the performance of the proposed scheme is found optimum as compared to the traditional approach. But in the proposed technique the performance of the network is lacks in terms of throughput. Thus in near future the throughput optimization is performed.

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