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SECURE AND EFFICIENT METHOD FOR INCREASED NETWORK LIFETIME IN WSN USING MOBILE ADHOC BASED CPS

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Abstract— In recent times, the advancement in the wireless communication and network security has made it possible to connect and operate numerous devices by constructing reliable networks. Efficient topology control methods ensure energy saving in static networks. Mobile ad-hoc based CPS are most suitable platform for constructing networks. The deisgn faces some major research challenges, namely the need to enhance network connectivity constructed and to reduce the energy consumption and end-to-end delay between the nodes. To address these research challenges, a novel technique called mobility aware local tree based reliable topology is introduced (MA-LTRT) along with reliable route establishment algorithm. The much needed approach of providing security for data is also taken care in this project. Thus, a security mechanism which provides authenticity and safeguards the information during its transmission is introduced using Blowfish algorithm.

Keywords— Mobile Ad-hoc Based CPS,Energy Consumption, Network Connectivity, MA-LTRT

I.INTRODUCTION

The cyber physical system has emerged as crucial co-domain in network security and has attracted many researchers as it provides reliable modelling of physical system. In addition to this the mobile ad-hoc networks (MANET'S) also possess huge research opportunities and it not only minimizes the energy consumption, but also improves network connectivity. The energy saving is ensured in the static networks by the use of topology control methods. Each node will be able to decide its appropriate transmission power instead of assigning homogeneous value to the whole network by using topology control algorithms. Therefore, this project focuses on evaluating the effect of moving nodes on network connectivity. The study takes into account some well known localized algorithms, namely Local Minimum Spanning Tree (LMST) [3] and the recently proposed Local Tree-based Reliable Topology (LTRT) [2] which is capable of generating reliable topology for static networks. Using these algorithms as the base, new characteristic feature "mobility aware" is proposed and mobility aware local tree based reliable topology is designed and proposed. Data security and authentication is provided in this project which is the major and vital contribution of this project along with the reduction of power consumption and better network connectivity [1]. Thus, the at most care is taken to efficiently and reliably transmit the data. The algorithm used in the data security is "Blowfish algorithm".

II OVERVIEW OF THE EXISTING TOPOLOGIES CONTROL METHODS AND THEIR SHORTCOMINGS

In the past, many topology control algorithms were proposed. Examples of these algorithms include Cone based distributed topology control (CBTC), Local minimum spanning tree (LMST), Local tree based reliable topology (LTRT) and so forth. CBTC is topology developed by Li et al [4].

In CBTC, every node sets its range of transmission to connect with its neighboring nodes, which are on the fan shaped area. The angle of their contact is denoted as α. In this method, all nodes can decrease its transmission range when the value of α is more as the probability that the neighboring node exists in the area rises with an increasing value of α.

Accordingly, it is observed that when $\alpha < 5\pi=6$, the network connectivity is ensured [4]. The shortcoming of the CBTC is that it creates too many redundant links while constructing the network topologies. Hence, this topology demands more power consumption. The LMST is the topology control method based on features and design of structure of tree [5], [6]. In LMST, every node constructs the topology based on the MST (Minimum Spanning Tree) [7] with the data from only neighboring nodes which are at distance of 1 hop. But, since this topology, which is created by LMST, is a directed graph, add on messages are necessary to calculate the non-directed graph.

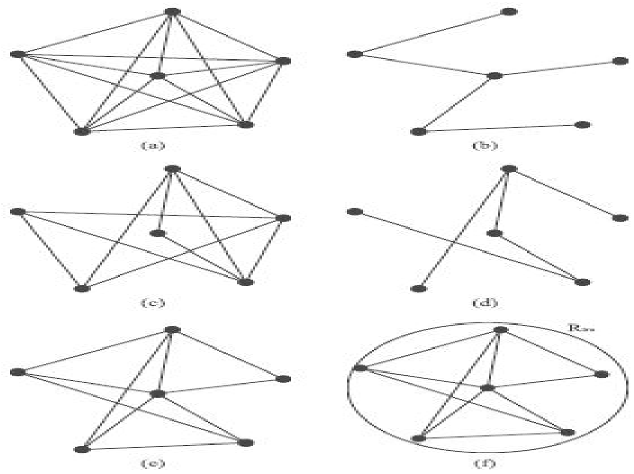


Fig 2.1 An example of construction of topology in LTRT (a) Complete tree, (b) 1st MST, (c) (a)-(b), (d) 2ns MST (e) (b)+(d), (f) Setup of radius

In LMST, every node constructs the topology based on the MST (Minimum Spanning Tree) [7] with the data from only neighboring nodes which are at distance of 1 hop. But, since this topology, which is created by LMST, is a directed graph, add on messages are necessary to calculate the non-directed graph. Accordingly, in LTRT [8], topologies are created based on LMST and Tree-based Reliable Topology (TRT) [9].

This technique assures *k*-edge connectivity, i.e., if the number of failure links is smaller than *k* connectivity in network is sustained and not lost. Fig. 2.1 depicts an example in which a node constructs a topology so that the redundancy of the topology is set to two in LTRT.Fig. 2.1(a) depicts the example of the complete tree constructed by the six nodes.

Using tree, the node favours a first MST as shown in Fig. 2.1(b), and saves the topology information at first. Now, the node chooses another MST from the tree so that the first MST is removed from the complete tree. This is denoted in Fig. 2.1(c).

The second MST becomes totally distinct from the first one as shown in Fig. 2.1(d). The prime motive behind selecting LTRT for such a CPS is due to LTRT's ability to control ``redundancy" (i.e., redundant net- work connectivity) effectively.

III THE MOBILITY-AWARE LOCAL TREE BASED RELIABLE TOPOLOGY

In the earlier LTRT algorithm only the 2 parameters envision was performed, those are communication range and energy associated with the node. The distance parameter was not considered. Hence, in this project the distance parameter is considered and is envisioned. The 4 basic parameters governed in this project are Energy consumption, Average moving speed of node, Network connectivity and Delay.

The Packet delivery ratio (PDR) is the ratio between the total numbers of the message packets successfully received to the total number of packets transmitted. To improve the PDR it is necessary to consider energy, distance and communication range together and analyze. The transmission type considered here is the packet transmission type.

While transmission if in case the node fails, the procedure is to find the shortest path and send the message through the shortest path node. The most vital improvement done in this project is the information security while transmission, which is needed to ensure the authenticity in communication and to safe-guard the information from eavesdroppers.

A. METHEDOLOGY

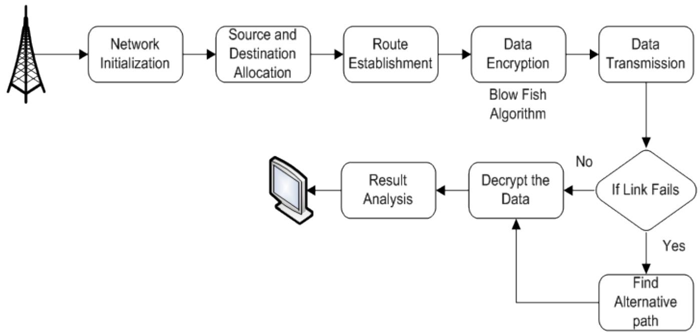


Fig 2.2. Architecture of proposed MA-LTRT method

The improved version of LTRT could provide reliable communication in the mobile ad-hoc networks to an extent as it preserves a certain level of redundancy of network connectivity.

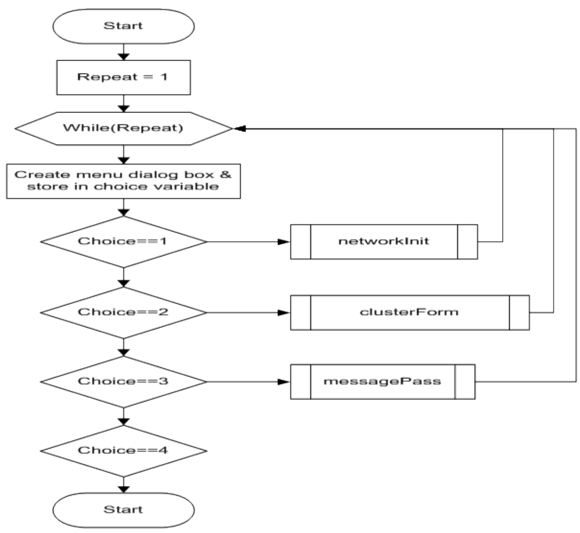


Fig 2.3. The overall Flowchart of the MA-LTRT

The Figure 2.2 depicts the Block architecture of the proposed MA-LTRT method and fig 2.4 shows flowchart. The network of the nodes present within the Mobile Ad-hoc are initialized, which further starts forming into topology depending upon the MA-LTRT topology algorithm. Further, the Cluster heads and the other branches are formed. The cluster head broadcasts the "HELLO" Message to the neighbouring nodes, this process is termed as "Beaconing". When the beaconed message is accepted by the free node the topology is formed with respect to the Cluster head.

A1. NETWORK INITIALIZATION

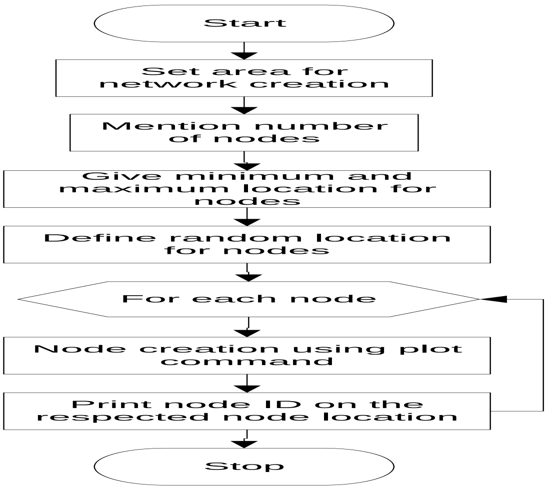


Fig 2.4 Network initialization process flowchart

As shown in fig 2.4, for network initialization, the 100x100mm area dimension is used with number of nodes as 20, with the location of x and y, respectively. Setting initial parameter for nodes like type of nodes, node identification (node ID), node energy and setting the node size.

A2. SOURCE AND DESTINATION SELECTION

In this model, the source node as well as destination node for sending the respected data by entering the respective source and destination numbers during the execution time is selected.

A3. RELIABLE PATH ESTABLISHMENT

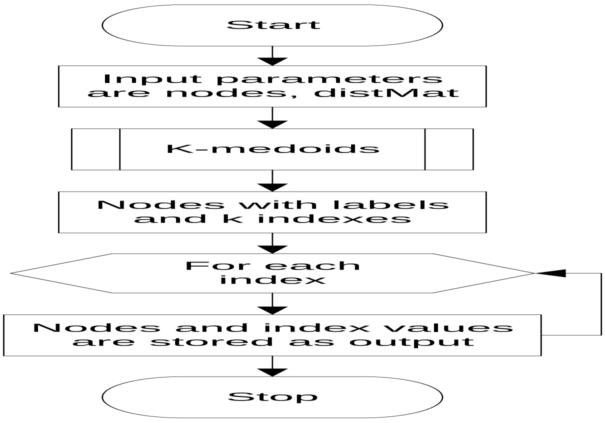


Fig 2.5 Reliable path establishment process flowchart

As shown in fig 2.5, the allocation of source and destination nodes is done manually during execution process.For reliable establishment of the path, the vital parameters necessary for this are source, destination and intermediate nodes. Note that all these 3 parameters act as the inputs. The transmission range is considered as 30m.

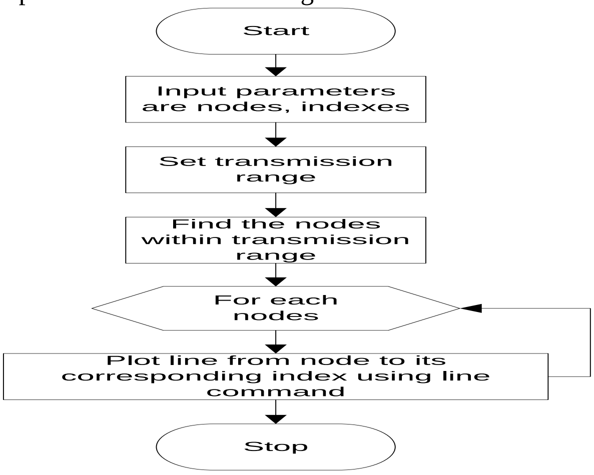


Fig 2.6. Transmission range setting process flowchart

If the range lies within transmission range, the directly the data transmission is carried out or else the nodes which are within the range needs to be found out and the shortest transmission path needs to be found out and selected, as shown in fig 2.6. For convenience, the shortest node is renamed as "Ranged nodes". All these steps are repeated until the message is transmitted successfully.While finding shortest path, the intermediate destination acts as the source for the next level node and so on till the message is successfully transmitted and efficiency of 100 % transmission is achieved.

A4. ENCRYPTION

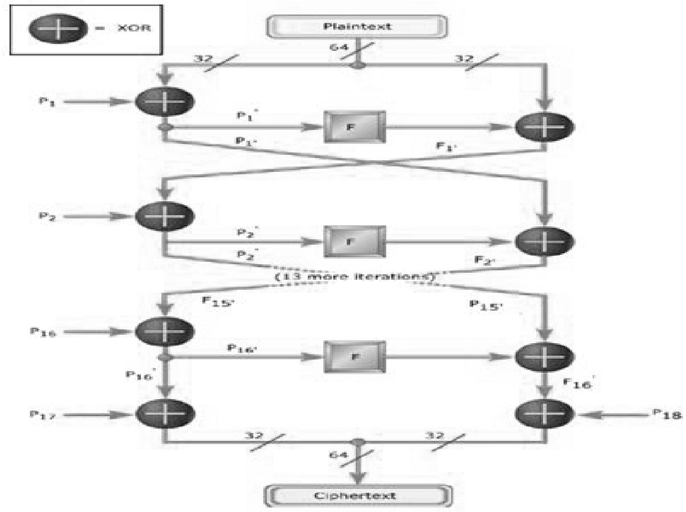


Fig 2.7. Blowfish algorithm flowchart

As shown in fig 2.7, n this project, it was vital to consider the complete message and divide it into user data sub-segments band the transmit it. If this is achieved only then message is transmitted efficiently. Thus, to meet this requirement of the "Blowfish algorithm" which has been considered. Further, the transmitting of data is done using the routers which have been selected previously. Also, the checking for the node failures is done. Here the link condition is that if the link is not equal to 0, the alternative path has to be found out.

A5. DECRYPTING DATA

The message size is considered to be 4Kkb and the data (beaconing message) size is considered as 1Kb. These sizes are standard and remain unchanged throughout the project. The decryption is done using blowfish algorithm at the receiver side using the function named data transmit. Then the decrypted plain text is shown to receiver and decryption is performed accordingly. The reconstruction of MST is repeated after finding out the redundant transmission range. Finally, the power consumed and the network connectivity analysis is performed with the earlier design and observations are noted and plots are displayed. Hence, the results are obtained are their performances are analysed in detail and the observed plots are recorded.

B. ALGORITHM OF THE MA-LTRT ALGORITHM WITH DATA SECURITY

The algorithm of the MA-LTRT method is given below with the sequential steps of execution.

(1) Initialization of Network with 20-30 numbers of nodes randomly allocated location with area of 100X100.

(2) Selection of Source and Destination nodes.

(3) Establishment of Route from source and destination using shortest path algorithm by measuring minimum Euclidean distance.

$$\textit{Euclidean Distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

(4) Encryption of Data using Blow Fish Algorithm and Transmit the data.

(5) Check whether all the nodes are active or not. If Link failures, find the alternative path. The Data Decryption and receive the data and performance analysis is performed

IV THE RELIABLE ROUTE ESTABLISHMENT ALGORITHM

In AODV, the source node transmits the information through the route which is determined by the first RREQ (Route request) arrived at the destination[10].

In order to achieve the reliability of the selected route, the RRS algorithm using the concept of a *stable zone* and a *caution zone* based on a mobile node's positioning, speed and directional information obtained from GPS is proposed.

A. Stable Zone and Caution Zone

Stable zone means it is the area on which a mobile node can maintain a constant link with its neighbor node since they are located near to each other.

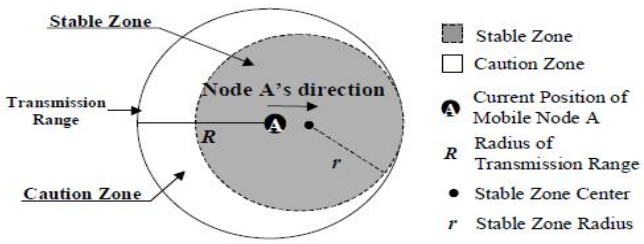


Fig 2.8 Stable Zone and Caution Zone

As shown in fig 2.8, *Caution zone* means the area on which a mobile node can maintain an unstable link with its neighbor nodes since they are located away from each other. These zones are used for coming to conclusion whether the link state between any two nodes is reliable or notThe *stable zone* and the *caution zone* change dynamically depending on the mobile node's speed and directional information.

B. Protocol Description

The Reliable Route Selection (RRS) algorithm using the concept of stable zone and caution zone is expressed, and the

procedure to apply this algorithm to the route discovery procedure of the existing on-demand routing protocol (i.e., AODV) is discussed[10]. In this project, the name of AODV is modified as AODV-RRS. In AODV-RRS, the GPS information is summed into the RREQ control packet of AODV that is initiated by a source when a route discovery is to be performed. The added fields are given as follows:
[current_mn_position (x, y), stable_zone_center (x', y'), stable_zone_radius (r)]

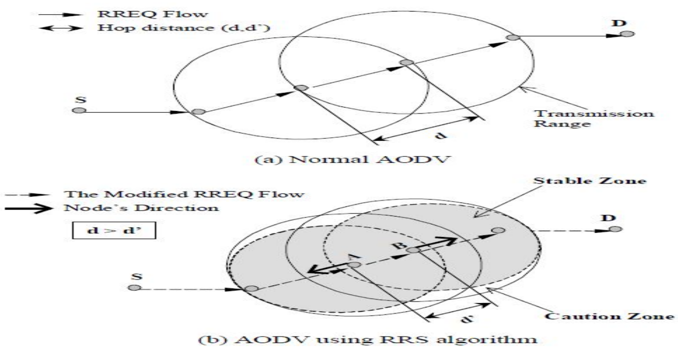


Fig 2.9 The Comparison of RREQ Flow

Current_mn_position (x, y) indicates the current position of a mobile node, stable_zone_center (x', y') indicates the center of stable zone, and stable_zone_radius (r) indicates the radius of stable zone. Fig. 2.9 shows how RREQs are flooded to the destination by AODV and AODV-RRS.

In this process when a route discovery by AODV is performed, an intermediate node floods a RREQ request to other nodes as soon as it receives a request RREQ, except when a duplicated RREQ is received and the node is not present in the destination.

If it is assumed that two adjacent nodes on a selected route are located in the border of each other's transmission range (which is, caution zone shown in Fig. 2.8). A route is created by AODV-RRS, it may have more transmission delay than a route by AODV due to the possibility of increased hop-counts of AODV-RRS (in Fig. 2.9, observe the difference of hop distance (*d* > *d*')).

In this analysis, it is assumed that the maximum speed of a mobile node is 12.5 m/sec. Hence, it is extremely needy to determine the optimal value of the equation *stable_zone_radius(r)*.

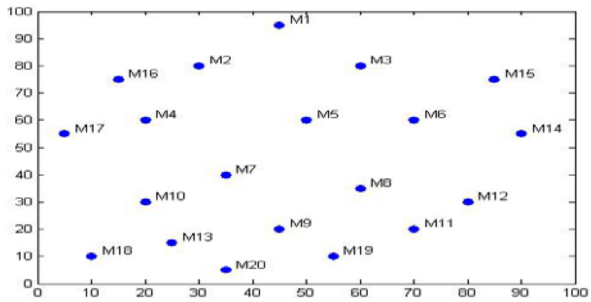
$$r = R - \beta \times S_{MN} \quad (1)$$

As shown in equation 1, in this context, *stable_zone_radius(r)* is found out by the above expression, where β is the constant value that determines the range of *stable_zone_radius(r)*, R is the transmission range of a mobile node, and S_{MN} is the speed of the mobile node. As mentioned above, although higher value of β makes a more reliable route, but it causes large number of hop-counts.

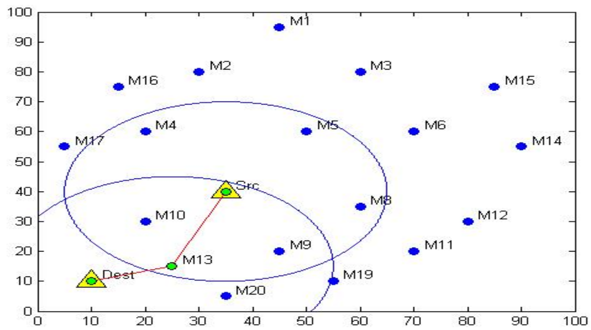
IV RESULTS ANALYSIS

The sequence of execution in this project is depicted by the functional plots as shown below. The sequential functioning of network initialization, route establishment, data transmission after encryption, re-transmission on link failure, energy consumption and number of nodes relation, end-to-end delay and average node speed are diagrammatically represented.

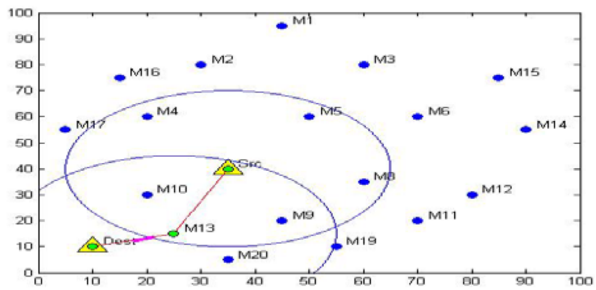
- **Network Initialization**



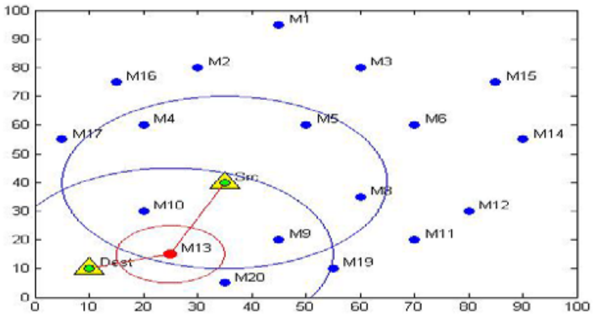
- **Source(SRC.) and Desination(DEST.) selection with the Route Establishment**



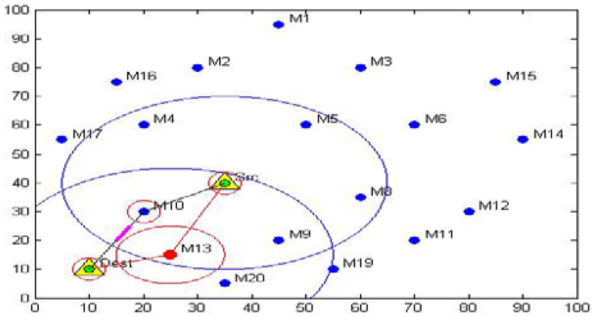
- **Data Transmission from SRC. TO DEST.**



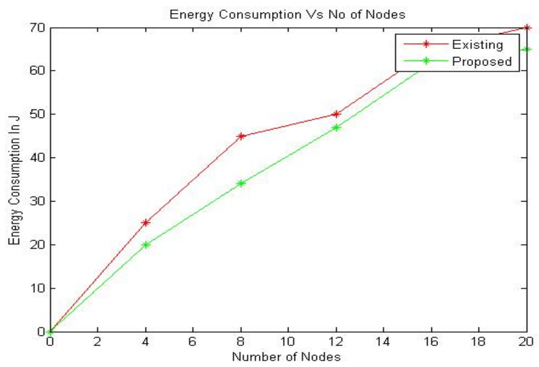
- **Fault node detection**



- **Re – transmission of the message by using shortest path available**



- **Energy consumption v/s number of nodes plot to compare the existing and proposed methods energies**



- **Average end-to-end delay v/s number of nodes plot to compare the existing and proposed methods delays**
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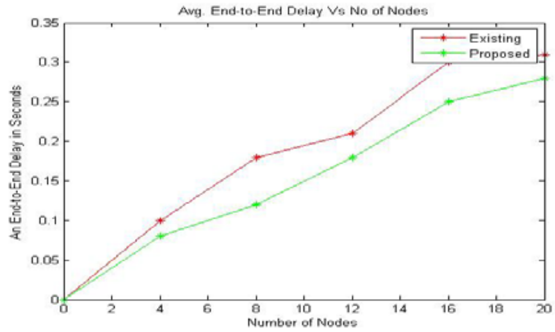
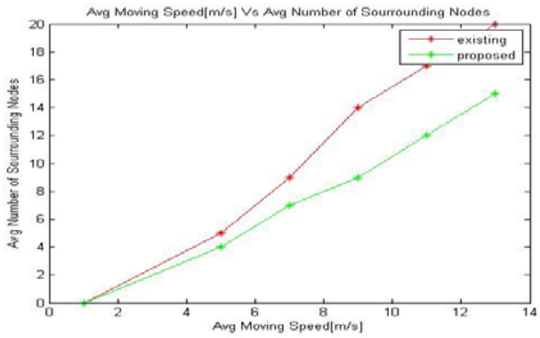


- **Average moving speed v/s average number of surrounding nodes plot to compare the existing and proposed methods average moving speed**



V CONCLUSION

On executing proposed method and analysing the results after execution, it is concluded that the design successfully caters the motive to meet the design challenges. On observing the plots generated after execution it proves that the proposed method's results are much efficient and design challenges of improving network connectivity and decreasing energy consumption and end-to-end delay between nodes is been fulfilled.In this proposed method an effective method to dynamically re-establish the link immediately after link failure is also introduced. It played vital role in improving network connectivity.

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