A Comparative Analysis Of Two Position Based Hybrid Routing Algorithms Over MANETs.

Mr. Chethan Chandra S Basavaraddi [1], Smt. Geetha N.B. M.Tech [2],

Department of Computer Science, University B.D.T. College Of Engineering Davangere–577004, Karnataka
Visvesvaraya Technological University, Belgaum, Karnataka - India.
Ph: 09916704280, 09844508359, India.

Abstract

Mobile ad hoc networks (MANETs) are autonomously self-organized networks without infrastructure support. In a mobile ad hoc network, nodes move arbitrarily; therefore the network may experience rapid and unpredictable topology changes. Here each node participating in the network acts as host and a router and therefore must forward packets for other nodes. Because nodes in a MANET normally have limited transmission ranges, some nodes cannot communicate directly with each other. Hence, routing paths in mobile ad hoc networks potentially contain multiple hops, and every node in mobile ad hoc networks has the responsibility to act as a router. Researches in this area are mostly simulation based, and in this paper we will be analyzing the performance of DWI-PBHRA routing protocol with the PBHRA. In the performance evaluation of the protocol, the protocols are tested under the realistic conditions including evaluating performance when applied to variable pause times and constant number of nodes we perform extensive simulations using NS-2 simulator.

Keywords: Hybrid routing, Extended battery life, Manet, Position Based Routing, Ad-Hoc Networks, Mobility.

1. Introduction

In recent years, the study of *mobile ad hoc networks (MANETs)* has attracted a lot of interest, mainly from the networking community. A significant part of the research has focused on routing, which is particularly challenging in MANETs due to their dynamic nature [8], and requires algorithms that work in a fully distributed way, are able to self-organize, and show robust and adaptive behaviour. As a result, a number of MANET routing protocols have been designed [7], [3]. However, due to the costs and technological difficulty of setting up real and large MANET test beds, most of this research is carried out in simulation.

These simulations are usually based on simplified scenarios, where nodes move randomly in an open area, and rely on idealized models of physical phenomena such as interference. Recently, experiences with real world test beds [2] have lead to an awareness that results from such simplified simulation scenarios do not reflect well the performance that can be expected in reality. There is therefore now a lot of interest in simulation studies that reflect more complex, realistic situations. In this paper, we investigate the distinctive properties in terms of limitations such as the mobility patterns, and data patterns, and we study how they affect the effectiveness of the two routing algorithms.

2. Related Works

Extensive research has been done in modeling mobility for MANETs. In this section, we mainly focus on experimental research in this area. Much of the initial research was based on using random waypoint as the underlying mobility model and Constant Bit Rate (CBR) [5] traffic consisting of randomly chosen source-destination pairs as the traffic pattern. Routing protocols were mainly evaluated based on the following metrics: packet delivery ratio (ratio of the number of packets received to the number of packets sent) and routing overhead (number of routing control packets sent). However, in this paper we focus on the impact of mobility models on the performance of MANET routing protocols, so our two observations regarding to discuss the effect of movement mobility speed of the nodes to evaluate the performance of the two Geographic Position Based Routing Algorithms, using NS- 2[11] simulator considering the problem from a different perspective, using the simulation with varying number of movement speed at an invariable pause time which should be zero under weakest case because a longer pause time of the node may be insignificant for mobile Ad-hoc network with frequently and fastly moving nodes, based on the routing load and the connectivity of three typical routing protocols of ad-hoc networks with the different simulation model and metrics like (mobility speed, simulation times, connectivity sources).

2.1 Routing Protocols for Ad-hoc Networks

To compare and analyze mobile ad-hoc network routing protocols, appropriate classification methods are important. Classification methods as Figure 1 help researchers and workers on mobile wireless ad-hoc protocols and designers to understand distinct characteristics of a routing protocol and find its relationship with others [13].

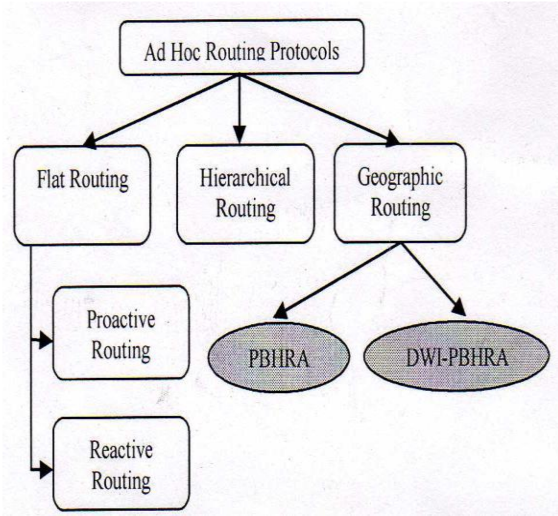

Fig 1: Classification of the Routing Algorithm.

2.2 Mobile Ad-Hoc Networks MANETs

In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. The primary goal of such an ad-hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Route construction should be done with a minimum of overhead and bandwidth consumption. An Ad-hoc routing protocol is a convention or standard that controls how nodes come to agree which way to route packets between computing devices in a MANET. In ad hoc networks, nodes do not have a priori knowledge of topology of network around them, they have to discover it. The basic idea is that a new node announces its presence and listens to broadcast announcements from its neighbors. The node learns about new near nodes and ways to reach them, and announces that it can also reach those nodes. As time goes on, each node knows about all other nodes and one or more ways how to reach them.

3. Summary Of Routing Models For Simulation

In mobile Ad hoc Network the routing can be categorized into three categories namely, proactive routing, reactive routing and hybrid routing. Many proactive protocols stem from conventional link state routing. On-demand routing, on the other hand, is a new emerging routing philosophy in the ad hoc area. It differs from conventional routing protocols in that no routing activities and no permanent routing information is maintained at network nodes if there is no communication, thus providing a scalable routing solution to large populations. His category of protocols combines the best features of the proactive and the reactive categories. Nodes within a certain distance from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given node. For routing within the zone the proactive approach is used and for the nodes that are located beyond the zone a reactive approach is used. Here we will discuss the two models which will use some of the table driven or proactive and on- demand reactive routing concepts. Although these two models comes under Hybrid protocols they differ from the other hybrid protocols as this two comes under the Geographical position based routing algorithms which are interested in localized nodes. Localization is realized by GPS that is use to determine the geographical position of the nodes. The position change occurs due to nodes mobility.

3.1 The PBHRA Model

Routing algorithm called position based hybrid routing algorithm (PBHRA) [9] was developed to optimize bandwidth usage of ad hoc networks. In the PBHRA algorithm, a central node, in other words a master node is assigned as it is in infrastructured wireless networks and directs the routing information. When nodes require sending data to a target node, they take the location of target node and the route to achieve it from master node. Accordingly, they send their data through that route. At this stage, the PBHRA differs from infrastructure wireless networks since data is sent via central station in infrastructured wireless networks. However in this algorithm, the master node behaving as if it is central node helps only while finding the route to achieve the target. The main goal of PBHRA is effective use of bandwidth by reducing the routing overload. Additionally, the other goals of the algorithm are to extend battery life of the mobile devices by reducing the required number of operations for route determination and to reduce the amount of memory used.

3.1.1. Working steps of algorithm

The detailed working steps of the algorithm are these: (a) The first node that stands up, while network is firstly started is assigned as master node. If two nodes are opened at the same time and two master nodes form, these nodes compare MAC addresses in the first packets that they took from each other and the node whose MAC address has higher value decides not to be the master node. The details of master determining process are given in the following section. (b) Master node broadcasts packets in regular intervals and declares to the other nodes in the network that it is the master node. These packets are called "master node announcement packet (map)".(c) The nodes excluding master node send "update packets (up)" to master node. In these packets there is information about the geographical position of nodes (as x, y, z coordinates), rest of battery life as percentage and node density. There are destination address, source address and id area in the update packet. Id area is used for in order to update the related line of position information matrix that master node will form.

The receiver address is the current address of the node that sent updating data. Sender node increases id area in the packet each update. In this format of updating information is processed as a row element in P matrix kept on master node. If updating information is taken from the same node formerly id values are compared. The packet that has higher id value is recorded and follow former record is changed.

$$P = \begin{pmatrix} x_1 & y_1 & z_1 & b_1 & d_1 & id_1 \\ x_2 & y_2 & z_2 & b_2 & d_2 & id_2 \\ \ldots & & & & & \\ \ldots & & & & & \\ x_k & y_k & z_k & b_k & d_k & id_k \end{pmatrix} \ldots\ldots(1)$$

(d) Master node forms position information matrix by using packets that come from other nodes. There are position information as (xi,yi,zi), battery life as bi, density di and node update sequence number idi in the columns of this matrix called P matrix. The row numbers of the matrix are equal to number of nodes. This matrix for k-node network is given in (1).

$$l_{i,j} = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2 + (z_j - z_i)^2} \ldots\ldots (2)$$

(e) Master node calculates the distance of each node to each other by using the first, second and third columns of P matrix that is given in (1). It makes this process by using the (2). In the result of this, q square matrix that's dimension is equal to number of nodes in the network. M distance matrix for k-node network is obtained as given

(3).

$$M = \begin{pmatrix} l_{1.1} & l_{1.2} & \ldots & l_{1.k} \\ l_{2.1} & l_{2.2} & \ldots & l_{2.k} \\ \ldots & & & \\ \ldots & & & \\ l_{k.1} & l_{k.2} & \ldots & l_{k.k} \end{pmatrix} \ldots\ldots\ldots(3)$$

The diagonal of M will be zero as the distance of every node to itself is zero. Also with a condition i _ j, the distance between i and j and the distance between j and i are the same, thus the matrix M will be symmetrical matrix. Therefore the upper triangular part of matrix M will only be calculated. The lower triangular part of M will be filled by upper triangle. As a result of this, the computational time, which is an important factor for battery life of a node, is reduced. (f) The node in the center of the network is determined. The total of row elements of M distance matrix given in (3) are derived and transferred to column matrix T that is given in (4). The number of the row that has the smallest element of T matrix is equal to the number of the node that is in the center of the network.

$$T = [\, t_1 \;\; t_2 \;\; t_3 \; . \; . \; . \; t_k \,] \ldots\ldots\ldots\ldots(4)$$

Where

$$t1 = \sum_{n=1}^{k} l_{n.1} \ldots\ldots\ldots\ldots\ldots(5)$$

(g) New master node candidate is the node that is in the center of the network. Master node asks candidate master node if it can be the new master node. If the answer is positive, it sends the whole routing information that it keeps on itself to the new master node and also it declares new master and its position information to the other nodes. If the answer is negative, the second central node for the T matrix is the new master candidate. The same processes are realized for this node. Candidate node can refuse to be the master node because of low battery life or high density.

(h) New master node sends broadcast packets to the network relating to being master node. The updating packets that will come from other nodes are collected in P matrix as the former master node did. New master node repeats the steps between a to h.

(i) The other nodes send event based updating packets to the master node when they changed their position, their battery life got under threshold level and their density increased. Thanks to id value sent in P matrix related to that node. Because other nodes send id value that is one bigger than the former in the update packet they sent.

(j) According to this algorithm, normal nodes requisition from master node path information to destination node when they want to send a data to any destination.

Master node assigns a cost value to the intermodal borders with fuzzy logic by using M matrix and P matrix when a request relating to a destination comes to itself. In this way a graph consisted of nodes and borders forms. G matrix is formed in order to keep the cost values of graph. The forming of G matrix will be handled in the next section. (k) Master node supplies an optimization in order to found the path between source and destination with the least cost over the formed graph. The shortest path, in other words the path has lowest cost is determined by using Dijkstra or Bellman Ford algorithm.

(l) Master node declares the result got from j and k steps to the node which requested path and related node send its data using this path. When any node will demand routing path from master node, it sends a "route request packet (rqp)" to the master node. Master node sends "route reply packet (rrp)" to the node which requested a route. Master node answers to the node that is the owner of request by determining most optimum path to the destination node from the source node and replacing an optimization on graph structure that is formed when master node received route request packet.

(m) If master node goes far from central position or battery life falls down a threshold, it transfers the mastership to other node, which has minimum row total value in M. Nodes decide to be a master node or not in

accordance with battery lives and densities. In the case of master node's closure with any reason, a "secondary master" node is assigned in order not to make network stay without a master. This assignment process is made by the master node. Master node selects the nearest node to itself as the secondary master. It sends the routing information that it holds on itself to the secondary node in certain periods. The frequency of data sending to the secondary master is four times of the interval of master node broadcast packet sending
(n) The other nodes do not hold information belonging to whole nodes and do not make any process related to routing. But they hold "master node packet" that comes from master node in their memories.
Figure 2 shows the flow chart of the algorithm whose detailed steps were given.

3.1.2. Determining role of master node
According to PBHRA algorithm, there are three roles for a node in the network. These are master, secondary master and normal node. The process of determining secondary master's role is determined by master node. For this reason, a node has to know whether it is a master node or a normal node. Determining of being a master is realized with following steps:

(a) A node in the network waits for 30 second after it stands up
(b) Did the node receive master node announcement packet (map) in this period?
c) If the answer step b is yes; (c1) Did it receive one map, or more maps than once?
(c1a) If it receives one map, it records at its memory the address and position of node from which it receives a packet as master node. Thus, it decides itself that it is a Signal
.normal node. c1b) If it receives maps more than once, it compares the address in the packets received. It records the one with low address and its position into its memory as master node. It decides that it is a normal node itself.
(c2) It sends an update packet
(up) containing its position to master node whose address is stored in memory.
(d) If the answer of 2nd step is No; (d1) There is no master node in the network. It decides that it is a master node itself; (d2) It broadcasts maps for period of 30 seconds.
e) Finish.

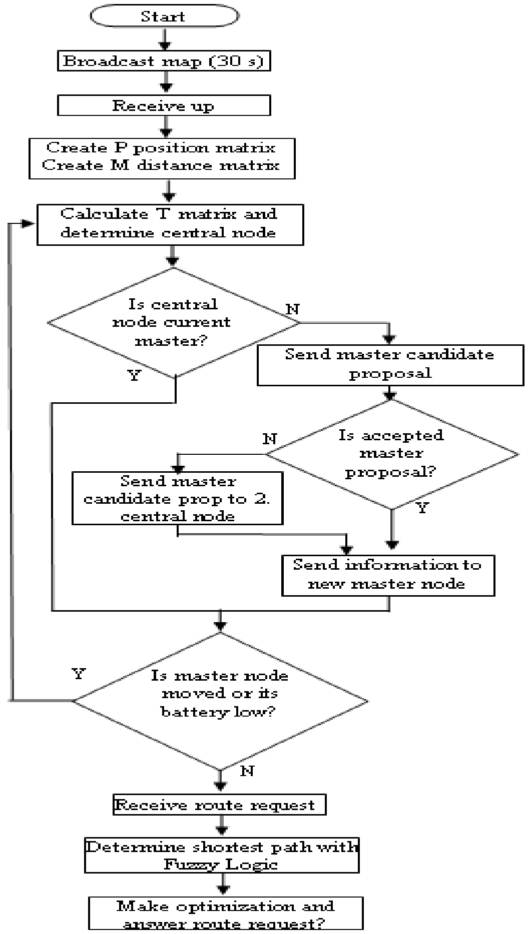

Figure 2. Flow chart of PBHRA algorithm

3.2 The DWI-PBHRA Model
The distributed workload implied approach to the PBHRA is the work with the goal of monitoring the mobility in the network and the other goals where to reduce the energy consumption for communication, reduce the routing overhead and making the network more reliable. The central nodes, in other words a primary (Brain) and secondary (Heart) nodes are assigned as it is in infrastructured wireless networks and directs the routing information. When nodes require sending data to a target node, they take the location of target node and the route to achieve it from brain node. Accordingly, the data is send through that route. The heart node is newly implemented to monitor the networks mobility by broadcasting frequent alive packets in the network. And the algorithm provides the network with the recovery mechanism, for unexpected crashes of Master, making the network more reliable.

4. Design Of The Experiment
The Algorithms to be analyzed for routing need to be experimented under the carefully designed routing traffic base configuration and network scenario, and to vary the node density and mobility at a time to stress the network

in different directions. Careful selection of these control parameters enables us to assess and isolate the effect of network size, with fixed application traffic CBR. In addition, design of the base condition, network topology, and routing are to be taken into account the real networks for which the results should be applicable.

4. 1 Mobility Setup

A mobility model [10] should attempt to mimic the movements of real Mobile Networks. Changes in speed and direction must occur and they must occur in reasonable time slots. For example, we would not want Mobile Networks to travel in straight lines at constant speeds throughout the course of the entire simulation because real Mobile Networks would not travel in such a restricted manner. There is several mobility models supported, nodes in the simulation set up move according to a model that is well known as the "random waypoint" model. The movement scenario files we used for each simulation are characterized by a pause time. Each node begins the simulation by remaining stationary for pause time seconds. It then selects a random destination in the 500m x 500m space and moves to that destination at a speed distributed uniformly between 0mps and a maximum speed of 10mps. Upon reaching the destination, the node pauses again for pause time seconds, selects another destination, and proceeds there as previously described, repeating this behavior for the duration of the simulation. Each simulation ran for 200 seconds of simulated time. We ran our simulations with movement patterns generated for a fixed pause time of 30 Seconds.

4.2 Traffic Setup

A traffic generator named Cbrgen was developed to simulate constant bit rate sources in NS-2, act as the important parameter of our simulation to compare the performance of each routing protocol. We chose our application traffic sources to be constant bit rate (CBR) sources. When defining the parameters of the communication model, we experimented with sending rates of 1.2 packets per second and packet sizes of 512 bytes to observe the consistency.

4.3 Effect of Unvarying Pause Time

Pause time can be defined as time for which nodes waits on a destination before moving to other destination. We used a constant pause time as a parameter as it is measure of mobility of nodes. Low pause time means no de will wait for less time thus giving rise to high mobility scenario.

5. Simulation Results And Performance

This section presents a comparative analysis of the performance metrics generated from all simulations, evincing general and relevant aspects of the evaluated routing protocols in the diversity of network mobility levels that can occur over the Position Based Hybrid Routing Algorithm, and Distributed Workload implied Position Based Hybrid Routing Algorithm. Considering the diversity of routing protocols user mobility levels (20, 40, 60, 80, and 100 m/s). Performance metrics that have been proposed for the performance evaluation of an ad-hoc network protocol. The following metrics are applied to comparing the protocol performance. Some of these metrics are suggested by the MANET working group for routing protocol evaluation [6].

Packet delivery fraction ratio: The ratio between the number of data packets originated by the "application layer" CBR sources and the number of data packets received by the CBR sink at the final destination [1], [12].

Routing packet overhead: Routing Packet overhead RPO is the total number of transmissions routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet (each hop) counts as one transmission [4].

Packet loss ratio: The ratio of the data packets originated by the sources failure to deliver to the destination.

5.1 Analysis Based on Energy Consumed by Cluster-heads

The Energy consumed by the cluster heads were compared for both the algorithms under the diversity of routing protocols user mobility levels, and the results shown in the Figure 3 suggests that in the DWI-PBHRA model the cluster heads consumed lesser energy compare to the PBHRA at any mobility levels.

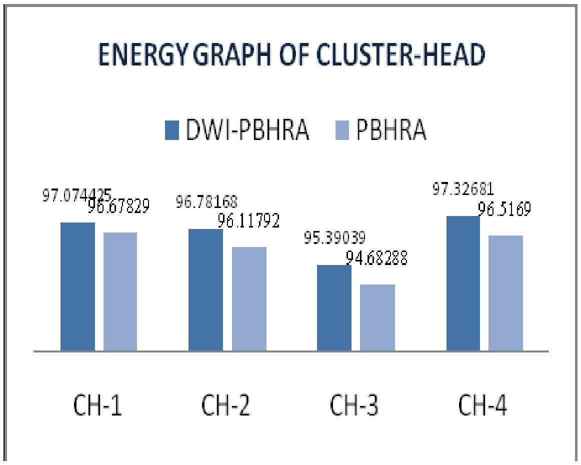

Fig 3: Energy Graph of Cluster-Head

5.2 Analysis Based on Packet Routing Overhead

The routing packet overhead is the packets need to be transferred to make a connection for communication, and from the results of the simulation the DWI-PBHRA performed better with less packet routing overhead in the network at the various levels of the mobility.

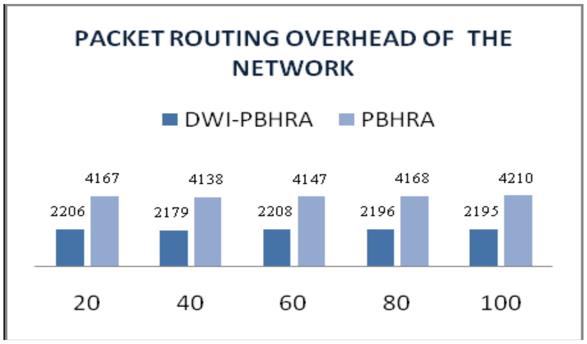

Fig 4: Packet Routing Overhead of the Network

The Figure 4 is the graph with the x axis for variable pause time and the y axis is for the no of packets for the network to establish and connection to be made for the transfer of the data in the network. This analysis was made under the fixed simulation setup where the simulation was made for 200secs.

6. Performance Analysis

Performance analysis has done for the pause time with packets received, pause time with consumed energy. During the simulation it was found that a change in the pause time affects the energy consumption and packet delivery fractions in the network. Every time the network needs to be monitored and every hop need to reliable for transfer of data hence topology changes frequently need new routes for data transfer. It was found that for more mobility or short pause time was not managed well in the infrastructure less network where the infrastructure based network with central control were more capable of handling large networks better in high mobility. Here our proposed scheme has given better results in terms of packed delivery fractions as well as energy savings.

7. Conclusion

The area of ad-hoc networking has been receiving increasing attention among researchers in recent years, as the available wireless networking and mobile computing hardware bases are now capable of supporting the promise of this technology. Over the past few years, a variety of new routing protocols targeted specifically at the ad-hoc networking environment have been proposed, but little performance information on each protocol and node tailed performance comparison between the protocols has previously been available. This paper has presented a comparing performance of two Position Based routing algorithms that comes under the hybrid routing algorithm category, include the properties of table driven and on demand protocols and are usually interested in localized nodes. For routing packets between wirelesses mobile hosts in an ad-hoc network PBHRA and DWI-PBHRA using a network simulator like NS-2 with scenario consist of fixed network size, number of nodes and movement speed in a range of 0 to 10 at variable pause time. The General observation from the simulation: The Distributed workload implied position based routing algorithm which was developed with the goal of monitoring the mobility of the network that it achieved by introduction of heart node and its pulses, The Performance got a difference because of the distribution of the work among the member, Brain and Heart nodes. Whereas the master node in the Position base Hybrid routing algorithm had more overload of routing and giving central control, the reliability was there in the new approach of brain and heart with its recovery mechanism from crash of Master. The Results showed the distributed workload implied position based hybrid routing algorithm outperformed the position based hybrid routing algorithm for the energy consumption by cluster head, packet Routing overhead, and packet delivery fraction.

Acknowldgment

I wish to thanks, Geetha N. B., for her valuable motivation, guidance and suggestion, which helped me for completion this Research paper.

References

[1] C. E. Perkins, E. M. Royer, S. R. Das, and M. K. Marina, "Performance comparison of two on-demand routing protocols for Ad Ho c networks," *IEEE Personal Communications Magazine Special Issue on Ad hoc Networking* , vol. 8, pp. 16-28, Feb. 2001.

[2] C. Tschudin, P. Gunningberg, H. Lundgren, and E. Nordstrom, "Lessons from experimental MANET research," *Ad Hoc Networks Journal*, vol.3, no.2, pp.221– 233, 2005.

[3] E.Royerand, C. K. Toh, "A review of current routing protocols for ad hoc mobile wireless networks," *IEEE Personal Communications*, 1999.

[4] J. Bro ch, D. Johnson, and D. Maltz, The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks, *IETF Internet Draft*, Dec. 1998. (http://www.ietf.org/internetdrafts/ draft-ietfmanet-dsr-01.txt)

[5] Kevin Fall and Kannan Varadhan, "ns notes and documentation". *The VINT project, UC Berkeley*, LBL, USC/ISI, and Xerox PARC, May 1998.

[6] L. Layuan, Y. Peiyan, and L. Chunlin, "Performance evaluation and simulations of routing protocols in Ad ho c networks," *Computer Communications*, vol. 30, pp. 1890- 1998, 2007.

[7] M. Abolhasan, T. Wysocki, and E. Dutkiewicz, "A review of routing protocols for mobile ad hoc

networks," *Ad Hoc Networks*, vol.2, pp. 1–22, 2004.

8] N. H. Vaidya, "Mobile Ad ho c networks routing, mac and transport issues," *Proceedings of the IEEE International Conference on Computer Communication* INFOCOM, 2004.

[9] Resul Kara ,Ibrahim Ozcelik and Huseyin Ekiz (2010). Anew routing algorithm in MANETs: Position based hybrid routing. *Scientific research and essays* Vol. 5(3), pp. 328-238.

[10] T. Camp, J. Boleng, and V. Davies, "A survey of mobility mo dels for Ad ho c network research," Wireless Communications & Mobile Computing (WCMC), *Special issue on Mobile Ad Hoc Networking, Research, Trends and Applications*, Sep. 2002.

[11] The Network Simulator - NS-2. (http://www.isi.edu /nsnam/ns/index.html).

[12] Y. Wang, V. C. Giruka, and M. Singhal, "A truthful geographic forwarding algorithm for Ad ho c networks with selflsh nodes," *Proceedings of the International Journal of Network Security*, Nov. 2007.

[13] Yasser Kamal Hassan, Mohamed Hashim Ab d El-Aziz, and Ahmed Safwat Ab d El-Radi, "Performance Evaluation of Mobility Speed over MANET Routing Protocols" *International Journal of Network Security*, Vol.11, No.3, pp.128-138, Nov. 2010.

[14] Boukerche A, El-Khatib K, Xu L, Korba L (2005) An efficient secure distributed anonymous routing protocol for mobile and wireless ad hoc networks. Computer Communications, Volume 28, Issue 10:1193–1203

[15] Moaveninejad K, Song W-Z, Li X-Y (2005) Robust position-based routing for wireless ad hoc networks. Ad Hoc Networks, Volume 3, Issue 5:546–559

[16] Rango FD, Gerla M, Marano S (2006) A scalable routing scheme with group motion support in large and dense wireless ad hoc networks. Computers&Electrical Engineering, Volume 32, Issues 1–3:224–240

[17] Ghosh RK, Garg V, Meitei MS, Raman S, Kumar A, Tewari N (2006) Dense cluster gateway based routing protocol for multi-hop mobile ad hoc networks. Ad Hoc Networks, Volume 4, Issue 2:168–185

[18] Wang Y-H, Chao C-F (2006) Dynamic backup routes routing protocol for mobile ad hoc networks. Information Sciences, Volume 176, Issue 2:161–185

[19] Ahn CW (2006) Gathering-based routing protocol in mobile ad hoc networks. Computer Communications, Volume 30, Issue 1:202–206

[20] Eisbrener J, Murphy G, Eade D, Pinnow CK, Begum K, Park S, Yoo SM, Youn J-H (2006) Recycled path routing in mobile ad hoc networks. Computer Communications, Volume 29, Issue 9:1552–1560

[21] Song J-H, Wong VWS, Leung VCM (2007) Secure position-based routing protocol for mobile ad hoc networks. Ad Hoc Networks, Volume 5, Issue 1:76–86

Author Profile:

Mr. Chethan Chandra S Basavaraddi : pursuing M.Tech (CS) from Department of Computer Science, University B.D.T. College Of Engineering Davangere–577004, Karnataka. Visvesvaraya Technological University, Belgaum, Karnataka - India.
Ph: 09916704280, 09844508359, India.

Smt. Geetha N.B. M.Tech : Asst. Professor, Department of computer Science, University B.D.T. College Of Engineering Davangere–577004, Karnataka, India..
Ph:09480794017

Smt. Anitha G. BE,ME : Chairperson,
Department of computer Science, University B.D.T. College Of Engineering Davangere–577004, Karnataka, India.