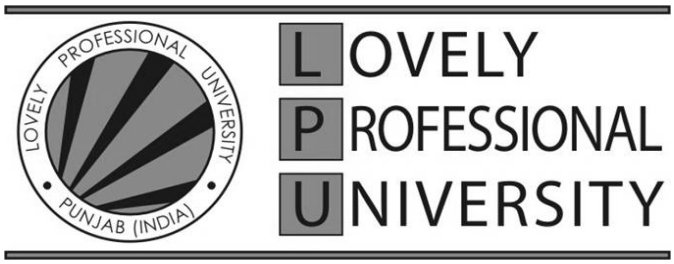

AN OPINION DYNAMICS BASED ADVANCE STABLE ELECTION PROTOCOL IN THREE LEVEL HETEROGENEOUS WIRELESS SENSOR NETWORK

A Dissertation Proposal
submitted

By

Virpal Kaur

to

Department of Computer Science

In partial fulfilment of the Requirement for the

Award of the Degree of

Master of Technology in Computer Science Engineering

Under the guidance of

Er. Vikram Dhiman

(Assistant Professor)

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LOVELY PROFESSIONAL UNIVERSITY
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School of:Computer Science and Engineering

DISSERTATION TOPIC APPROVAL PERFORMA

Name of the student	:Virpal Kaur	Registration No	:11300848
Batch	:2013-2015	Roll No	:A25
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Details of Supervisor:

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Specialization Area:Network and Security(pick from list of provided specialization areas by DAA)

Proposed Topics:-

1. WIRELESS SENSOR NETWORK(WSN) Energy aware Routing Protocol for WSN in Heterogeneous N/W
2. ADHOC NETWORK
3. VANET

Signature of supervisor 18360 18/09/17

PAC Remarks: Performance investigation of previous routing Protocol with the proposed routing Protocol.

APPROVAL OF PAC CHAIRMAN Signature: Date: 11/10/17

*Supervision should finally encircle one topic out of three proposed topics and put up for an approval before Project Approval Committee (PAC).
*Original copy of this format after PAC approval will be retained by the student and must be attached in the Project/Dissertation final report.
*One copy to be submitted to supervisor.

Abstract

Wireless Sensor Network has become a foremost field of investigation in communication field. There are various extensions of WSN like MANET, VANET etc. Due to its vast applications, it is inherited with several challenges. The challenges lies in improvement of energy efficiency, reliability, network lifetime etc. Stability period is very important to a network as a large instable region would reduce the packet delivery ratio severely. The stability period is explained as the time from the emergence to the time at which the opening node expires. Censorious matter of wireless sensor networks (WSNs) is enlarging the span of performance (lifetime). Because of finite energy resources, their exits number of deficiencies. This becomes a major problem in heterogeneous networks as LEACH is not effective in this case. This paper proposes a novel opinion dynamics model based Advanced Stable Election Protocol designed for reducing the instable region in a network with three level distribution of energy. The opinion dynamics modelling is based on the nature of human discussion where people discuss with different opinions of their own and finally arrive at a common conclusion. A social influence factor is calculated and opinions are updated accordingly. The probabilities of each node for being selected as cluster head are optimised using this model. The results are found to be quite encouraging and the instability region is shown to very narrow. The packet delivery ratio is also seen to be improved.

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CERTIFICATE

This is to certify that Virpal Kaur has completed M.Tech dissertation Titled **An Opinion Dynamics based Advance Stable Election Protocol in Three Level Heterogeneous Wireless Sensor Network** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of the dissertation has ever been submitted for any other degree or diploma.

The dissertation is fit for the submission and the partial fulfilment of the conditions for the award of M.Tech Computer Science & Engg

Date: _____

Signature of Advisor

Name:

DECLARATION

I hereby declare that the dissertation proposal entitled, **An Opinion Dynamics based Advance Stable Election Protocol in Three Level Heterogeneous Wireless Sensor Network** submitted for the M.Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

Date: _____

Investigator

Regn. No. _____

CHAPTER 1
INTRODUCTION

Wireless Sensor Network (WSN) is a mesh network composed of nodes having the properties of self-healing that allows the link association of nodes to reconfigure them and try to find the alternate paths for the nodes where the link fails or powered-down nodes and self-organizing because it provides permission to a network for configuring the changes due to joining of new nodes without manually do the changes. Wireless sensor network is reposed of an enormous amount of tiny sensing elements in computer network environment. Sensing elements have the effectiveness of sensing the surrounding behaviors. Sensing nodes are the powerful enough to gather the data from different devices, stored data, sensing and transmitting information in the network. In sensor network, nodes are not required to be installed, as these can be deployed easily anywhere in the network. The gathered data from different devices can be retrieved.

A wireless sensor network is a consolidation of various sensor made devices that communicated without any requirement of wires. The sensor nodes are of low cost thus it is cheaper to install and data transfer requires no wiring. A wireless sensor network has inbuilt capability that it provides monitoring. It processes the structural information; wireless sensors have an important role. In WSN, the sensor nodes are cooperative in nature.

In wireless sensor network, for processing of gathered data impressive computational resources are available. Wireless Sensor networks have auto organizing capability which is implemented in MANET systems. Individual element is a collaboration of different number of processing elements, memory units, actuators, sensors, a power source and RF transceiver. Wireless Sensor Network is a latest technology that has an ability to coordinate a large network into a single network. It consists of large number of devices which are of low cost. Wireless Sensor Network is a distributed system which is light weighted in real life scenario. There is no need of external infrastructures in wireless sensor network to communicate with other devices. The sensor in wireless sensor networks are deployed as self-organized and multi hop in nature. The wireless sensor networks consume a lots of energy while transfer

data from one device to other. There is need to adjust transfer and sensing rate to avoid power consumed in wireless sensor networks [1].

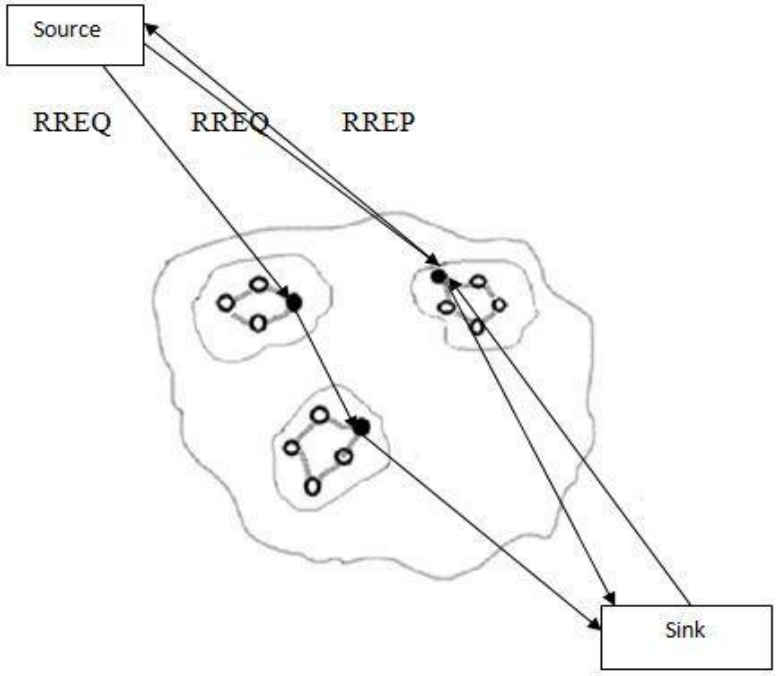


Figure 1.1 Communications through Cluster Head in WSN

1.1 Architecture of Wireless Sensor Network

The architecture of wireless sensor network is represented in figure 1.2:

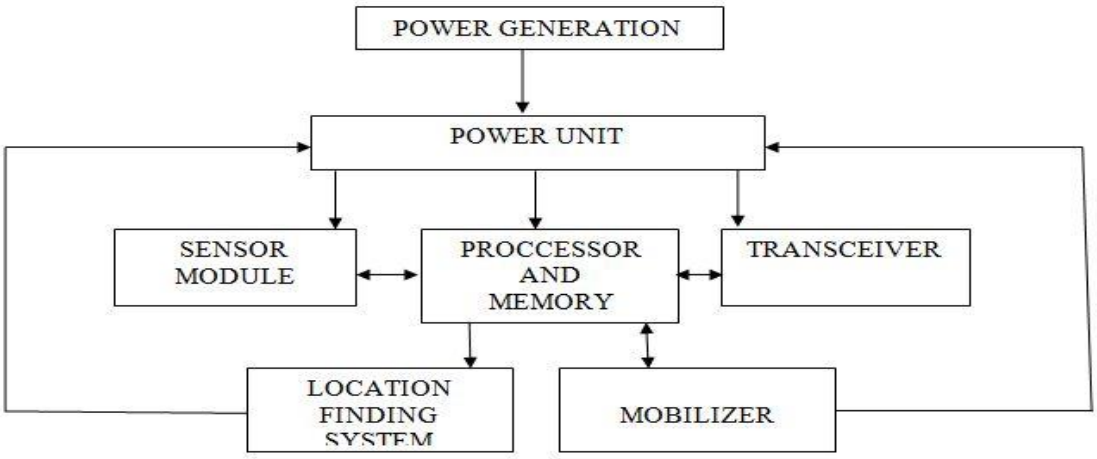


Figure 1.2 Block diagram of Single node of Wireless Sensor Network.

1.2 Characteristics of Wireless Sensor Networks

The significant features of wireless sensors networks are:

- It is easily accessible.
- Presence of mobile nodes in the network.
- It has capability to withstand with faults.
- It provides node diversity.
- When it is deployed becomes scalable in nature.
- It endures in hostile circumstances.
- Restraint for usage of battery power in nodes.
- Dynamic topology in nature.
- Installation and configuration is simple.
- It can be used in generous utilities.

1.3 Key Issues Overview

Presently various types of wireless sensor applications designed which provides the ways to development. In monitored environment, multi-tasking sensor nodes are been used to make the measurements. These nodes are fulfilled with variety of functions that can compute physical behaviour of attributes like humidity, light, temperature, acceleration, acoustics, bromidic strain, rate of change of speed, magnetic area. Data aggregation is done by Gateway bridge nodes containing maximum analysing energy, capability, and communication area from the sensors in the field and then relay to destination. WSN is the composed of both distinct and entry nodes.

Each sensor node is responsible for facilities various types of utility program on sensor elements, the growth of newly environments, storage plans and operating systems. The

communication protocols empower the transmission between sensor nodes. The sensor nodes are able to control or manage themselves efficiently in the wireless network.

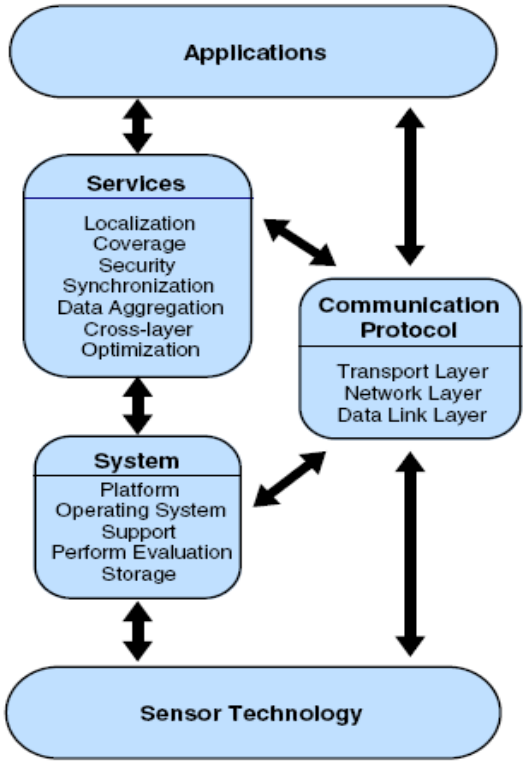


Figure 1.3 Broad classifications of multiple issues in a WSN

1.4 Problems and Energy Issues in Wireless Sensor Networks

As it mentioned before, deceasing energy consumption on different sensors in the network and attaining the standard of quality in solutions given by networks is a main challenge. In this thesis, we address a number of problems arising from several applications of Wireless sensor networks with a polynomial-time solution during emphasizing the energy minimization issue of networks. The problems are considered fall in wide categories of clustering, broadcasting, monitoring, and topology control of Wireless sensor networks. Mainly focuses on devising the distributed algorithms for problems, where different nodes are execute the algorithms to compute solutions of problem a global nature. A distributed algorithm where nodes are individually execute in that algorithm which make the decisions

without knowing the global topology of network. Although, in distributed algorithms, it lets to nodes know a little global information.

1.5 Broadcasting Issues

Broadcasting is a method by which a message, created by a node in network, that is forward to many other nodes in the network. Follow a simple coding scheme to do this. Because a lot of unwanted message transmissions are created and relayed in network that in turn, causes nodes to dissipate the valuable energy quickly. Therefore, need to devise energy efficient algorithms which can avoid or at least reduce the amount of redundant transmissions.

1.6 Virtual Backbone

Virtual backbone can be seen as to correlate of communication infrastructure in wired networks that helps to reduce the retransmissions number of energy-stiff sensors. In virtual backbone, many nodes in field are committed in transmission. Normally, a virtual backbone is responsible for relaying information throughout the whole network. The size of linked dominating set is smaller, thus only few number of transmissions in network. The problem is to calculate the connected dominating sets in a distributed way and other relevant issues.

1.7 Family of Connected Dominating Sets

A crucial observation is regarding the small sized or optimal CDSs in WSN. Although the normal focus of research for the broadcasting algorithms is to attain small cardinality connected dominating set, creating a single connected dominating set and use all time that causes the nodes into connected dominating sets to run out energy faster than other nodes. It is because of the nodes in associated dominating sets can be responsible for forwarding the messages in the network on the behalf of other nodes, when any node in network has few messages to broadcast. Consider the vital aspect, the problem of computing the linked dominating sets in a distributed manner like that only one connected dominating set is active for particular period of time. Therefore, using CDSs iteratively, we can expect to

substantially decrease the energy consumption of the different nodes by repeatedly switching them back and forth from active to sleep mode and enhance the lifecycle of the network. The life validity of WSN will be elapsed time between the placement of the sensors and the time when the sensor run out of an energy.

1.8 Clustering

Clustering is a heavily discussed topic in WSN community, the motive is to portioned the entire network area in a group of clusters and choose one node as a cluster head from an each of clusters. Each CH is supposed to be active and coordination works, e.g., sensing, data gathering, and transmitting data on behalf of the cluster to the destination or sink, while remaining nodes that is the cluster member can go into the sleep mode. One of the basic problems in clustering is to decrease the number of CHs under condition which for any node in networks either a CH or connected to at least one CH. It would leave the sensors in an energy-efficient sleep mode. This problem is known as the dominating set problem. Although, as the set of CHs is busy for all the time for processing, sensing, and transmit data, they immediately run out of energy, while another nodes are left with considerable energy. This causes a significant imbalance in energy the reserve in nodes and decreases the network lifetime. The probable form to control the bearings is to treasure a family of the disjoint sets of CHs or change them active iteratively like that energy consumption is balanced in all the nodes in network.

1.9 Disjoint Dominating Sets

WSN addresses the following issue: Given a Wireless sensor networks, find the dominating sets in large number from disjoint group. A graph set is a subgroup of the nodes in such a way that any node can either be subset or a neighbour of few nodes in subset. Searching a graph for disjoint sets is called as the Domatic Partition problem. The dilemma of treasure trove the enormous number of disjoint dominating sets in sensor field or displays centralized algorithm to solve a problem.

1.10 Target Monitoring

Monitoring is extensively discussed topic in sensor area networks. Generally, the goal of research in this line is to devise scheduling algorithms that different sensors in network are assigned time-slots that indicate to them while which time-slots that will be active and during that time-slots they will sleep. Provide a Wireless sensor network that monitors specific targets, it is sometimes possible to find only a subset of sensors and engage to do the monitoring activity. Therefore, instead of creating all nodes active for purpose, choose possibly a small subset that can guarantee the same monitoring. The observation leads researchers to devise efficient algorithms such that at any time only a small number of nodes are made active to monitor all the targets in question inspections the target monitoring problem. Provide a set of stationary targets T and a set V of sensors, problem asks for creating a family of the subsets of sensors that called the monitoring sets, like that every monitoring set monitors of all the targets. The monitoring sets are iteratively created active in order to give continuous monitoring to targets. The objective of problem is to increase the number of sets and increase the maximum number of the participations of sensor in monitoring sets.

1.11 Self-Protecting WSNs

An interesting problem that deals with sensors is the level of protection by other sensors. Sensors give monitoring to the targets, it is necessary to provide them level of protection like that sensors may take specific actions when attack has been targeted on them. A natural idea is to sensors by neighbours such that the neighbours can inform base station when sensors are in danger. Sometimes it required to know that every sensor in network is in better health to render the tasks. A bad sensor, a malfunctioning and dying out sensor could not inform base station of its condition, targets are monitored by bad sensor that become unprotected or the system has no other way to know about vulnerability. In case, we need to find subset of the sensors whose function has to monitor the sensors, like that any sensor fails or cannot functioning properly on these sensors that will notify base station of situation.

The base station takes certain actions, such as, placing additional nodes in the replacement of non-functioning ones to give continuous protection to the targets. Keep in mind, the p-self-protection subset problem has formally. The p-self-protection subset problem is defined to be a subdivision of nodes is done in such a way that for any node

appearing in the network field there are at least p nodes from subset that monitor it. The problem of p-self-protection is (p _ 1).

1.12 Topology Control Problems

Topology control is pivotal problems that received lots of attention while its numerous applications in Wireless sensor networks like as connectivity, coverage, and routing. The main idea is to attain a sub-graph from underlying network to remove some links to enhance the performance of network in some ways. In general, topology control algorithms deals with search a suitable structure of given graph. The sub-graph is expected to have certain features that mainly facilitate routing decisions in the network. Finding a topology in above features has specific advantages. The number of routing algorithms involving the well-known GPSR can only be applied if and only if network topology is planar.

The smaller neighbourhood is faster information processing of node. Having some neighbours causes a minimum of transmissions that helps prolong the lifetime of network by limiting the no. of retransmissions. Topology algorithms to remove longer links in network and keep them smaller ones long links consumes much more power than the shorter links for transmission. It saves the energy in long run for routing or helps to extend the network's lifetime. It begins in showing the cases where an error in exact geographic position, and the distances between neighbouring sensors, that can create algorithms yield unwanted results. The strong and resilient local algorithms with the realistic assumptions are those which supposed to give an `acceptable' performance in average cases. This chapter provides theoretical and experimental results.

As centralized algorithms may not be compatible in large Wireless sensor networks due to energy and scalability issues, in this thesis design energy-efficient has distributed and local has algorithms to address the aforementioned problems. There are distributed solutions which are fast, scalable, and easily implemented in Wireless sensor networks for the problems except for domatic partition problem, where provide a centralized algorithm.

Thus the contributions of the thesis are:

- For connected dominating set problem, design and analyzes a fast, distributed or constant-approximation algorithm for.
- Solve energy consumption issue of sensors in balanced way by creating a set of connected dominating sets in distributed fashion.
- Develop a technique for problem of approximately searching the unit disk graphs with maximum number of dominating sets.
- Presenting the local solution to target monitoring problem.
- Provide a distributed constant-approximation algorithm for self-protection problem.
- Introduces an easily, fast, implement able local algorithm for topology control problem in WSNs.

1.13 Thesis Outline

The remaining part of work includes: Chapter 2 discuss the various literature work in this area and an extensive survey of a few papers is provided. Chapter 3 presents the proposed methodology. The results are shown and explained in Chapter 4 and lastly Chapter 5 discusses the conclusion of work and the future works that can be done.

CHAPTER 2
REVIEW OF LITERATURE

S. Swapna Kumar et.al (2012), "Energy administration of compound organization of routing in Cluster Based WSN" discussed about the fundamental issues of wireless sensor network that makes it more efficient is power management. Their main concern was to make energy efficient system [2]. This paper also defines the hierarchal clustering with sleep scheduling. The author discussed the novel architecture of the layers. The analysis for performance of simulation results for various models with APIT, DV-Hop, ROCRSS and amorphous techniques are mentioned. Individual research has been carried out for routing path clustering, optimization, sleep scheduling and routing towards meeting the goals of Quality of Services (QoS). The main challenge still remains unresolved for optimal cluster building because of pros and cons of two distinguished methods of cluster building namely centralized and distributed. More energy is consumed in ideal listening. Based on the novel approach as discussed, the new architecture for cross-layer protocol is formed that have great deal of optimizing energy consumptions and provide a better QoS. The proposed architecture is ready being made available in the Firmware for the new design of sensor hardware.

There have been various attempts at the problem of clustering in wireless sensor networks for heterogeneous conditions. Numerous researchers have proposed various techniques for the same. In [31] Aderohunmu et al. proposed that WSNs are equipped to solve many complicated operations, in field executing that need energy related sensors for constant power to enhance the network life-period specifically in diversity regions. These schemes are implemented to optimize the power depletion in sensor fields. The enhanced SEP cluster in 3-level settings of node is maximizing the entire network life-period. Simulation outcomes prove that Enhanced-SEP consequences in better performance compared to existing clustering techniques in both homogenous and heterogeneous settings.

In this paper, Katiyar, Vivek [2], proposed that the demand of wireless sensor networks is increasing now-a-days in various areas such as battle field surveillance, disaster mainframe, and border security surveillance which is described by Hart, Quaritsch, Dudek and Bokareva.

In various areas, enormous sensing elements are placed which may not even noticed but doing job continuously. Clustering is fundamental way to increase the validity of sensor field by decreasing energy depletion which further makes the network more scalable. Analysts in field of wireless sensor know that these elements are comparable, but these may be of individual battery powers to increase life-period of a WSN. In this research, the crunch of diversity in WSNs will display the characteristics, goals, complications etc.

Amir Shiri et.al (2012), "Newly operating caching way to assurance the desire transmission reliability in WSN": This paper proposes a way to overcome the damage of data packets by caching information in few of sensor area nodes. These nodes are the mixture of Extended NACK and Active Caching methods known as New Active Caching (NAC).The proposed [5] approach used in this paper is the combination of Active Caching and Extended NACK approaches. In order to increase the reliability in Extended NACK approach some of the nodes are considered as caching nodes. Consider a network with eight nodes. In this network, nodes are taken as caching nodes. Packets were sent by source node will reach the sink based on multicasting method. The transmitted packet by source node has successfully reached node 1. Node E will transmit the packet so it can reach the sink through node F. If node E does not receive the transmitted packet again in a certain time, it will infer as node F has not received the packet and packet loss has occurred and it will send a NACK message to node D consequently and node D will send the same NACK message to caching node C. After receiving the NACK message by caching node C, this node will re-transmit the packet. As a result this seems to be optimized in factors such as delay in packet transmission, number of transferred packets and energy consumption. The common methods used to recover information in case of packet loss in WSN being E2E and HBH methods. The results indicate that AC method shows a better performance in comparison to previous methods, hence a new approach which tries to reduce the number of NACK message and increases the lifetime of the network. This approach is called NAC was compared with AC method. Results of the simulations indicate that the proposed approach in parameters such as transfer delay of packets, number of transmitted packets and energy consumption demonstrates better performance.

In [7], Divya, C. proposed that wireless sensor networks are commonly sensors distributed in a area where various kinds of data is sensed, after that this information is relayed either to rest of the elements or to final destination or sink. Such elements can sense the differences in physical framework such as –pressure, temperature, speed, velocity etc. This information can be sensed by all elements in the field are passed to destination for final evaluation. The wireless areas are useful in various jobs like habitat monitoring, forest fire detections, military surveillances, landslide detections. Here the modern clustering scheme is presented by correcting the SEP for diverse sensor network, called EE-SEP.

Basilis Mamalis et.al (2009), "Clustering in WSN" have presents the gathering of elements in clusters, ordered routing and information collecting protocols also favours the scalability of nodes. Hierarchical clustering depletes the power consumed in transmission and decreases the quantity transmissions between the nodes and sink. This protocol offers rapid concurrence and reduces the power used [9]. In the clustering techniques nodes make quick arrangements. This paper gives lights over area of multi-hop transmission and multi-level clustering.

In this paper, Kumar, N. [14], proposed an adequate solution to maximize the lifetime of WSN. The clustering algorithms basically utilize two techniques, first one is the selection of cluster head by more residual energy, second one is the rotation of cluster heads on probability basis periodically, for same distribution of energy consumed with generic nodes in cluster hence enhances the lifetime. To forward the data packets to base station, cluster heads make cooperation with cluster heads, on the probability the cluster heads are selected and large residual energy node cannot be opted as cluster head.

In this, Mishra, Yogesh et al. [15] proposed the energy efficiency which is a key issue to design the protocol, because its sensor nodes have time energy of battery backup. There are multiple modern protocols that extend the lifetime of wireless sensor network with efficient battery power of sensor node. In this proposed a newest protocol Energy Level Stable Election Protocol in the Wireless Sensor Network. It analyzes and compared the results and performance of modern protocols like ESEP, LEACH, SEP, TEEN and TSEP with ELBSEP.

The simulation conclusion displays that performance and throughput of proposed protocol that provides the effective and significant the energy efficiency with more network lifetime compared to protocols.

In this paper, I.F. Akyildiz [16] proposed that each sensor node has various components: an internal antenna, a radio transceiver or a microcontroller, connected with antenna, which has a battery power or in build energy source. The sensor nodes can changes, according to the size, functionality, type, complexity and applications of the different sensor nodes. The cost of multifunctional sensor is mainly larger than the normal one functional sensor node. Cost and Size deficiencies of generic nodes results in analogous ceiling on the assets which includes memory, power backup, efficiency, computational speed, processing speed, durability, accuracy and communications bandwidth.

In this paper, Faisal, S [17] proposed that, Wireless Sensor Networks is combinations of huge number of generic nodes that co-operate to achieve a sensing function. A hybrid routing protocol Zonal-Stable Election Protocol is responsible for transmission in heterogeneous WSNs. In this, some nodes can transmit data and information directly to base station during some use clustering method to transmit information to the destination or sink. It implemented Z-SEP and compare with LEACH and SEP protocols. The simulation results displayed that Z-SEP increased the stability period or throughput than included protocols like LEACH and SEP.

In this thesis, I.F. Akyildiz et al. [22] proposed the idea of sensor networks is illustrated by creating the micro electro-mechanical concurrence system technology, digital electronics and wireless communications. First task is to explore the energy of sensor network and take the review of influents that affect the design of given network field. After that outline the architecture for communication between the generic nodes, then protocols and its algorithms are designed and developed for an each layer.

CHAPTER 3
PRESENT WORK

3.1 Problem Formulation

Long standing problems are energy management and clustering in wireless sensor network. In today's scenario the on-going challenge is to find a mechanism to efficiently transfer data with improved throughput, network efficiency, and energy and network lifetime in WSN. The life-period of a network is stated in several ways:

- The period when nodes start transmitting data until the death of first alive node.
- The time for the node to start transmitting data to the death of last node in network.

A term known as instability region is defined as the period gap among the depletion of origin and final element in sensing area. The aim of this thesis is to minimize this instability period as far as possible.

3.1.1 The Problem of Clustering

The clustering problem involves the design of clusters, number of nodes in particular cluster and election of CH among cluster members. The clustering phenomenon can be explained briefly as follows.

- Cluster members can communicate directly with their CH of a cluster
- The data collected from cluster members is relayed by CH to the central sink or base station by passing through all other CHs

The major objectives of Clustering can be summarised as:

- Data aggregation is allowed
- Reduce the data relaying rate
- Resources can be reusable
- Virtual backbone is formed by CHs and gateway nodes for inter-cluster routing
- Cluster create the more stable and smaller structure of network
- Overall lifetime of network is improved

- Updating activities for data collection is the responsibility of CH

3.1.2 The Problem of Heterogeneity

Two broad classifications of clustered sensor networks are homogeneous in which all nodes having same battery power and hardware complexity and heterogeneous. In case of static clustering where after the chosen as CH they have to serve for the whole life-period of the field in case of homogeneous area, because the cluster head nodes are over-burdened with the longer distance for transmitting information to base station or sink requiring more processing power and co-ordination between the nodes which causes the cluster head nodes to be died before other nodes. To overcome this situation it is required that all other nodes will also lost their battery at the same time, thus minimum amount of residual energy is starved when the system ends. The possible solution can be change the appearance of a CH regardless and systematically through each node as discussed in LEACH [5]. On other hand, in case of diversified sensor field, variety of elements having various levels of energy and their operation capability is also unique. Main idea is to extra battery energy is provided too few cluster head nodes which are able to minimize the hardware cost for the remaining network but the goal of rotation is not possible for longer time. When the nodes using multi-hopping technique to grasp the cluster head, the nearby nodes to the cluster head having more burden because of relaying resulting in non-uniform energy drainage in sensor network. Lower hardware cost achieved by heterogeneous networks and uniform energy drainage achieved by the homogeneous networks are the two most important characteristics of a sensor network where both cannot be fused in the same network. The main focus of this thesis work is to contrast the behaviour of homogeneous and heterogeneous sensor networks in sense of overall network cost.

3.1.3 Instability Problem

The problem with LEACH protocol is that it has been designed in such a way that each node gets equal chance of being chosen as a cluster head of the cluster. The reason is that each node should be live for equal times so that there is minimum packet data loss. But this protocol is designed for homogeneous networks and fails in cases of heterogeneous networks where the nodes are distributed with unequal energies in the beginning. In case of

heterogeneous networks the stability period is decreased and the instability period is increased.

3.1.4 Stable Election Protocol and its Challenges

The SEP was the first to address the impact of energy heterogeneity of nodes in WSNs that are hierarchically clustered. They assign weighted probability to each node based on its energy level as the network evolves. One major characteristic of this approach is that it rotates the cluster-head to adapt the election probability to suit the heterogeneous settings that is the selection of node probabilities are based on the original energy of a node correspondence to its neighbour nodes which prolongs the chance of time interval in the area before the depletion of the origin node. SEP protocol has been used in the presence of heterogeneity. Stable Election Protocol (SEP) is the modification to LEACH protocol. In this scheme, 2 planes of hierarchy and two categories of elements (normal and advance nodes) are proposed. The diversity appraised technique having higher elements stability. SEP maintains the energy consumption balance in well-mannered. It is on the basis of glutted selection feasibility of every element to be chosen as CH in accordance with residual battery power in all elements. The power of advance nodes is higher than the normal nodes thus chances to become cluster head is more for advance nodes. The shortcoming of SEP is that the selected cluster head is not dynamic; hence nodes away from cluster head will die first. Also the energy of higher level of nodes is not efficiently utilized in SEP. To solve the problem of instability, researchers in SEP redefined a new epoch for the sensing field. There are 2 varieties of elements normal and advanced where advance having more backup power than normal nodes are used. The advanced nodes become cluster-head more times during the same epoch according to SEP model estimation. The new proposed epoch is equal to 1/p SEP considered as an election probability on the starting power of every element. In SEP, weighted feasibilities for normal and advanced elements were choosing as extra energy introduced into the network. The probabilities and the total initial energy are given below respectively:

$Pnrm = p(1+ma)$

$Padv = popt\ (1+a)/(1+m)$

$Etotalopt = n\ E\ (1+ma)$

Where Pnrm be the glutted feasibility of the normal nodes and P can be glutted feasibility for the advanced nodes and m can be the proportion for advanced nodes having greater backup power as compared to normal nodes and finally, Eadv is the entire beginning power of the field elements.

In this scheme, the issue is to design an improved stable election protocol for three level hierarchies. The nodes are to be distributed energies in three layers. 85% nodes are to be assigned as normal nodes while 10% are to be assigned as advanced nodes while 5% are to be assigned as super advanced nodes.

3.2 Objectives

The major objectives of this thesis can be summarized as follows:

- To study and analyze various energy efficient clustering techniques for WSN
- To identify the network imbalance problem in stable election protocol for WSN
- To identify the load balancing problem of cluster heads in SEP protocol
- To propose enhancement in SEP protocol to overcome the problem of network lifetime and stability of cluster heads and its member nodes
- To design a hybrid protocol for heterogeneous networks involving three level nodes
- Build an Opinion Dynamics based model for solving optimization problem and use it for optimizing the values of probabilities for each level cluster head selection in each round
- Analyze the performance of our developed algorithm in terms of packet data loss and stability period.

3.3 Methodology

Here a method is proposed to review the brunt of node's heterogeneity in WSN, in charge of energy of sensor nodes that are clustered in hierarchical manner where some nodes are elected as cluster leader known as cluster head which are responsible for aggregation of the data from their cluster members in its vicinity and relaying that information to the sink or destination. The major assumption is that some percentage from the population of sensor

nodes is having higher amount of energy resources while rest percentage of nodes acquiring lower energies which become the cause of generating heterogeneity in the network operation. Basically this heterogeneity originates from the initial setting of the network. Another assumption is that the sensor nodes or icons are scattered randomly (uniformly) which are not mobile, the dimensions and x-y coordinates of the base station in the sensor field are known previously. The behaviour of sensor networks becomes very ambiguous afterwards the depletion of leading element in existence of heterogeneity. In classical clustering schemes the energy of all sensor nodes is same which enables the nodes to take the benefits for heterogeneity behaviour in terms of nodes energy level. I am proposing an advanced SEP, which defines the nodes heterogeneous to increase the network time and stability period, which is useful where the reliable evolution is needed for many applications in the sensor network. Advanced SEP is based on an opinion dynamics based model to optimize the probabilities of each level cluster head selection. By simulation in MATLAB showed that advanced SEP enhances the stability period and packet delivery ratio as compared to (and that the average throughput is greater than) the SEP clustering protocols.

3.3.1 Advanced Stable Election Protocol

This thesis proposes an advanced SEP based on opinion dynamics for optimizing the probabilities of each level. The protocol works such that first the nodes are distributed randomly. The nodes are divided into three levels as follows:

- Level one: These are termed as normal nodes and given an initial set of energy. These type of nodes constitutes around 85% of the nodes and is expected to die first if we use the normal LEACH protocol
- Level two: These are termed as advanced nodes and given an initial set of energy higher than that of normal nodes
- Level three: These are termed as super advanced node and given an initial set of energy higher than that of advanced nodes

3.3.2 Human Opinion Dynamics Model

Modelling human behaviour has been an interesting area of research for quite a time now and a lot of theories have been put forward to emulate the real life dynamics into a mathematical

model. HOD is one such recent area which has been recently claimed to solve complex optimization problem. Although roots of this approach lies in SITO, they are found to have limited utility in high dimensionality problems and are based on discrete opinion formation. HOD model is utilized to develop an optimizer referred as Continuous Opinion Dynamics Optimizer (CODO). The model is based on the opinion formation mechanism of a group of individuals during a discussion and has four primitive fundamentals- social arrangements, point view area, social impact and restore order. Social structure forms the platform for different individuals to interact with each other where each individual are placed on the nodes of the social graph. A cellular automata model is employed with a modified form of Moore's neighborhood where all the individuals are included as neighbors of each other rather than immediate orthogonal members as in Van Neuman topology or all immediate eight neighbors as in simplistic Moore's topology. Opinion space is different from the social space and refers to a hyperspace, where the opinions of each individual affects each other and is modified under a certain update rule. An important difference of HOD based optimization from PSO is that, in opinion space, collision is possible, i.e. two individuals can have same opinion at a time while two insects cannot have the same position in the swarm at a time. Opinions are considered to be continuous here to suit our problem of optimization where optimizing parameters can have any value within a finite range. Opinions are influenced by the opinions of its neighbors depending on their social influence which is defined here as the ratio of social rank of any individual to the distance between them and is given by:

$$w_{ij} = \frac{SR_j(t)}{d_{ij}(t)}.$$

Here, SR is determined by the inverse of the fitness value of an individual, where fitness value is the error which needs to be minimized. Each individual's opinion is updated by the following rule given as:

$$\Delta o_i = \frac{\sum_{j=1}^{N} (o_j(t) - o_i(t)) w_{ij}(t)}{\sum_{j=1}^{N} w_{ij}(t)} + \eta_i(t), j \neq i,$$

Where $o_j(t)$ is the opinion of neighbors of individual i, w_{ij} is the social influence factor, and η is adaptive noise introduced to justify individualization in society after a certain consensus limit is reached. Individualization phenomena are inspired by Durkheim's theory of division

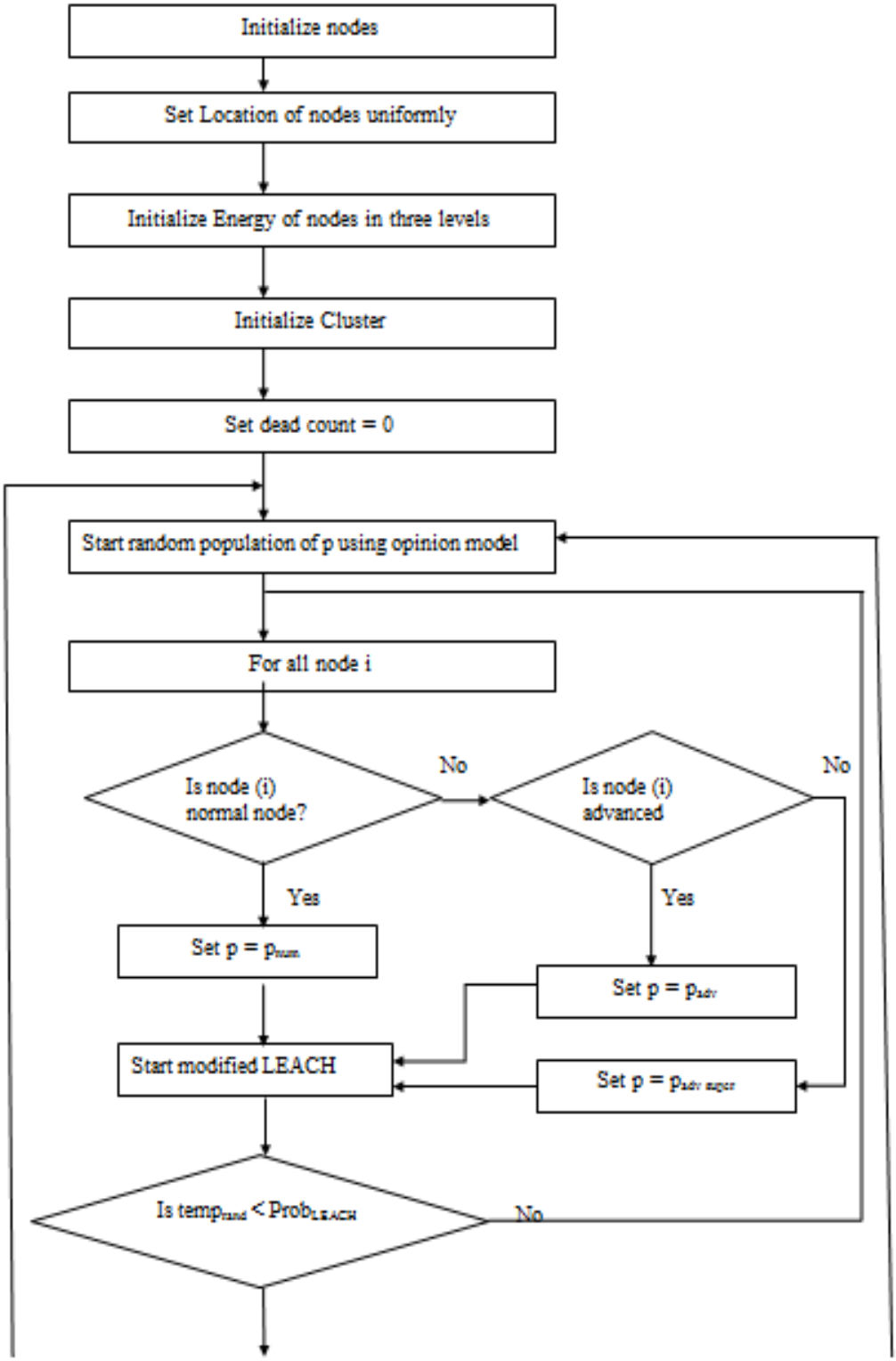
of labor in society which was used by(Mäs et al., 2010)to simulate a model where individualization co-exists along with integration in society. Similar context meaning was given by (Kennedy, 2010)to explain craziness factor introduced during development of PSO. The inclusion of this term makes the optimization algorithm more robust and increases its exploration capabilities, preventing it from being trapped in local extreme while encountering complex optimization problems. η is a normally distributed random noise with mean zero and standard deviation 'σ' and is given by:

$$\sigma_i(t) = S\sum_{j=1}^{N} e^{-f_{ij}(t)},$$

Where '*f*' is the difference in fitness factor between i^{th} and j^{th} opinion and *S* denotes the strength of disintegrating force. *S* needs to be adjusted as a compromise between individualization and integration i.e. as more number of individuals attains similar fitness, individualization increases. This increases the robustness of the algorithm at the cost of convergence rate.

3.3.3 Algorithm

The complete algorithm is shown in Figure 3.1.


Initialize nodes
Set Location of nodes uniformly
Initialize Energy of nodes in three levels
Initialize Cluster
Set dead count = 0
Start random population of p using opinion model
For all node i
Is node (i) normal node?
No
Is node (i) advanced
No
Yes
Yes
Set p = p_{nor}
Set p = p_{adv}
Start modified LEACH
Set p = $p_{adv\ super}$
Is $temp_{rand}$ < $Prob_{LEACH}$
No

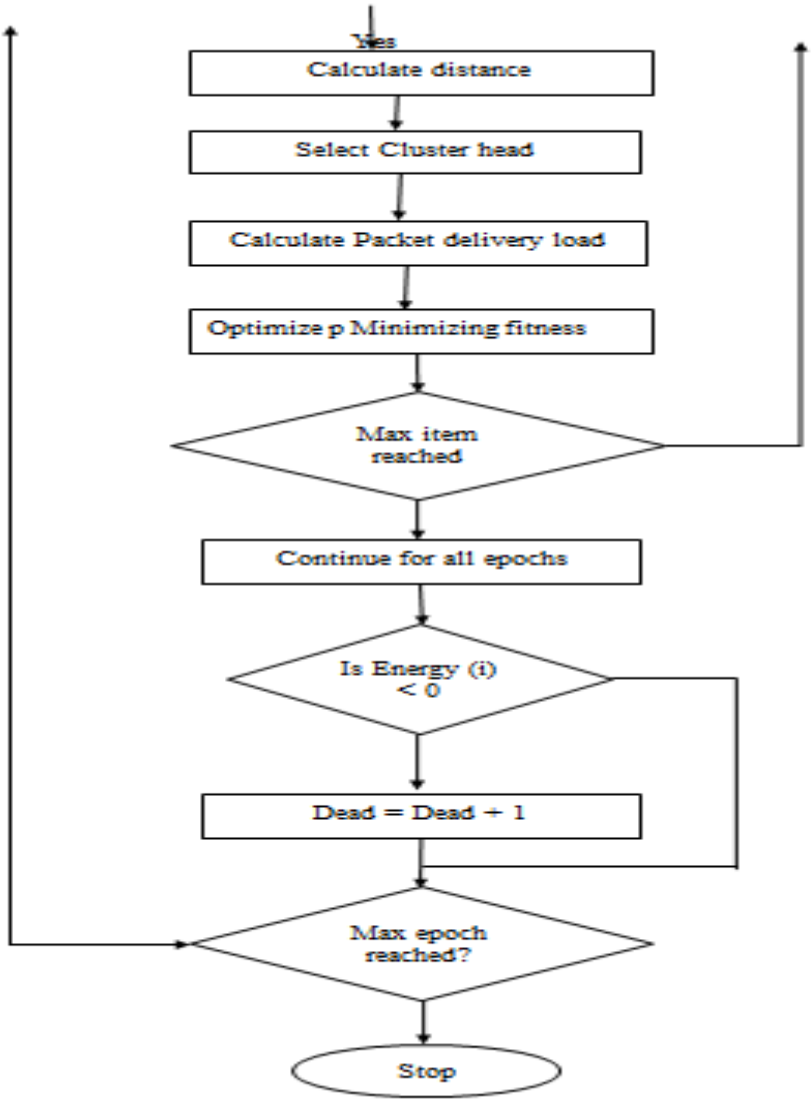


Figure 3.1 Algorithm for proposed method

CHAPTER 4
RESULTS AND DISCUSSIONS

The above problem is simulated for a condition of 100 nodes distributed uniformly in a 100x100 unit area. The nodes are given initial set of energies as specified above. Radio model of transmission has been considered. All the simulations are done on a PC of 4 GB RAM, 2.7 GHz processor on MATLAB R2012b. The simulation results are shown below.

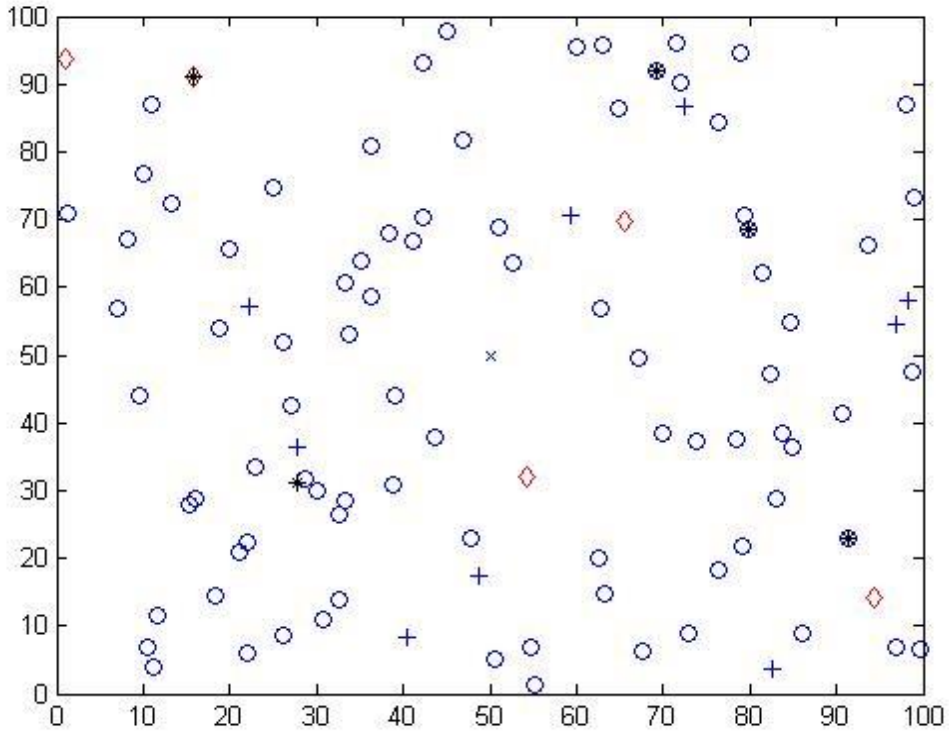


Figure 4.1: Node distribution

Figure 4.1 represents the various nodes distributed in the 100x100 area. The simulation runs for 200 epochs. The normal nodes are shown by ‘o’ while ‘+’ represents advanced nodes and ‘Δ’ represents super advanced nodes. The ‘*’ represents that the particular node has become cluster head at least once. As the epochs increases the number of nodes becoming cluster head increases.

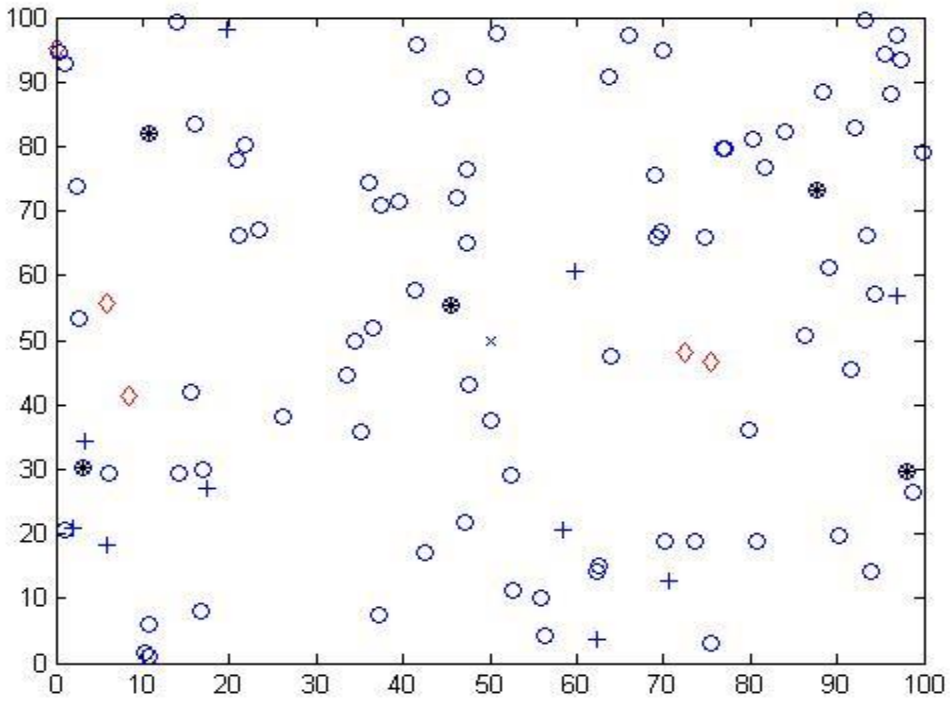


Figure 4.2: Node Distribution after 30 rounds

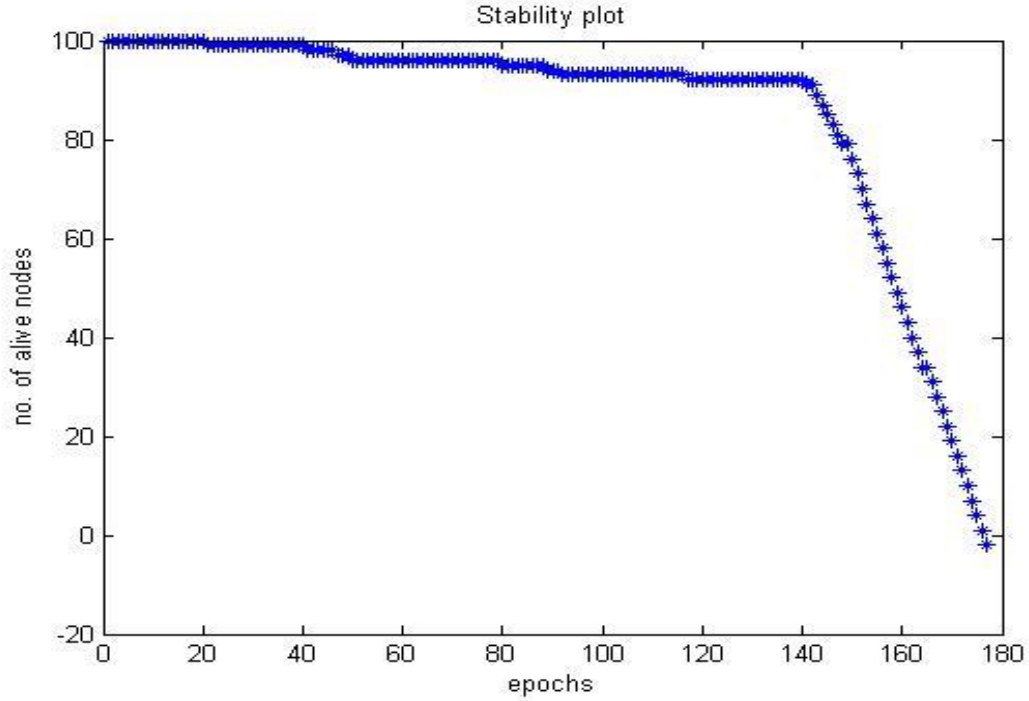


Figure 4.3: Plot of Stability region

Figure 4.3 represents the stability plot. The number of alive nodes is plotted against the epochs. As it is shown that with the increase in rounds, some nodes started dying out. It is required that the number of nodes dying out should be as minimum as possible for maximum number of iterations. The algorithm is designed in such a way that the almost all the nodes starts dying out simultaneously. As shown by the results, the slope of the curve increases sharply in the negative direction after around 130 iterations. This is desired as it reduces packet data loss during stable period.

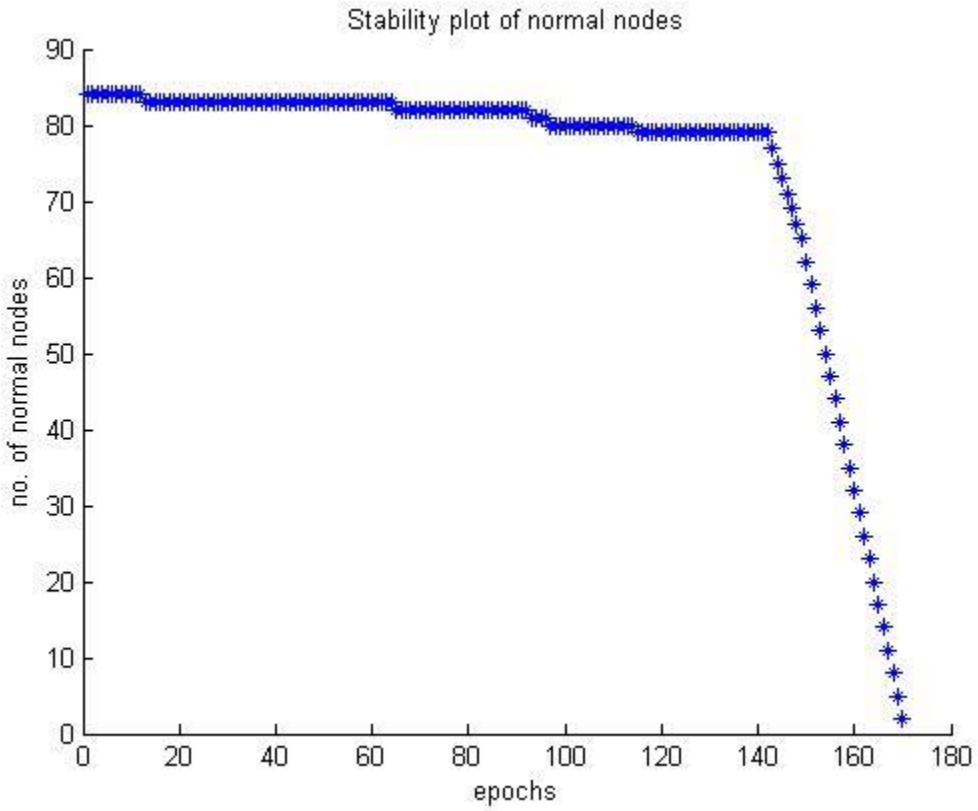


Figure 4.4: Stability plot of normal nodes in proposed method

Figure 4.4-4.9 represents the stability plot of normal, advanced and super advanced nodes separately for proposed method and compare the results with simple SEP.

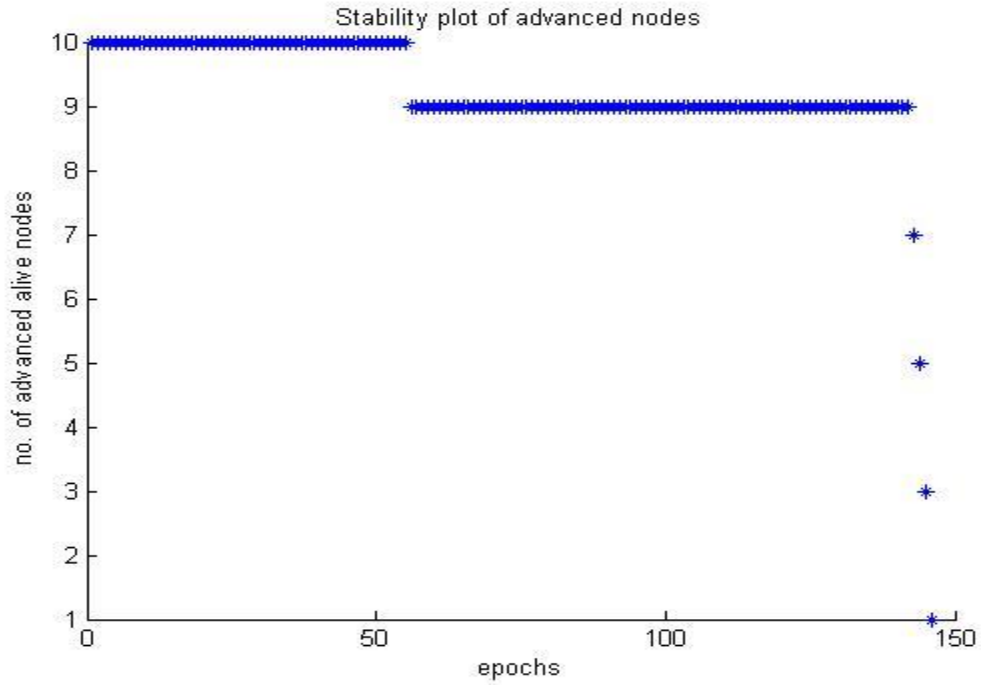


Figure 4.5 Stability plots of advanced nodes in proposed method

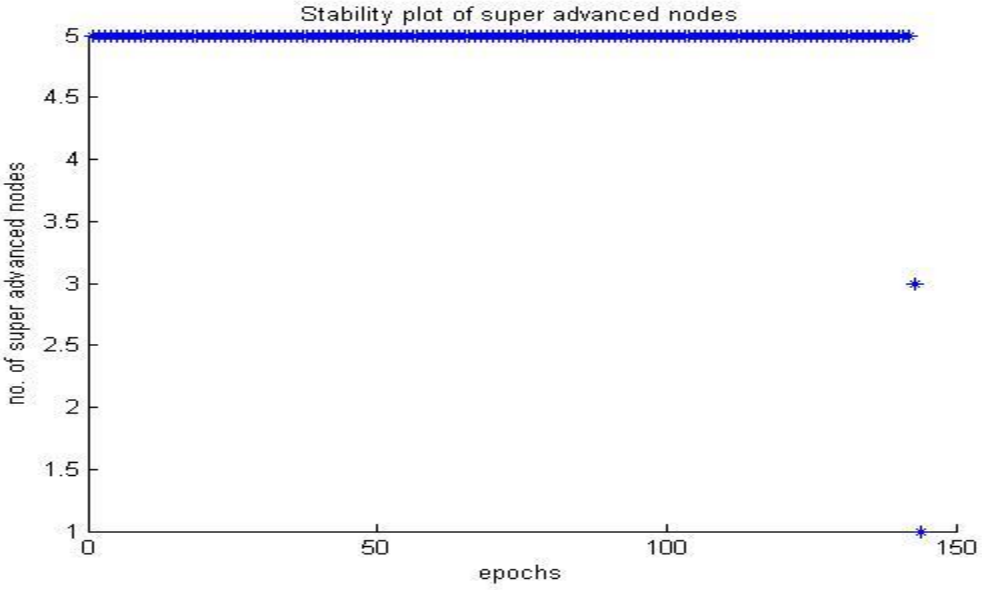


Figure 4.6 Stability plot of Super advanced nodes in proposed method

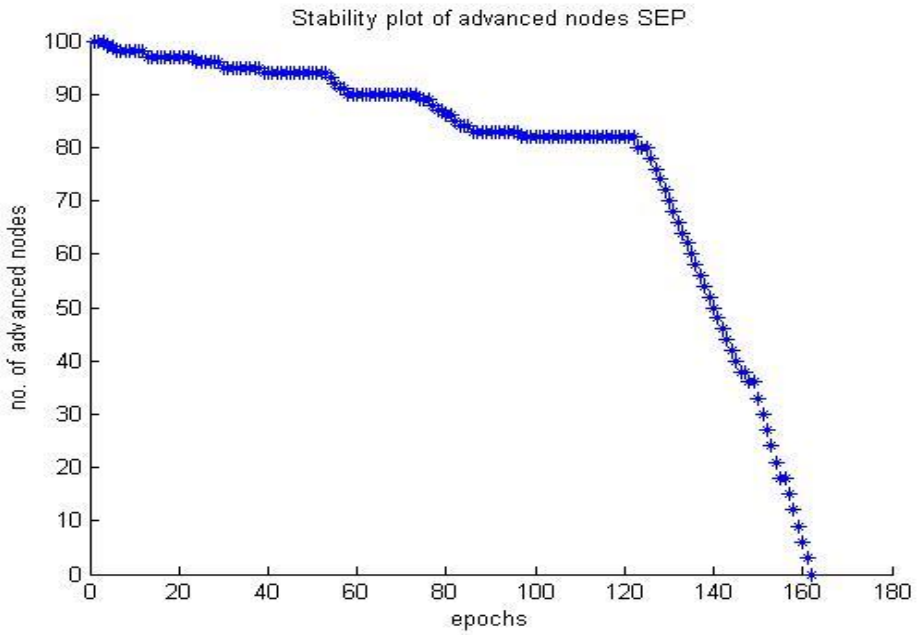


Figure 4.7: Stability plot of simple SEP

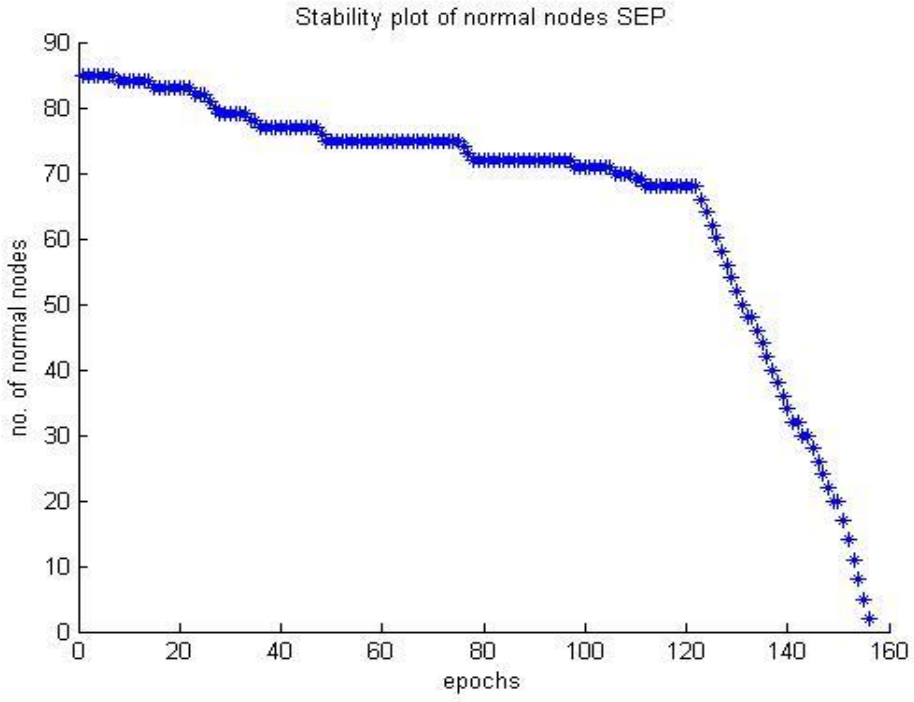


Figure 4.8: Stability plot of normal nodes in simple SEP

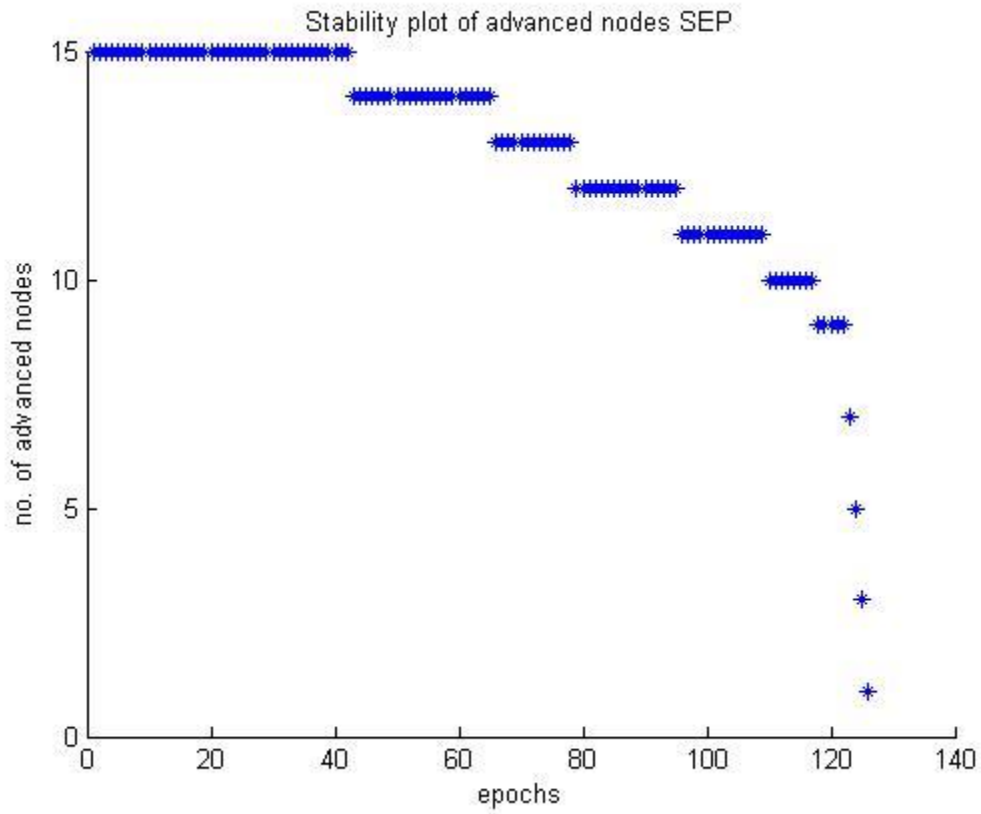


Figure 4.9: Stability plot of advanced nodes in simple SEP

The packet Delivery Ratio (PDR) is prescribed by the number of packets accepted to that of the number of packets directed towards destination. It is desired that the PDR remains as high as possible. The protocol is designed such that most of the nodes die simultaneously so that they are alive together for most of the time thereby maintaining the prolonged stability zone.

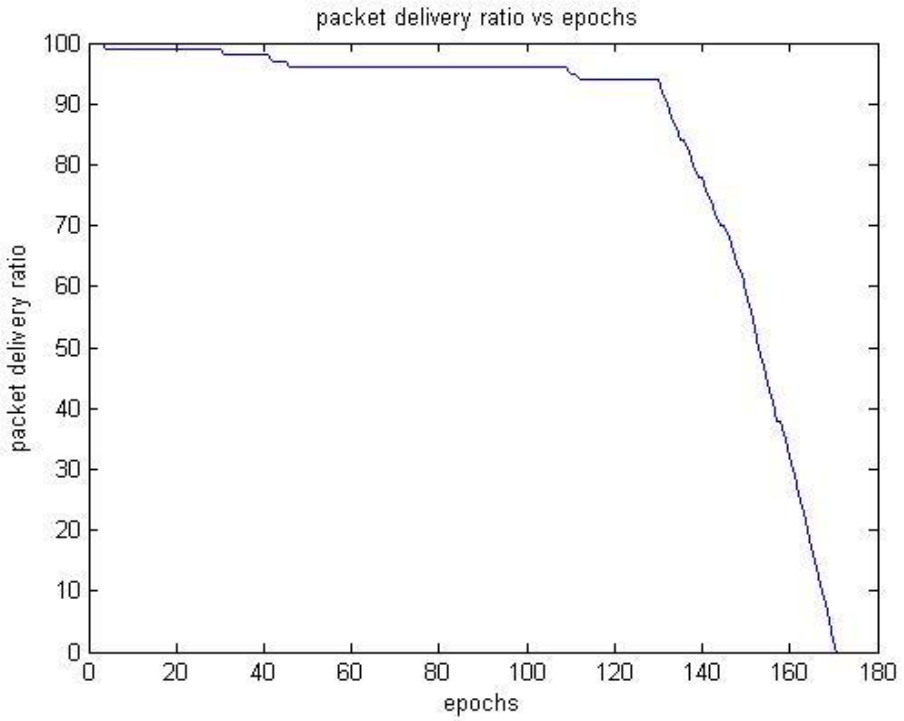


Figure 4.10: Packet Delivery Ratio in proposed method

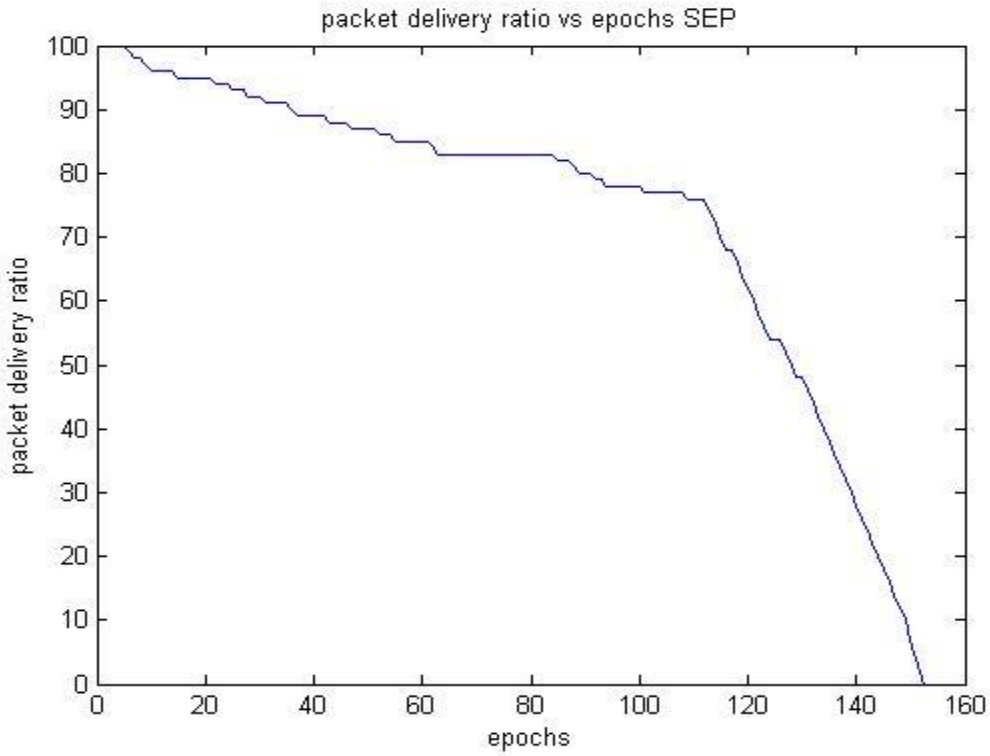


Figure 4.11: Packet Delivery Ratio in simple SEP

As presented through the figure 4.10, the PDR (packet delivery ratio) in percentage is close to 85% for most of the stability period. This ensures a smooth operation and reliable network operation. When compared to packet delivery ratio of simple SEP as shown in Figure 4.11, it is found that there is a significant improvement in terms of stability period as the packet delivery ratio starts diminishing in our proposed method quite late and sharply when compared to normal SEP.

The outcomes clearly proved that the performance of proposed algorithm superior in case of PDR and prolonged stability period. The stability period is very important as once the nodes start dying in large numbers the chances of packet data loss starts increasing. The network has been simulated for only 100 nodes which can be further extended to larger number of nodes or even sparse networks.

CHAPTER 5
CONCLUSIONS AND FUTURE SCOPE

An Advance Stable Election Protocol has been developed to resolve the obstacle comes in the stability period of sensor elements during hierarchical node distribution. The heterogeneous distribution is such that all nodes are not provided with equal energy in the beginning as assumed by LEACH protocol. Hence there is a need to modify LEACH protocol in order to work in this environment. Three level distributions are considered and an attempt has been made to develop a novel methodology for extensive network with three-level heterogeneity. The solution is found by varying the probabilities of a node to be elected as cluster head in every round as per the network conditions and an opinion dynamics based model is applied to optimize the value of probability for election of cluster head via LEACH mechanism. The opinion dynamics modelling includes optimization based on a model which selects on the basis of discussion taking place in a group. Social Rank and Social Influence Factor has been calculated. The opinions are updated based on the social influence factors.

It is shown that the stability period is extended and the instability period is reduced sharply. Also the packet delivery ratio is found to be improved for most of the stable zone. In future, the scenario can be extended to higher levels. Also more experiments involving different number of nodes can be performed and analysed.

CHAPTER 6
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