AN IMPROVED APPROCH FOR CONGESTION CONTROL IN WIRELESS SENSOR NETWORK

Dissertation submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

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PROPOSED TOPIC : CONGESTION CONTROL IN WIRELESS SENSOR NETWORK

Qualitative Assessment of Proposed Topic by PAC		
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Overall Remarks: Approved (with major changes)

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ABSTRACT

The Wireless Sensor Network (WSN) is used in an environment where wires or cables are not possible to reach or installation cost is comparatively much higher. WSN is easy to install and maintenance is less as compared to cable network. WSN is a combination of small sensor nodes where resources are running on these nodes to consume the energy. Increase the life of WSN, there is a need of clustering which divides the load between the nodes.

In the literature we have seen various congestion control clustering algorithms to increase the lifetime of the WSN. The aim of this research work is to provide effective congestion control clustering mechanism to increase the network stability. In this work, we have studied and analyze existing priority based application specific congestion control clustering protocol (PASCCC).

We have analyzed and compare existing protocol with the proposed protocol on the basis of parameters lifetime, no of rounds, throughput. We have implemented a congestion control using grid-based clustering technique. With the help of this technique congestion is less as compared with an existing technique. The experimental results are showing that our grid based network performance is much better than the PASCCC.

ACKNOWLEDGEMENT

First and foremost I would like to thanks almighty for giving me courage to bring up this dissertation. I would like to show my gratitude to some of the people who have helped me to make this report of my dissertation. I would like to thanks to my mentor Mr. Mandeep Singh who has encouraged me to get through this dissertation, further more I would like to thanks to my friends who gave me support in numerous ways from the stage when the idea of the thesis was conceived. I am very much thankful for my parents who gave me support for my studies.

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DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation entitled "**AN IMPROVED APPROCH FOR CONGESTION CONTROL IN WIRELESS SENSOR NETWORK**" in partial fulfillment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. Mandeep Singh. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

Date: _____ *Signature of Candidate*

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SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the MTech Dissertation entitled "**AN IMPROVED APPROCH FOR CONGESTION CONTROL IN WIRELESS SENSOR NETWORK**", submitted by **Gaurav Kapoor** at **Lovely Professional University, Phagwara, India** is a authentic record of his original work carried out under my guidance and supervision. This work has not been submitted elsewhere for any other degree.

Signature of Supervisor

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   Date: _____

   Internal Examiner

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   Name: _____

   Date: _____

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LIST OF ACRONYMS / ABBREVIATIONS

WSN	Wireless Sensor Network
QoS	Quality of Service
CH	Cluster Head
BCH	Backup Cluster Head
BS	Base Station
PDF	Probability Density Function
PASCCC	Priority-based application specific congestion control Clustering
GBCCC	Grid Based Congestion Control Clustering
MANET	Mobile ad hoc network
TDMA	Time Division Multiple Access
LEACH	Low Energy Adaptive Clustering Hierarchy
PEACH	Power Efficient and Adaptive Hierarchy
HEEP	Hybrid Energy Efficiency Protocol
DEEC	Distributed Energy Efficient Clustering
EDEEC	Enhanced Distributed Energy Efficient Clustering
SEP	Stable Election Protocol
RLE	Run-Length Encoding
LZW	Lempel-Ziv-Welch

CHAPTER 1

INTRODUCTION

1. WIRELESS SENSOR NETWORK

The Wireless Sensor Network (WSN) is used in an environment where wires or cables are not possible to reach or installation cost is comparatively much higher. WSN is easy to install and maintenance is less as compared to cable network [1]. Now a day's wireless systems and mobile ad-hoc network (MANET) is being widely used for the purpose of data transfer. With the latest WSN technologies, small sensor nodes are being used for the purpose of transferring the data packets. Few sensor nodes are being utilized to handle the data packets. Traffic jam normally happens while transferring the data from source node to the sink node. In WSN every sensor node requires detailed hardware receiving mechanism, memory, processing unit, etcetera [2]. Energy is an essential parameter while transmitting data in the network.

WSN is used in many areas:

- Home CCTV camera networking
- Military area region
- Pollution looking
- Aircraft management
- Traffic management system
- University intranet

1.1 CLUSTERING (GROUPING)

The main goal of clustering in wireless sensor networks is to collect data packets between sets of nodes under a group. After collecting data packets, cluster head is responsible for transferring those packets to BS (Base Station) [3]. Clustering provides a good lifetime to a wireless sensor network. Clustering usually uses two techniques. First, it elects a cluster head having more energy level. Second, it rotates cluster head in every round for the purpose to distribute the energy among nodes in each cluster group. Energy consumption notification in clustering is a function which delivers the information of remaining energy

of each sensor node. A part from this, a lot of work has been done in WSNs with LEACH (Low Energy Adaptive Clustering Hierarchy) protocol. Nowadays, there are other clustering methods which are commonly used in place of leach protocol. These methods are HEEP (Hybrid energy efficiency protocol) and PEACH (Power efficient and Adaptive clustering Hierarchy) [3]. The objective of these methods is to minimize energy usage by the sensor nodes.

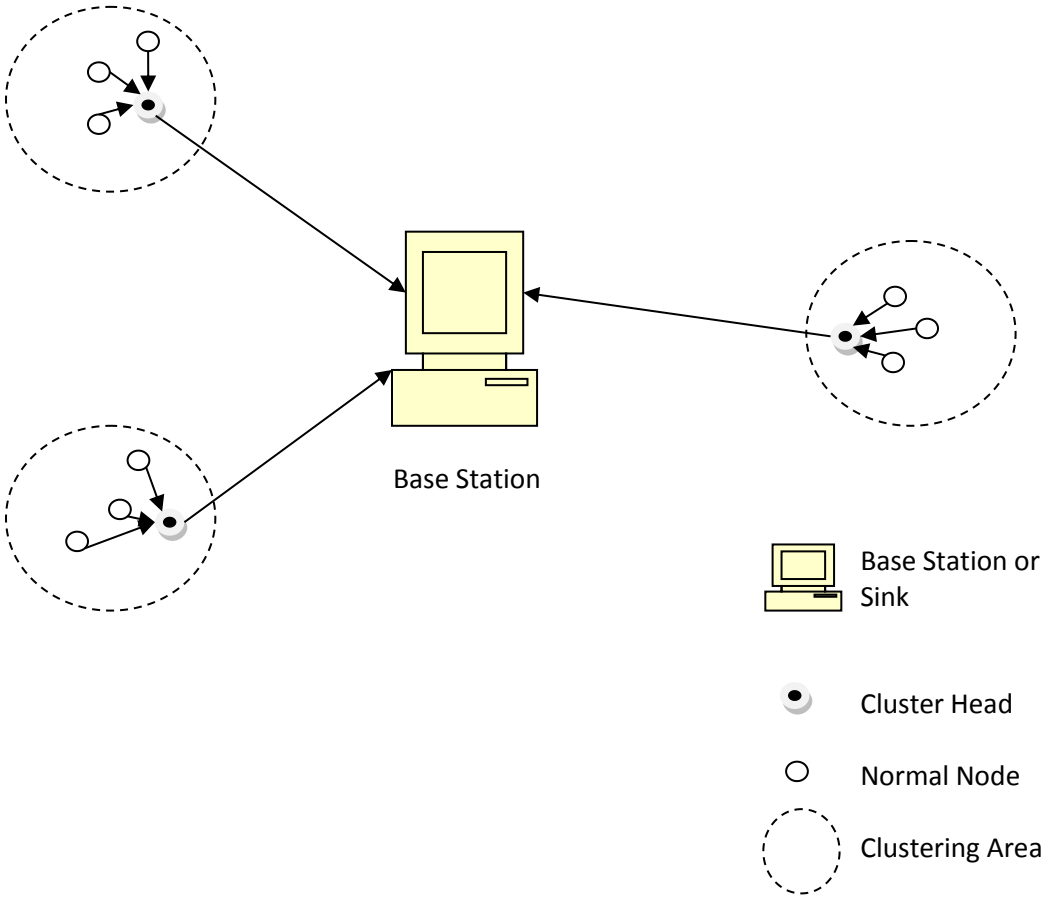


Figure 1.1: Overview of wireless sensor network [2]

Clustering Objectives

Clustering is a way of grouping the nodes. Mostly it is using in a wireless network. Various kinds of things are involved in clustering. Various objectives of clustering are listed below.

1.1.1 Fault-tolerance

WSN network is connected with small sensor nodes. Each node has its own battery life and hardware. In the complete system process, functional failure of each node is to be inspected which can be a CH (Cluster Head) node. This fact comes when some sensor nodes certainly stop working in some harsh situation or in any kind of circumstances. Some nodes may get physically damaged or crashed. To deal with such issues, several clustering ways are being recommended. This is the responsibility of clustering mechanism to cut down the failed node from the connected network or to switch the network with another working node to transfer the data packets [4].

1.1.2 Maximizing network Life-time

There are different kinds of wireless networks such as mobile network. Resources are running on these networks to consume energy of nodes. Battery life of these nodes is quite limited in mobile network. While transferring the data packets from one node to another, energy level lowers every time. In order to handle energy management in WSN, clustering plays an important role to extend life-time of nodes and to lessen the burden of nodes while data transferring. Few methodologies are being used for transmission of data packets to base station through cluster head. The main aim of clustering is to offer the energetic node called CH node in every clustering group. In each and every round, CH node is changed with its own energy value. Through this rotation of CH node, the network lifetime has improved [8].

1.1.3 Load balancing

In the clustering mechanism, load balancing is another useful technique. In every round, while transmitting data packets from one node to another, the available energy of each cluster member node is checked [12]. Therefore, in every round the energy of the cluster head node is checked and the node with maximum energy level gets elected as cluster head. So in every round, sensor node might be rotated and the load will be balanced. This load balancing technique helps transmitting data packets efficiently. Figure 1.2 below shows the concept of load balancing.

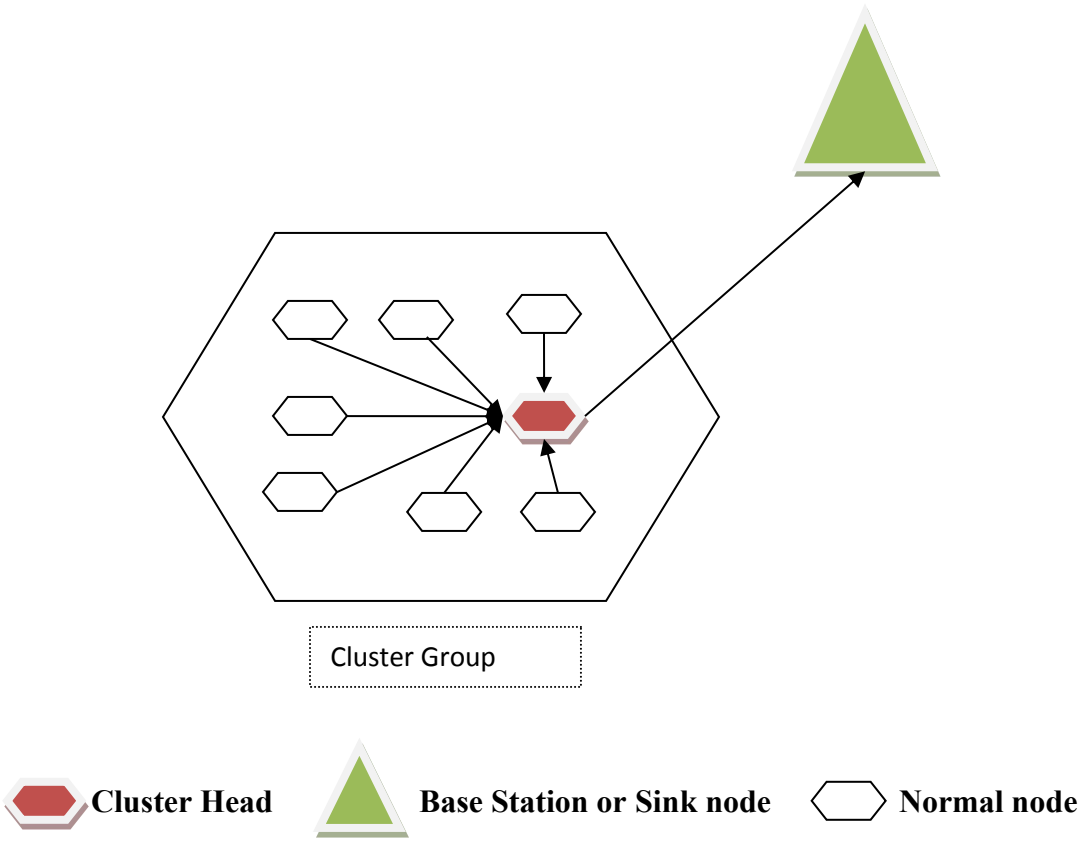


Figure 1.2: Clustering mechanism in WSN [5]

Types of Clustering

There are basically two types of clustering mechanism is using First one is inter clustering and second one is intra clustering. The whole network is divided into some regions that region is called as cluster group. Inside a group there are non cluster head nodes and cluster head node. Intra clustering is a mechanism when the communication is happening in between the nodes within the group. Inter clustering is a mechanism when the node of one group send the data to the node of second group that is called as inter clustering mechanism. Most of the time inter clustering is happens with the help of cluster head nodes in various groups.

1.2 PASCCC- PRIORITY-BASED APPLICATION SPECIFIC CONGESTION CONTROL CLUSTERING PROTOCOL

PASCCC was the protocol which was used to enhance the network life time using energy management. In this network the energy is divided in between the nodes. The data was transferred through the nodes, Problem comes when all sensor nodes needed to send data packets to sink node which creates congestion and results into overloading. PASCCC was the protocol that came with cluster hierarchy using congestion detection and mitigation which was based on priority of the packets. The priority was based on two types of packets. First, Humidity packet and the second was temperature packet. In that network the priority of humidity packets was low as compared to temperature packets. In this protocol, temperature packets needed to report immediately to base station when the hard threshold is reached on a particular value [12]. So, with the help of cluster head packets reached to the sink node as shown in figure 1.2. When node transfers data packets from one node to another the available energy of nodes decreases. To resolve this problem, the sensor nodes were classified in the small groups called clusters group, wherein each group had a coordinator called Cluster-Head (CH). In a cluster, node having maximum energy was elected as CH node in each group. Cluster-heads rotate randomly in each group due to its energy consumption as well as communication overheads [13]. The threshold value [14] was used for CH selection. If the level of energy of CH was less than the threshold value then that node will not be selected as a cluster-head node in the current round. Apart from this, while using clustering, all normal sensor nodes do not require communicating directly with base station. Cluster heads are mature to arrange the cluster members (CMs) and collect the data packets from them and to send those packets to the base station. In WSN, every node has its timestamp. Timestamp is a time period where a node has to be respond in that time period to another node. If the node is not responding due to any circumstance, rest of all sensor nodes are required to be re-clustered to rectify the dead nodes. At last, it should be noted that the pasccc was mainly designed to work in a temperature range between 50-100^{o} Celsius. As author had discussed that the priority of temperature packets was high, so during congestion humidity packets were dropped in a queue to give priority to temperature packets. Every sensor node had temperature sensors which awoke only when data packet with

temperature above 50^{o} C arrives. This value was saved in a local variable of each sensor node. So this protocol only works where the key parameter is temperature.

1.2.1 Clustering Stages: PASCCC

- Setup Stage
- Steady state Stage

In the **Setup stage**, each sensing node had a random number. If that random number was less than the threshold value [12] then that node got selected as a cluster head (CH) for that specific round. Cluster head send an acknowledgement message to all neighbor nodes with its identity. After receiving the message, nodes transmit a joining message to CH. The probability of a node to be a CH node is 1/p. If there were 100 nodes in a network then each node can be a CH node for maximum 10 times. After created a cluster group, each CH assigns a TDMA to its each group member. In PASCCC, 10% nodes were advanced nodes having greater energy value as compared to others. Therefore it was created a heterogeneous number of nodes in the network.

In the **Steady state stage,** nodes could transmit data packets to its Cluster head node. CH node transmits the data packets to base station. After a study state stage was completed, again a new round began for clustering nodes wherein a new CH was selected based on their energy levels.

1.2.2 Energy dissipation: PASCCC

Energy consumption happens in WSN due to transmission of data packets and data aggregation. Energy consumption of cluster head is different as compared to non-cluster head nodes. Thus, in PASCCC first energy occupied by non-ch nodes is accounted and then for the cluster head node by some equations [12]. These equations were used to check temperature, humidity and energy level of nodes.

1.2.3 Mitigation and congestion identification: PASCCC

Balanced clustering mechanism was used in PASCCC to ensure the selected of different cluster heads in each round. In cluster groups, there were some regions which remain

vacant. For this, PASCCC inherited the mobility feature which was used to cover the vacant regions in cluster groups. The mobility mechanism ensured the connectivity between nodes and covers vacant areas. During connectivity, high priority temperature packets were sent on base station within the TDMA. To reduce the level of congestion, humidity packets were dropped. In PASCCC, sensor nodes were much capable to cover vacant region randomly and to prevent the loss of packets. In the setup stage of PASCCC, the cluster head assigned a TDMA to their associated members. If the requested messages exceed the threshold limit, CH opened a 1 bit piggyback time slot for non-ch nodes. When that 1 bit piggyback was open then the humidity sensor of CH gets off automatically. The piggyback were used to prevent the congestion in a network.

1.2.4 Model of Queue: PASCCC

The queuing model [12] was based on first come first serve. In this model, there were two load balancing mechanisms. First was the normal network and was used when load of packets was normal. Second one was used when the network was overloaded with congestion. In this model, the P_L and P_H parameters represented low and high priorities of packets whereas Q_{TH} and Q_{TL} parameters represented high and low threshold limits. Some of the rules of queue based model were given below:

- If there was congestion then drop low priority packets which were in a queue and keep high priority packets in the queue.
- Incoming packets were buffered.
- If queue reached the threshold limit then drop the low priority packets based on node type.

1.3 CCGBC- CONGESTION CONTROL USING GRID BASED CLUSTERING

Grid-Based clustering mechanism was a kind of mechanism where the life time of network was enhanced using energy management by the nodes. Nodes were rotated in each rounds and that node was elected as a cluster head node which was having the higher energy in that group. The Figure 1.3 is showing a grid based network in which nodes are pointed randomly with the different energy value. CCGBC was the cluster based technique using congestion detection and mitigation which was based on priority of the packets. The priority was based on energy of the packets. There was a queue in this model which was based on FIFO. The packet first came in the queue which had a higher priority which was considered by the energy of the node. The inter clustering mechanism was implemented in the CCGBC network So, with the help of cluster head packets reach to the sink node as shown in Figure 1.3.

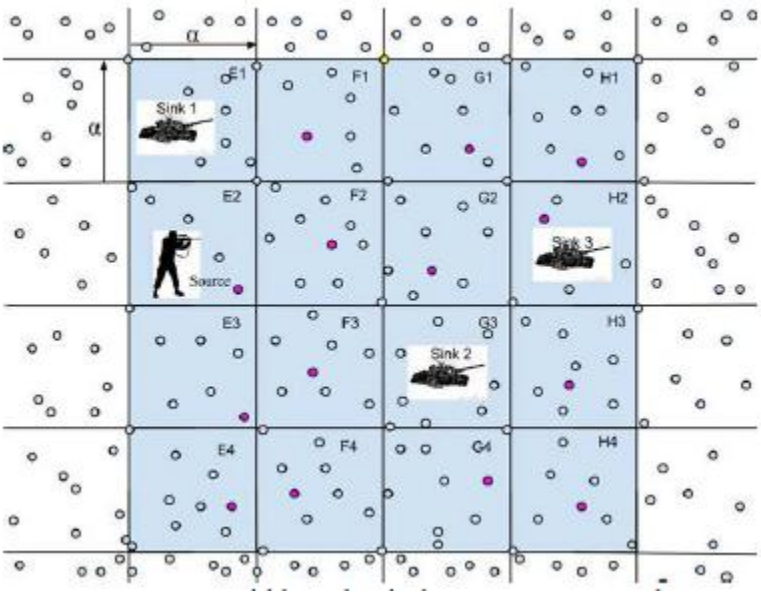


Figure 1.3 Grid based Network [55]

In the above figure there were N-Sink nodes those collect the data from their native nodes. In this there were N numbers of cluster heads in a network. They collected the data from their native nodes and passed it to cluster head of that group. Cluster head then passed the data to another cluster head till the packet reached to the base station which was called as sink node. With the help of this network we had implemented our developed network which is showing in Figure 1.4

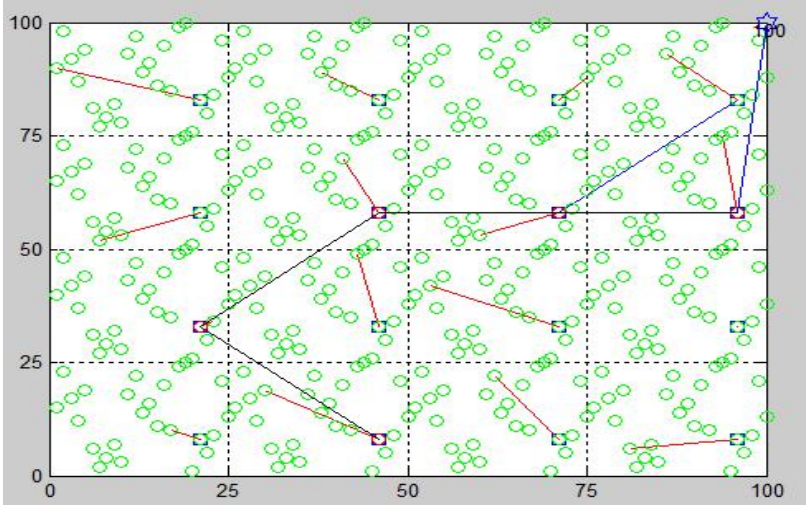


Figure 1.4 Cluster head based Grid

In Inter clustering mechanism when cluster head node transfers data packets from one cluster head node to another cluster head of different group the available energy of nodes was decreased. To resolve this problem, load balancing mechanism was implemented in developed network wherein the sensor nodes which was having high energy in every round that was selected as cluster head node of this group and so on. Cluster-heads rotate randomly in each group due to its energy consumption as well as communication overheads [13]. The threshold value [14] was used for CH selection. If the level of energy of CH was less than the threshold value then that node was not selected as a cluster-head node in the current round. In a figure 1.4 there were various groups in a network and the nodes were placed randomly. Green rounded nodes were non cluster head nodes and the node which was having rectangular in shape in each group that was a CH node which was elected with its energy value. On the top right there was a base station which was called as sink node. The responsibility of the cluster head nodes was to collect the data from its native nodes and passed it to the base station with the help of inter clustering mechanism where a CH node of one group was transferred the data to another CH node of another group. This process was working till the data packet is reached to the base station. If the node was not responding due to any circumstance, that node color was changed as red color of node which was marked as a dead node. No data was to be transferred to the dead nodes in this mechanism.

1.3.1 Clustering Stages: CCGBC

- Data Broadcast
- Data Forward

Data Broadcast: In a gird based network showing above in Figure 1.4 each grid was made with the 25 into 25 of distance. In each group there were normal nodes and a cluster head node. Each node has its unique ID when the packets were transferred from the normal node to the cluster head (CH) node. Few parameters were considered such as energy consumed while transferring the data packet, time consumed by it and so on. Each node was randomly generated and with the help of mobility mechanism nodes were rotated simultaneously. Cluster head was much advanced it can transfer their data in both upper, down, left and right position. See the Figure 1.5 below in which a CH can transfer their data in both the direction. In our developed paper this criteria is followed.

Data forward: In this work data packets were transferred from one CH to another with 2 conditions first was network traffic and the second one was the shortest path of CH. In this work a single cluster head was compared with maximum 5 nearest Cluster heads and after sorting data was transferred. The data was transferred with the shortest path of cluster head but if the traffic was in the path then it rotated to the second most of the path. Through this way data was broadcasted.

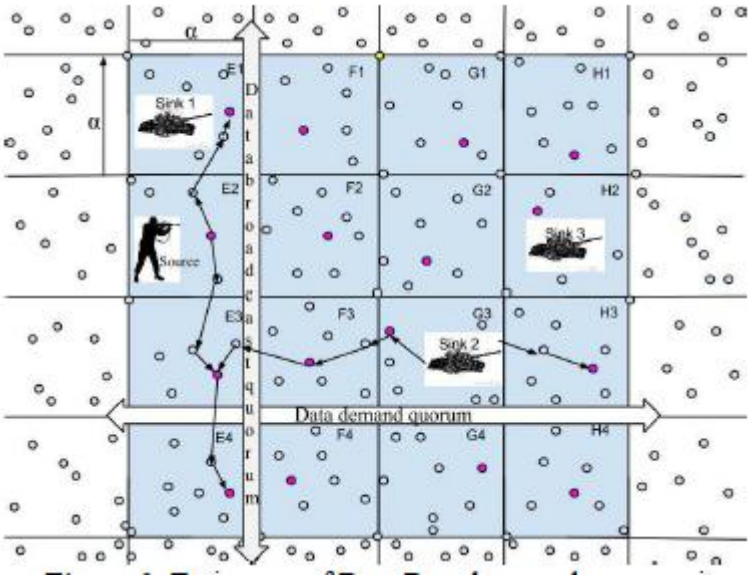


Figure 1.5 Data Broadcasting [55]

1.3.2 Energy dissipation:

Energy consumption happened in WSN due to transmission of data packets and data aggregation. Energy consumption of CH was different as compared to non-cluster head nodes. Thus, in CCGBC first energy occupied by non-ch nodes was accounted and then for the CH node by some equations [12]. These equations can checked such as euclidean distance, size of packet and energy level of nodes.

1.3.3 Mitigation and congestion identification:

Balanced clustering mechanism was used in CCGBC to ensure the selected of different cluster heads in each round. In cluster groups, there were some regions which remain vacant. For this, CCGBC inherits the mobility feature which was used to cover the vacant regions in cluster groups. The mobility mechanism ensures the connectivity between nodes and covers vacant areas. In our base paper the congestion rate was high as compared with our proposed work because the area of network was greater in our base paper and the area in our grid based network was less for CH selection due to the Grid based network. The area was divided in a grid manner where an each grid there was a cluster head which collect the data from its native non cluster head nodes. During connectivity, high priority packets were sent to the queue with data compression RLE technique within the TDMA. To reduce the level of congestion, less prioritized packets are dropped inside the queue.

1.3.4 Model of Queue: CCGBC

The priority based queuing model [12] was used in our work which was based on first come first serve. Overloaded and congested network we had set a limit of packet was 10 in a single group. A queue was not congested if the packets were less than ten of the size. When the packet size was increases from 10 it means the congestion occurred in that group, that time when the packets were dropped from the queue which were in the front, because our queue was following the FIFO model. Hence load on cluster head decreases along with congestion with the help of priority queue.

1.3.5 Compression technique: RLE

Run-Length Encoding (RLE) was a compression technique which was used to compress the data. It was a lossless data compression technique used to enhance the lifetime of network and to save the energy consumption by the nodes. Data compression techniques were using in a network to improve the efficiency of network. There are wireless sensor nodes in a network whose responsibility is to take the data from the other nodes and transfer the data to another node. This is a main responsibility of nodes. To enhance the lifetime of network or nodes the data compression was a very good way to implement it in the network. This technique was used in our proposed paper CCGBC. Take an example to understand how this compression technique is working. Supposed there is a string like:

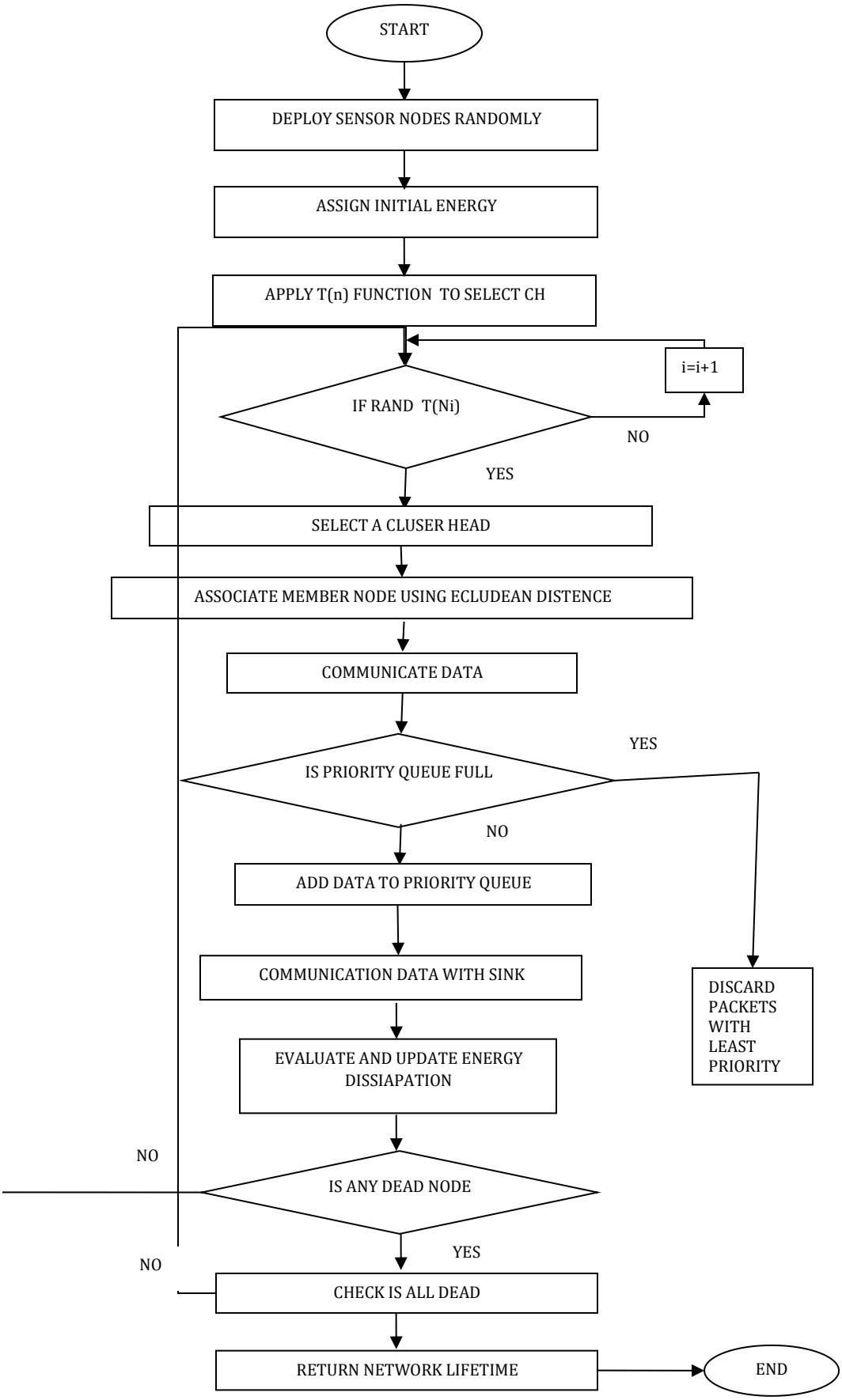
INPUT: "WWWWWWWWBTTTTTTTTTT"

Now RLE was compressed this string into like:

OUTPUT: 8W1B10T

In the above example there were eight times W, one time B and ten times T. The length of Input was 19 characters and with the help of RLE compression it converted that input into 7 characters. So the energy was consumed less with the help of RLE technique.

1.4 FLOW CHART OF EXISTING PASCCC TECHNIQUE



CHAPTER 2

REVIEW OF LITERATURE

N. S. Patil et al [1] proposed a paper for Data Aggregation in Wireless Device Network. Device networks are generally assorted with sensing nodes. These sensor nodes are battery based and would co-operatively pass the sensed packets to sink. To optimize the network usage, it is important to efficiently use the energy. To achieve the same, network traffic should be controlled and number of files to be transmitted should be reduced. Wireless system networks have confined electrical power and limited size of battery & memory. So, in this literature, Authors have showing the various kinds of data aggregation techniques inside a wireless sensor network. These techniques are such as centralized aggregation, In-network approach, tree based and cluster-based aggregation. Authors have also discussed the suitability of a standard protocol in WSN where resources tend to be limited.

D. Izadi et al [2] worked on Alternative Clustering Scheme in WSN. In this paper explains that in clustering mechanism there is always a need of cluster head. If CH fails in any circumstances, it will stop receiving the data packets and the data would be lost in this scenario. To resolve this issue, author presents an alternative clustering wherein a BCH (Backup cluster head) will always be present in the absence of CH. In this paper, authors had discussed a self-configurable clustering (SCCH) mechanism to detect CHs failure and replace a BCH in place of failed CH.

A. V. D. Byl et al [3] states an evaluation of Compression Techniques for WSN. In this paper author has discussed that in a wireless sensor network there is limited bandwidth between nodes, which is important to reduce the data bit to meet the application performance. If a less bit data transferred between nodes then energy would be saved. So, for this the author shows the various techniques for data compression in WSN. These compression techniques are lossless compression, lossy compression and hybrid compression. The focus of this paper was to identify and evaluate compression techniques for the data transmission and for saving energy. This paper compares lossless

compression technique with lossy compression technique. Author tells that the lossless technique is used where the data is related to text information and lossy technique is used when the data is fluctuated or in the form of picture.

E. D. Raj et al [4] worked on a technique called EDRLEACH (Energy Distance Relation Low Energy Adaptive Cluster Hierarchy) which is based on distance based cluster head. In this paper author has used an energy efficient algorithm for cluster head selection. Authors have showed the consumed energy by cluster head and the relation between cluster head and non cluster head nodes. In this paper authors tells few limitations of LEACH, comparison of nodes density and the distance between nodes, An Energy efficient formula is used to get the energetic node in clustering groups and the energetic node would be a cluster head node in a current round, that energetic node should transfer the data packets to Base station. Apart from this author also discussed the consumed energy by the cluster head node by itself, So that in a next round the highest energetic node would be a cluster head node to transfer the data packets.

P. Papadimitriou et al [5] presented a new end-to-end node protocol, which is called as *Scalable Streaming Video Protocol* (SSVP). In this protocol various kinds of functions are used for uncast video streaming on the layers of UDP. SSVP employs *multiplicative decrease additive increase* (MDAI) techniques which manages and forwards the data packets in a right way and corrects the gaps in inter packets (GIP). So, the video could be broadcasted in a right manner. MDAI's new results show that SSVP is accepted by the protocols on that network where the video streaming occurs. If on the network there is a rough network setting comes than it spoils the video quality. This paper team explored via a layered adaptation technique that received the user's buffer as well as accept the quality of the video, along with huge differences inside a pending bandwidth at the end point of user. Author shows the version technique in this paper which is based on the protocol Layers that checks the amount of buffering at the receivers end and the pending bandwidth. This technique stops the useless layer changes which plays a bad effect on end users watching video quality.

S.JANCY et al [6] discussed the Packet Level Data Compression methods in WSN. Wireless device network consists of a set of wireless nodes. Every node has its different

processing capacity and different storage size. The main challenge today in this field of networking is to create the energy management in these devices. Different methods are introduced by various researches. This paper introduced us with sequential compression technique. This is a packet level data compression technique. The motive of this technique is to enhance the sensors energy level.

S. kaur et al [7] investigated the LZW Data Compression algorithm which is lossless in nature. This method uses a dictionary based text compression technique which generates a 5 bit code for every character instead of 7 bit ASCII code. Using this technique, the storage and transfer space utilization is less as compared to other compressed data technique. The text data can easily be compressed and that compressed data is transferred on to the network with the help of a node to node network. At last, it reaches to the base station and decoding is performed using decompression algorithm. In this paper, LZW compression rate of 30.3% and a reduction of physical space of up to 60.25% is achieved.

T. Jinjing et al [8] presented an efficient cluster-based routing protocol (ECBRP) method for real-time multimedia streaming for mobile networks. Firstly, a new algorithm was introduced in this paper to improve the stability of cluster heads used for cluster creation. Secondly, a device was designed to identify the cause of data packet loss. The device can reduce the route overhead and increase the decodable relation of video edge on the application layer. Thirdly, with the help of an adaptive packet save plan the routing protocol was enhanced in order to overcome network traffic issues. The simulation test results prove that the ECBRP is an efficient technique for cluster creation as compared to the simple routing protocol of cluster-based routing protocol (CBRP), and decrease frequency of cluster-head changes against CBRP are reduced by 80% in this protocol. As a result, the quality of real-time streaming of multimedia is much better in this paper.

A. Tripathi et al [9] conducting a survey on Data Combination. Wireless device networks consist of sensor nodes. These network devices can be applied in various fields like home monitoring, disaster management, security, defense, etc. Wireless device nodes are small in size with a limited processing capacity and very low battery power. This makes the device network prone to failure. Data collection is an efficient method in wireless device networks. Data aggregation reduces energy consumption by removing redundancy. The

paper focuses on various methods such as address-centric and data-centric are used for the purpose of data aggregation and energy conservation.

S. Sheikh et al [10] showing the Data Compression using Huffman based Algorithms. Text databases are developed using digital library within the last few years. The popularity of World Wide Web is enhanced. So, to deal with this issue compression setting pops up as a perfect answer that permits to lessen the storage requirements along with I/O businesses. The Huffman compression technique is widely used and is applied for shifting information via multi-places. Huffman encoding is a two pass procedure which is discussed in this paper. It allows to lookup into the present data without the need of decompression. For this reason, lookups speed is usually faster with plain text.

S. Tyagi et al [11] discussed on a method for wireless sensor networks which is based on automata based heterogeneous energy efficient selective clustering. Robot is assumed to be placed at every sensor node along with two types of sensor nodes, Normal and Advanced. These are carefully designed. Based on the probability weighted election (PWE) of each group, sensor nodes, cluster heads are selected by the machine. Robot at each SN receives reward from environment based on the PWE for the various sensor nodes. The automata based energy efficient clustering in an efficient way is discussed. For instance, if first node dies (DFN), alive last node (ALN) is chosen as the key parameter of the size for the lifetime of network. With the help of these parameters and the comparisons with the old protocols like SEP, LEACH, and LEACH-SC, author has defined different network setups.

M. Ahmad et al [12] worked on a priority based application specific congestion control clustering (PASCCC) protocol. In this paper, the author presents the heterogenic nodes. These nodes have different energy power as compare to other nodes. 10% nodes are advanced nodes which have high energy power. PASCCC controls the congestion with the help of creating a cluster head for every round and managing the load in between nodes. In this literature, author explains that there are two kinds of nodes. One is temperature based and another is based on humidity. The temperature based node packets have high priority as compared to the humidity node packets. So during congestion, the low priority based packets are dropped. This technique is used in time critical

applications. The comparison result proves that the PASCCC has much better congestion control mechanism as compared to other techniques such as LEACH and SIP.

R. Periyasamy et al [13] discussed Game Theory-based congestion. The Network congestion arrives once the targeted visitors are filled with the available capability on the network. Throughout over-crowding degrades the quality of the channel and leads to increased energy usage of nodes which results in declining the packets. Consequently, congestion control is critical to establish an efficient network. In this literature, it is advised to trim the power consumption by the nodes used in games by following the theory Hybrid Medium Access Control protocol. GH-MAC is combined with game based energy efficient TDMA protocol for intra-cluster messaging between the nodes such as Cluster-Members and the Cluster-Head. Performance of GH-MAC protocol is calculated by comparing it with straight MAC schemes and tested against energy consumption and parameters causing delays. This results into an improved network sensor device which has very less power utilization.

G. Nivetha [14] states the Energy Optimization Techniques in WSN. In this paper, the author surveys different clustering protocols which are being used for optimization in WSN. Some of the popular routing techniques which are discussed by the author are LEACH (Low energy adaptive clustering hierarchy), PEGASIS (Power-efficient gathering in sensor information), HEEP (Hybrid energy efficiency protocol) and PEACH (Power efficient and Adaptive clustering Hierarchy). In this research paper, author presented a survey on energy efficient clustering routing protocol and analysis that the PEACH has no overhead on cluster head selection. LEACH significantly improves the lifetime and energy consumption of the wireless sensor network as compared to other clustering protocols.

J. N. Al-Karaki et al [15] state Routing Techniques in wireless sensor networks. In this paper, the author surveys different routing techniques of network such as grid based, flit based, hierarchical based routing etcetera. These routing techniques work with various computer networks.

S. Chand et al [16] state the Heterogeneous clustering scheme for packet transfer between source and destination. Heterogeneous transfer indicates that nodes involved are of distinct categories. Cluster head can be chosen out of these nodes. Node with maximum energy is given priority. The performance analysis of this approach indicates better result as compared to existing approaches of LEECH and DEEC.

P. Bansal et al. [17] Proposes hierarchal clustering algorithm which is both efficient and stable. With stable, this literature describes number of dead nodes. These dead nodes reduce greatly. Energy efficient approach of PAGASIS is also describes in this literature. The aim of this paper is to present comparative analysis of both the approaches including LEECH and PAGASIS.

K. Zhang [18] states an energy efficient approach by the use of offloading. There exist data centre within cloud computing. Each data centre is allocated a particular load. If that load exceeded performance degrades. The offloading mechanism ensures that data center utilization is not over burden. Hence forth when utilization enhances beyond threshold value offloading comes into picture. Mobile applications generally support this feature. One of such technique is mobile edge technique. 5G heterogeneous network is followed in this case. Radio resource allocation and offloading in combination enhance the performance of the system in this approach.

K. Bousselmi et al. [19] States that the Energy aware scheduling enhances the performance by making the job executes in order which optimal for cloud. The jobs are allocated to data center in order which is performance resource optimal. Scheduling schemes could be many. The workflow partitioning is utilized for scheduling in the research papers. The researched technique utilize swarm partitioning algorithm is utilized. In the beginning Workflow Partitioning For Energy Minimization (WPEM) computation that sanction decrease in the network energy use of the workflow and the entire quota of data transmission stint a high degree of conformity . In the second agenda authors used the heuristic of cat and swarm accession to docket the engender allotment in order to reduce the workflow's global energy consumption as well as execution time.

K. Gai et al. [20] Energy aware scheduling is also performed in heterogeneous environment. It presents fast extension of mobile different embedded systems had led to auspicious hardware upgrade that supports multiple core processors. The energy use is becoming greater along with the computation capacity grows. Cloud computing is gauged one of the remedies to mitigating energy price. However the simply offloading the computations to the remote side cannot efficiently decrease the energy use when the energy price caused by wireless transmissions are greater than it is on mobile devices. In that research paper authors concentrate on the problem of energy wastes when tasks were allocated to remote cloud servers or different core processors. Their remedy aims to reduce the entire energy cost of the mobile different embedded system by using a best task assignment to different cores and mobile clouds. The nominated model is named as Energy-Aware Heterogeneous Resource Management model (EA-HRM2), which is supported by a main computation Optimal Heterogeneous Task Assignment (OHTA) computation. Experimental evaluations have verified our approach is effective to save energy when deploying different embedded systems in mobile cloud systems.

Z. Zhau et al. [21] Energy efficient data transfer in wireless sensor is proposed. The data dissemination schemes are followed to ensure energy efficiency. Buffer is used in order to store the data being transmitted. The data packet when transferred, it is compared against the data packet stored within the buffer. If packet is already transferred then the packet is neglected. Since quantity of data being transmitted is reduced hence energy is preserved.

M. Singh et al. [22] energy efficient fault tolerant techniques are presented through this literature. In wireless sensor network data is primarily transferred by the use of sensors. Sensors have a limited energy associated with them. Energy conservation is prime concern of this paper. In case of node failure recovery procedure is proposed through this literature.

X..Cui et al. [23] Energy efficient scheduling is proposed in order to achieve energy efficiency and fault tolerance. The fault tolerance strategy is observed by eliminating extra energy consumed by reducing emission of CO2 by sensors nodes. Cloud is basically considers but this technique can be implied on wireless sensor network as well.

S..Gupta et al. [24] Provides comparative analysis of various scheduling schemes which can be followed in WSN for achieving energy efficiency. Algorithm describes in this literature includes MSE, HGOP etc. the performance of MSE is observed as optimal one. In which Mobile sink nodes are considered for minimizing the energy consumption of nodes as sensors in WSN. The wireless sensor network does not passes data towards the nodes who does not having neighboring nodes. Such nodes are known as sink nodes. The system describes increases lifetime by eliminating sink nodes and provides better survival and stability as compared to LEECH.

X..Zhu et al. [25] Energy aware mechanism for virtualized cloud is proposed in this case. Real time tasks are considered in this case. Real time tasks are those which deal with real environment. EARH is a protocol employed in this case. Experiment results show better result in terms of energy conservation.

P..Chatterjee et al. [26] Multi-hop sink node elimination is considered to enhance the lifetime of wireless sensor network. The wireless sensor network does not passes data towards the nodes who does not having neighboring nodes. Such nodes are known as sink nodes. The system describes increases lifetime by eliminating sink nodes and provides least energy consumption hence provide better transmission process.

J. Zheng et al. [27] States the localization mechanism which is used to group the nodes on the basis of some properties. The distance may or may not play a part. The distance if considered then such technique is known as range based technique and if distance not considered than such technique is known as range free algorithm. The proposed literature describes range free algorithm along with neural network technique for energy efficiency.

R. singh et al. [28] WSN is prone to attacks since wide variety of users interacts with the system. In order to solve the problem localization is primarily used. The localization is the mechanism of making the nodes communicates on the basis of distance. Accordingly range free and range based algorithms are proposed. Sybil attack handling and energy conservation is proposed through this literature.

C. F. Wang et al. [29] Sink node handling is considered in this case. The wireless sensor network does not passes data towards the nodes who does not having neighboring nodes.

Such nodes are known as sink nodes. The system describes increases lifetime by eliminating sink nodes and provides least energy consumption hence provide better transmission process. The nodes having limited energy are discarded from transferring the data. Lifetime of network is greatly enhances by the use proposed technique. Sink Nodes are eliminated to conserve the energy.

I. Jawhar et al. [30] Graph based approach is used in order to handle redundancy and hence minimize the energy consumption. Energy consumption minimization is the prime objective of this literature. Lining of sensors is primarily used to satisfy the objective of energy conservation and speed up the overall operation.

M. Ayaz et al [31] explained the fundamental challenges in underwater wireless sensor networks (UWSNs), in which acous-tic links are used for high transmission power with high channel deterioration. These channels have high error rate and temporary path losses because of unstable underwater environment, which affects and decreases the performance of these networks. Along with this, limited resources and continuous node movements also create problems in delivering accurate data. For this purpose, authors have purposed two-hop acknowledgment (2H-ACK) mechanism which insures data delivery from sensor node to surface sink. In this model, two nodes maintain the same copy of data packet which helps to increase the reliability of data transfer.

R. Devi et al [32] discussed about the Wireless Sensor Network (WSN) which has prominentcontribution in the field of emerging. Sensor network is a network defined with energy nodes therefore energy is a very sensitive issue in this network. Some amount of energy loss happens when communication takes plan between nodes. It requires to reduce the overall communication over the network in order to save energy. Normally, every sensor network follows some network architecture. Clustering architecture is one of them in which whole network is divided into small parts known as clusters and each cluster is controlled by a cluster head. Base station is required in sensor network to control and manage the communication over the network. In most of the sensor networks, the positioning of base station is static and generally centralized.

V. James et al [33] briefly described clustering process in wireless sensor network. A hybrid energy efficient distributed clustering methodology is discussed in this paper. The Capacity based Clustering Low Energy Adaptive Clustering Hierarchy (CC- LEACH) has been used and the outcome has been evaluated against the existing LEACH clustering methodology. Results clearly show huge improvement in throughput, packet delivery ratio and receiving few packets at the base station. Clustering methodology methods on this paper show energy consumption and decrease in data transfer delays on dense wireless sensor networks.

N. Goyal et al [34] states about Data aggregation techniques in UWSN which are discovered by researchers in past years. Various protocols have been designed for Surveillance and monitoring. Data aggregation increases the network life and energy consumption during data transmission. According to the research, data aggregation techniques are divided into two major categories such as cluster based and non-cluster based.Moreover, Author also examined the simulation results of a technique with data aggregation and the results of same technique without data aggregation to show the impact of data aggregation. For this purpose author considered three cluster based techniques that are K-means, Round based clustering (RBC), and Distributed underwater clustering scheme (DUCS), whereoutputs are graphically represented in terms of delay, packet drop and energy consumption using NS-2 simulation tool.Author also gives a brief comparison table of existing data aggregation techniques. The future challenges of data aggregation in UWSN are identified and presented which justified the use of data aggregation technique along with routing protocol. UWSN is an efficient tool and has emerged the need of survey on data aggregation that may create further interest towards its scope and to overcome its constraints to meet the identified challenges.

M. Akbar et al [35] discussed two schemes for data gathering in Wireless Sensor Networks (WSNs). First is MS moves on random paths in the network (RMS) and another one is the trajectory of MS is defined (DMS). Network field is logically separated into small squares in both schemes. The centre point of each partitioned area is known as sojourn location of the MS. Author presents three linear programming based modelssuch as enhance network lifetime, decrease path loss and end to end delay. Furthermore, a

geometric model is designed to avoid redundancy while collecting information from the network nodes. Simulation results show that our designed schemes perform better than the selected existing schemes in terms of the selected performance metrics. Authors also compare their proposed schemes with UC - MS and DYN - NBC but results prove that RMS performs better than DMS if collecting data from dense regions is performed first and then remaining. However, DMS trajectory shows better performance in terms of stability.

K. Hirpara et al [36] Authors elaborated novel approach for Target Tracking by combining clustering and prediction based techniques to improve lifetime of Wireless Sensor Network. Target tracking is one of the most widely used applications of WSN. Target tracking is another important criterion in tracking accuracy which can be achieved by using appropriate tracking mechanism. Special characteristics of WSN are a trade-off between tracking accuracy and power consumption. By using the concept of clustering and prediction technique, it can improve tracking accuracy as well as provide energy-efficient solution. Furthermore, Energy-Efficient Constant Gain Kalman Filter based Tracking (EECGKFT) algorithm is used to optimize the energy usage and increase the tracking accuracy. It is required to collect data from network having a mobile Base Station (BS). In addition, the proposed algorithm also provides accurate trajectory tracking by minimizing the RMS error. The proposed technique becomes computationally light weight and gives more accurate results in WSN.

O. Chughtai et al [37] introduced Congestion Detection and Alleviation (CDA) mechanism to handle impairment of network performance in terms of PDR, throughput, end to end transmission of data and energy consumption per packet data. CDA detects both node and link level congestion within a time division management and alleviate it in a reactive manner. Congestion detection of nodes and the buffering is matured in this paper. However, the novel based procedure is used in this for detection of link level congestion by determining link utilization using back-off stage of Collision Avoidance with multiple Access carrier sense (CA/ MACS). Apart from this, CDA alleviates congestion reactively by either re-routing the data traffic to a new less congested, more energy-efficient route or bypassing the congested area. The pretending results showing

that CDA has performed better than CAF and NOCC in terms of PDR, throughput, end to end transmission of data and energy consumption per packet data.

T. Du et al [38] deeply explained analysis of Wireless Sensor Network and suggested named Dynamic message List for Efficient and Real time (DLER) data aggregation algorithm. DLER is developed using cluster based structure and routing methods are derived from the previous researches. DLER is work on network layer of WSN and a dynamic rundown will be made in separating device to store history information parcels at any point transferred by this device. When messages are landed to the separating hub, it will be contrasted and all things of rundown. On the off chance that the information parcel's substance is in the rundown, it will be surrendered else it will be transmitted without any delay. The things in the list will be refreshed and length of the list will likewise be balanced by the updated of frequency of items. In DLER, increased the transmitting performance of real time applications and the filtering efficiency is improved.

S. Uke et al [39] discussed formal approach in Wireless Sensor Network of data aggregation by using object oriented model approach and UML Diagrams. Various kind of application utilizes complex information structures and distinctive calculations for aggregation information. Author demonstrated UML techniques for aggregation of data in wireless sensor network prompts grow application better. Subsequently of extra sensor nodes being placed in an entire network system, which send the request on asset limitations is diminished, which prompts increment in redundant information. To reduce lessen this repetition or sorting out the information productively data aggregation protocol is used .These type of modelling tools enable us to divide in limited WSN application and convenient component which leads to develop application rapidly and efficiently.

A. Sarkar et al [40] discussed and analysed various parametric features of the routing protocols. These protocols are categorised based on nodes participation, clustering protocols, mode of functioning and network structure. Selection of best route is very significant in WSNs and selection depends on a number of parameters. Routing problems lead to decrease in network lifetime and increase in energy consumption. Various routing protocols are developed to solve this issue. As per author, chronological research report

reveals 42% work has been done in 2015 which is about the routing problems occurring during data transmission from sensor node to base station. The energy efficient problems which constitute about 44% are left to be discussed more. Moreover, the meta-heuristic study depicts that 16% routing problems are analysed by non-heuristic procedures and 10% has used bio-inspired algorithms.

R. Ramya et al [41] explained the energy utilization plays a vital role in wireless sensor networking. Clustering is one of the techniques used to optimize the energy consumption and increase network lifetime. A wireless sensor network (WSN) consists of low cost, low power, small in size and multi-functional sensor nodes. Routing protocols in WSNs are also application specific, which has led to the development of a variety of protocols. Author classifies the routing protocols in WSNs as data-centric, hierarchical and location based depending on the network structure. Data-centric protocol uses metadata structure to transmit sensed information to base station. Hierarchical routing protocol adopts the clustering approach by grouping sensor nodes. This method is highly scalable, therefore it is used in a number of applications. In case of Location based protocol, nodes are addressed by their location. Distance to next neighboring node can be estimated by signal strength or by GPS receivers.

E. D. Raj [42] States a brief overview on the selection of cluster head. The cluster head selection process is done with the help of any of the algorithms for cluster head selection. Energy is the primary constraint in designing any Wireless Networks practically.In this paper authors can optimize power consumption in WSN by using Low-Energy Adaptive Clustering Hierarchy (LEACH) and LEACH. Cluster head selection is based on some of the cluster head algorithms that enable to optimize power consumption of WSN. Author analysed three algorithms, Density and Distance based Cluster Head, Energy Efficient Algorithm for Cluster-Head Selection in WSNs, Consumed Energy as a Factor for Cluster Head, and discovered to a new algorithm called EDRLEACH, which is based on clustering with maximum lifetime for wireless sensor networks. This protocol helps to improve LEACH because it distributes cluster equally and decreases the unequal topology of cluster.

K. Maraiya et al [43] analysed various cluster head selection algorithms for data aggregation in Wireless Sensor Networks but all consume high level of energy to complete task. Therefore, author introduced new scheme related to clustering for data aggregation called “Efficient cluster head selection scheme for data aggregation in wireless sensor network” (ECHSSDA). Comparison has been with LEACH clustering algorithm in terms of energy consumption, cluster head selection and cluster formation.Results show that proposed algorithm is better than LEACH in terms of energy consumed by the cluster node and cluster head.

O. Banimelhem et al [44] states a Grid-based Multipath with Congestion Avoidance Routing protocol (GMCAR) as an efficient QoS routing protocol which is suited for grid sensor networks.Sensor network is divided into grid.One of the sensor nodes in each grid is selected as a master node.This master node is responsible for delivering the data generated by any node in that grid and for routing the data received from other master nodes. Each master node builds multiple diagonal paths which are connected with sink. Apart from this, it also creates horizontal or vertical path in boundary grid. In this way, protocol has the capability to use densely deployed grid and prolong overall network lifetime. Relay requirements cannot be fulfilled by using routing which is only based on grid densities. Therefore, author used hop count as a second factor for routing decision. Moreover the proposed protocol shows its superiority in achieving better utilization.

R. Grodi et al [45] discussed a new prototype design of parking occupancy monitoring and visualization system which allows ccommuters to have real-time updates on the parking spot occupancy status. This system uses wireless sensor network and wireless networks for checking parking space status and reporting to a database on a real-time basis.By using mobile applications or websites, commuters can easily access the parking space status information. As author explained, with the successful implementation of smart parking, economical and time costs associated with traffic jams, gas fuel wastage, and time looking for an empty parking space that is caused by inefficient parking will be significantly reduced.

G. Xie et al [46] states on wireless sensor network, utilization of the mobile sink to enhance network life time. In physical environment, all kind of obstacles make it difficult

for despatch mobile sink to find an obstacle-avoiding shortest route. Therefore, author introduced an energy-efficient routing mechanism based on cluster method. The mobile sink starts the data gathering route periodically from the starting site, then directly collects data from these cluster heads in a single-hop range, and returns to the starting site. Furthermore,to avoid the complexity of scheduling problem in WSNs, author purposed a scheduling mechanism which is based on spanning graphs and it presents a heuristic tour planning algorithm for mobile sink to find the obstacle avoiding shortest route.

M. A. Alsheikh et al [47] introduced a data bound compression algorithms with error bound guarantee for wireless sensor networks (WSNs) by compressing neural networks. This algorithm is used for data congestion in the network which is used for energy consumption. Compression is used in this paper to solve the adaptive distortion rate. This algorithm is used for real time information. Signal enhancement on the network and to perform the effective network and enhanced the energy consumption of network compression is must. It saves the energy of various nodes in an entire network. Apart from this, an energy comparison which is showing in this paper told that the compression can help reduce the energy level of the nodes and expand the lifespan of various field.

J. Qin et al [48] discussed the distributed consensus theory in multi-agent systems. Authors deployed a distributed K-means clustering algorithm as well as distributed Fuzzy C-means algorithm for cluster based network data in wireless system network (WSNs). The proposed *k*-means distributed algorithm is available for partitioning data observed by nodes into measured groups which have tiny in-group and big in out-group gap. The proposed *c*-means algorithm which is distributed and fuzzy that is able for distribution the nodes which can observed into different measure dependent groups with degrees of membership values ranging from 0 to 1. Some results are showing in this paper which compares the distributed algorithm and centralized cluster algorithm.

J. S. Lee et al [49] described the energy conservation is an important issue in WSNs. Many cluster algorithms have been designed to achieve this. Most of the previous work has done on LEACH and its variants are designed on two layer hierarchy. Instead of this, there are very limited method study three layer schema. Author proposed HHCA based on three layer hierarchy. In this algorithm, gird determined in a centralized manner and

then CH determined in distributed manner. Moreover, semi-distributed clustering approach by considering distributed clustering for the lower level cluster head selection and hybrid of centralized gridding for the base station selection. The simulation results in this paper show that the proposed approach is more efficient than other distributed algorithms. Therefore, the technique presented in this paper could be further applied to large-scale WSNs.

Y. Huang et al [50] discussed about the Communication Cost Reduction Scheme for Wireless Sensor Networks.Energy efficiency is a primary concern for WSNs. One of its most energy-intensive process is the radio communication. PKF, is suitable for typical WSN applications with adjustable data quality computation cost. Through an in-depth mathematical analysis, author formulated the tradeoff between energy efficiency and reconstruction quality of PKF. The validity and accuracy of the analysis are verified with both artificial and real signals. The simulation results using real temperature values demonstrate the efficiency of PKF without additional data degradation. It reduces the communication cost by more than 88% compared to previous works based on KF. PKF requires less computational effort while improving the reconstruction quality compared with the techniques without KF. The advantages of PKF are even more significant. It reduces the transmission rate by at least 29%. Besides, it can be integrated with network level techniques to further extend the whole network lifetime.

L. Cheng et al [51] proposed seamless streaming data delivery (SSDD) protocol for multi-hope clustering based WSNs with MEs. Scalable energy efficient inter-cluster route construction algorithm was designed which enhanced the energy and scalability for efficiency in inter-cluster conversation in hierarchical wireless system network. This support the mobility, author introduced cross-cluster handover mechanism and a lane reduction scheme. SSDD is capable to retain the E2Econnectivity of ME, while avoiding constant flooding of the sink location information as ME traverses access multiple clusters. This proposed protocol is also compared with existing protocol by using a simulation named ns-2 and result demonstrates that SSDD is lightweight and efficient. Therefore, it is particularly suitable for delivering streaming data in WSNs and MEs.

H. Chen et al [52] proposed a new paradigm of audio information collection based on the concept of audio-on-demand. Authors have considered a sink-free environment targeting for disaster management, where audio chunks are stored inside the network for retrieval. The difficulty is to guarantee a high search success rate without infrastructure support. To resolve the problem, a novel replication algorithm was designed which deploys an optimal number of replicas across the sensor network. It proves the optimality of energy consumption of the algorithm. They implemented a sink-free audio-on-demand (SAoD) WSN system, and conducted extensive simulations to evaluate the performance and efficiency of the design. The experimental results show that it can provide satisfactory quality of audio-on-demand service with short startup latency and slight playback jitter. Extensive results show that this design achieves a search success rate of 98 percent while reducing the search energy consumption by an order of magnitude compared with existing schemes.

X. Ding et al [53] tested a large amount of data to identify the WSN's signal transmission characteristics in factory environments and normal residence. In this paper used two types of tests in his experiments. The signal transmission characteristics of indoor WSNs are summarized from the analysis of massive data test. An energy balanced big data gathering algorithm called RTBDG is proposed to collect bugs of real time data and risk analysis for industry operations. Although, two sensor nodes can talk with each other instead of the gap between two sensor nodes, the RTBDG algorithm uses the round strategy and method of rebuilding cluster structure. The performance of this algorithm is compared with other three well known algorithms and the result shows that RTBDG algorithm is very good in energy consumption and enhance the system life time for gathering big data in real time.

Y. Hu et al [54] discussed about Clustering methods for energy-efficient Overlapping adaptive clusters. Improve the energy in WSN clustering plays an important role. In this paper author has proposed energy-efficient overlapping adaptive clustering methods. In this paper author has discussed about Single-hop and multi-hop schemes of clustering and Time driven and event driven schemes of clustering.

S. J. Shobana et al [55] discussed about Grid based congestion clustering control. In this paper author discussed about N-Sink nodes network mostly used in military area network where the tanks are established everywhere, GPS system sends the signals about the suspected area to Tanks then Tank takes their positions and fire on that area where the object is moving. Two kinds of packets are transferred in the network Broadcasted data packets (BDP) and Demand data packets (DDP). When sink needs data then DDP packets are working and on the occurrence of any event BDP packets are moved.

J.K.D. Keynes et al [56] states about Dense wireless network which was using a distributed clustering technique for Hybrid energy. In this paper author told about the enhancement of network energy level with the help of HEED (Hybrid energy efficient distribution). Most of the technique of clustering the LEACH protocol was basically taken. Reached at the Base station and energy efficiency for the network was very good in HEED. This protocol was avoiding the random selection. The selection of CH was based on the cost of communication and energy of the nodes. LEACH protocol was improved with the help of HEED.

V. Krishnani et al [57] states about the compression technique called K-RLE. This compression in-network technique used to save energy of the network. The benefit of this technique is to reduce the data broadcasting time because this compression was saving the energy while passing the data. Authors compared their K-RLE with another compression technique call LZW. Simple RLE was a lossless techniques and K-RLE was a Lossy technique. Authors told that the K-RLE is 40% much better than simple RLE.

K.C Lan et al [58] told about cluster in WSN on compressibility based data gathering. Collect the data from node to node is the main work by the WSN. Nowadays with the advancement of internet downloading was the attraction by the people. Most of the public are in the habit of information gathering. Internet has captured the youth. So compression plays an very important role while collecting the data. Authors of this paper told that the Hierarchical compressive data gathering (HCDG) was a currently best running method nowadays. Most of the HCDG was used random clustering (RC) but in this paper compression based clustering algorithm (CBCA) was used. Size of the data transmission is less in CBCA as compared with RC. CBCA was tested on collecting the water level

data if the flood occurs. There was a hierarchical tree represented in this network. Nodes transferred the data to its neighbouring nodes. CH selection in this technique was based on the threshold value. Energetic node was elected as the CH node to transfer the data to the base station.

CHAPTER 3

SCOPE OF THE STUDY

The purposed system is helping us in controlling the network traffic while sending data from one relay node to another. Before passing on the data, it compressed the data which has taken less time during transmission. Data is passing from one cluster head to another in compressed form and reaches to the base station. With the help of this work, reader will learn the benefit of the RLE compression which is performed in clustering based approach to compress the data and how to utilize the inter-clustering mechanism in the proposed congestion control using grid based inter clustering (CCGBC), how congestion is reduced with the help of CH load balancing and how to fulfill the vacant space using random area selection in every round while making a cluster group.

A combination of RLE compression and inter-clustering mechanism with grid based architecture is giving the benefit of load balancing and less packet drop in a system.

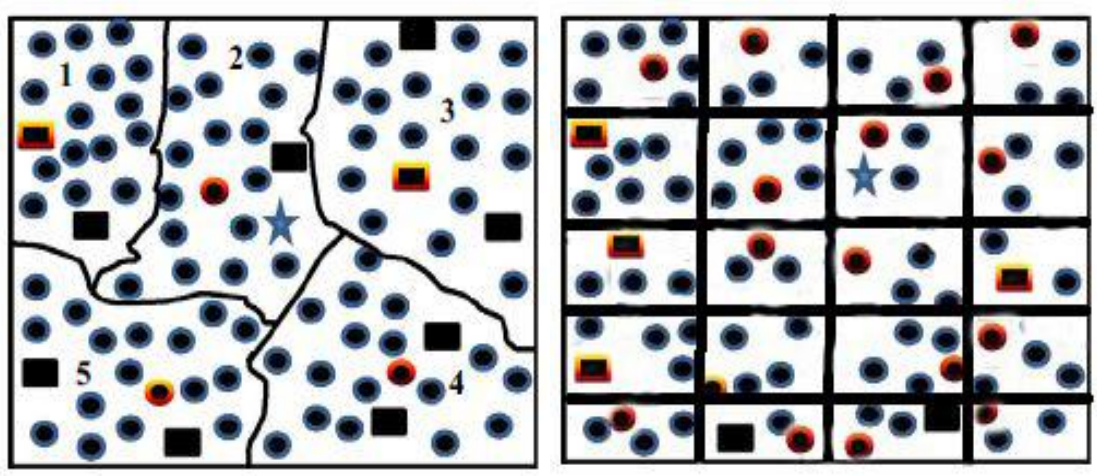


Figure 3.1 (a) Existing PASCCC Routing and (b) Proposed CCGBC Routing Technique

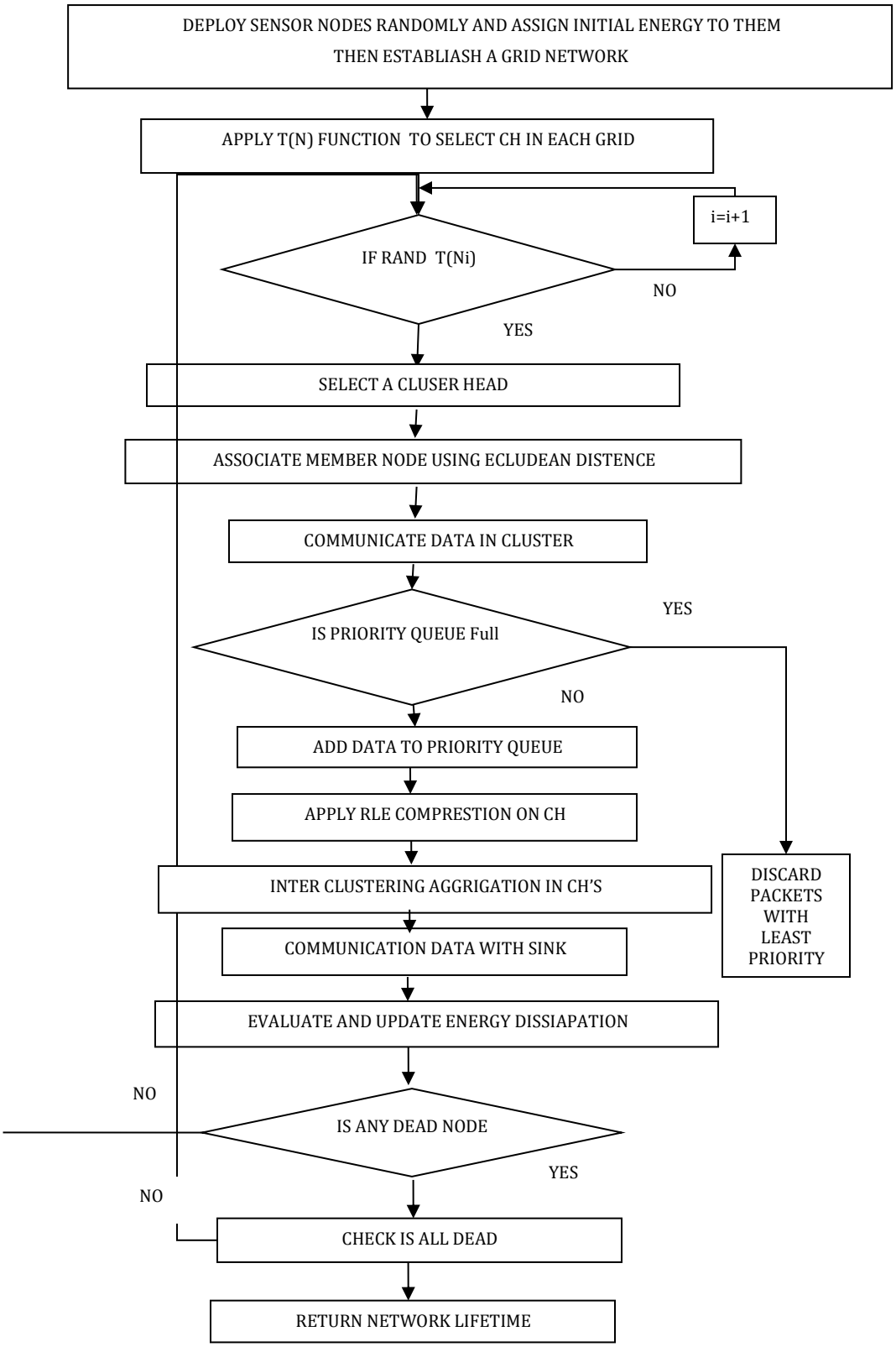
Black nodes are non-cluster head nodes whereas yellow nodes are cluster head nodes and the star is a base station which is called sink node. The comparison of these techniques is held in the chapter 4.

3.1 PROBLEM FORMULATION

PASCCC is the first protocol that has came with cluster hierarchy using congestion detection and mitigation. Basically that is based on priority of the packets. The priority is based on two types of packets; humidity packets and temperature packets. Humidity packets having a LOW priority and temperature packets has a HIGH priority. In this protocol temperature packets should report immediately to base station when the hard threshold is reached on a particular value [12]. So, with the help of cluster head that packets reached to the base station call it as sink node. When the node transfers the data packets from one node to another node then the available energy of nodes is decreased. To resolve this problem the sensor nodes are classified in the small groups called clusters group, where each group has a coordinator called cluster-head (CH). In clustering the node which is having maximum energy is elected as CH node in each group. The threshold value [14] is used for CH selection. If the level of energy of the CH is less than the threshold value, then that node is selected as a cluster-head node in the current round. Apart from this, cluster heads are mature to arrange the cluster members (CMs) and collect the data packets from them and to send that packets to the base-station. At last it should be noted that the PASCCC is a very good protocol but there is some drawbacks in this protocol such as the selection of a cluster head is performed in a very big area randomly CH is selected in this environment on the basis of their energy but while selection a CH it consumes a large amount of energy.

After analysis the PASCCC paper, the analytical result comes that the clustering mechanism, compression technique and energy management is not much efficient while passing the data packets to base station. Also, the inter-clustering mechanism is ignored while passing the data to the base station. Grid based architecture overcomes these drawbacks. In grid based architecture packets dropping ratio is less and the load on the nodes are balanced. A part from that the compression technique called RLE which is a lossless technique is used and inter- clustering mechanism and is implemented to enhance the energy level of nodes and to control the congestion. So, PASCCC performance is enhanced through CCGBC.

3.2 RESEARCH METHODOLOGY OF CCGBC



3.3 ALGORITHM

The aim of this algorithm is familiar with a network application in which random nodes are arranged and network is devoted to examine the surrounding nodes. There are few steps written below that will be used to solve the problem.

Step#1: Initialize number of nodes, energy, and location of base station for the network

Step#2: Establish a grid based network.

Step#3: since it is to be assumed that initially all the nodes have a same energy (E_{max}), 10% nodes are advanced nodes. Hence using a threshold function CH is selected. In this paper the total number of neighbors and average number of neighbors are helpful to get a threshold value.

Step#4: Choose a random value and compare that value with each node of a group. If the value of that node is greater than the random value that node will be elected as a CH for that single round. In the first round, each node has a probability of becoming the CH. That node which is selected as a CH for a round will become a CH in the next 1/p rounds. Assume if there are 100 nodes then 1/p is 1/100. So a single node could be a CH node around 10 times.

Step#5: Once a CH's are created, it transmits its identity to all other their native nodes related to that group using the Euclidian distance.

Step#6: After sending their identity CH waits for an acknowledgment from nodes. Once CH receives acknowledgements from all the nodes then CH is ready to get the data packets from these nodes.

Step#7: In a group CH checks the Priority Queue. Is it full or not? If the queue is full then it discarded the least priority packets. Otherwise it adds the packets into that queue.

Step#8: When the data packets are received by CH then it combines these packets into one packet and then it is compressed with the RLE compression technique.

Step#9: These compressed data packets are then transmitted to another group with the help of inter clustering technique. This process continues till the packets reached to the sink node which is called base station.

Step#10: At sink node data is evaluated and energy dissipation is calculated.

Step#11: At this point it checks that if any node is dead. If no then go to the Step 3. If yes then it checks all the nodes whether dead or not.

Step#12: If all nodes are dead then automatically it returns to the network lifetime. If no then go to step 3.

3.4 OBJECTIVES

The proposed research work was reduced the work load on nodes with the help of Grid based clustering mechanism. In clustering mechanism nodes were balanced with the help of cluster heads, Compression. In compression cluster head compressed the packets and make it as one packet than with the help of inter clustering it passed that compressed packet to another group where the other cluster head of that group was present to receive that packet. This process continues till the packets finally reached to the base station. In order to speed up the operation shortest path algorithm was utilized. The main motive of clustering was to produce an energetic node for a group for a particular round. Each round that node became a cluster head node which had a maximum energy. So, the energy balancing mechanism was performed in clustering. Moreover, the compression was used effectively to use bandwidth associated with the system.

Research work has following work:

- Enhance the energy consumption in our proposed work
- RLE compression technique and data aggregation using inter-clustering was used in purposed CCGBC
- After completion the result on simulation. It displayed the few labels such as
    - When the first node is dead
    - When the last node is dead
    - Total number of rounds
    - Lifetime of network
    - Energy consumption

3.5 TOOL USE

Existing and proposed system performs the simulation results the MATLAB Computer Application was used. The MATLAB is a mathematical tool and is also used for all types of mathematical calculations inside it. This tool is mostly used in image processes and

literature work. The practical implementation of the code area of domain was working perfectly fine. The introduction about the tool is as follows:

MATLAB

MATLAB uses the mechanism in order to create the simulation for the given problem and definition. The matrix laboratory is the owner of the MATLAB software. To create a system some mathematical environment is provided in order to create a system. There should be a good GUI environment. MATLAB environment is having good GUI in nature. In graphical user interface user can be operated by click and double click. On the other hand command user interface, user can operate by typing the commands. When user starts to install the MATLAB software then following screen will appear

Figure 3.2 Simulation Tool Matlab

CHAPTER 4

RESULTS AND DISCUSSION

4.1 EXPERIMENTAL RESULTS

Simulation was conducted in MATLAB. Energy consumed was evaluated on an average and maintaining fixed area of 100*100. Packets were transferred towards cluster head and then cluster head transfer the data towards base station. We compare CCGBC with PASCCC which was our base paper. We seized the experimental result using E_{elec}= 50 nJ/bit, r=100, E_{DA}=5 nJ/message/bit, Packet size 4000 bit, $Th_{enrgy\ =0.015}$ nJ/bit, E_{fs} = 10 pJ/bit, ETwo_Ray = 0.0013 pJ/bit, queue size=10 packets/Group.

4.1.1 Life Time of network

The Lifetime of network was judged with the stability and un-stability region. In the below results it was showing that the stability period of both PASCCC and CCGBC. When the first node died it was considered as in stability period. In experimental results in figure 4.1 which is given below it tells that in round number 850 first node was died in PASCCC, on the other side in CCGBC first node was died in round number 1080. Now comes to the un-stability period which tells when the last node died. In experimental results it came to know that the round number 4950 all the nodes were died in PASCCC as compared with CCGBC whereas in CCGBC on the round number 5500 nodes were died. So the lifetime of CCGBC was better than the PASCCC

Stability region indicated the packets transferred in case of low congestion region and were not blocked. Un-stability region on the other hand indicated that the packets transferred during heavy congestion. Packets drop was likely to occur if packets were transferred during un-stability region

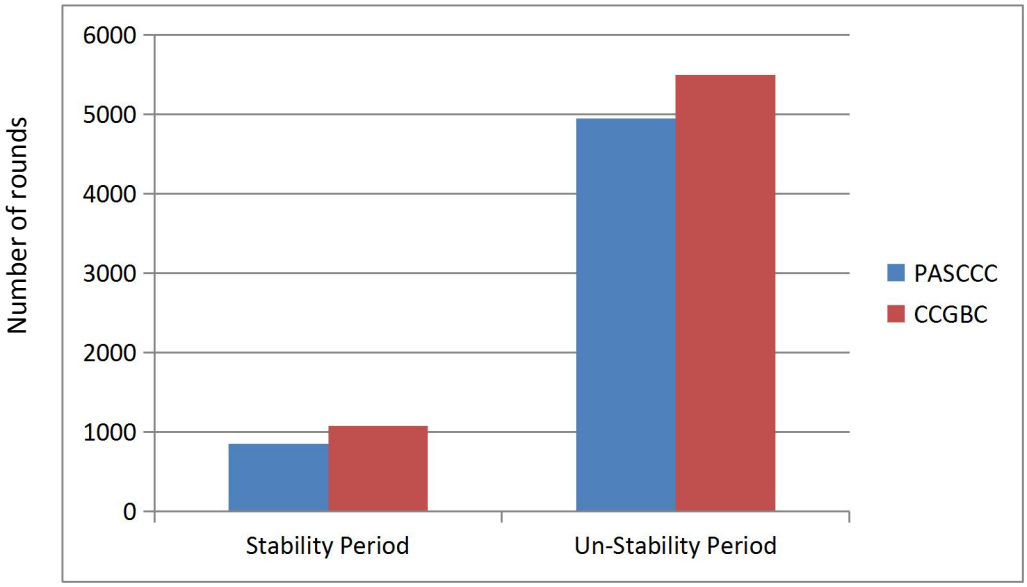
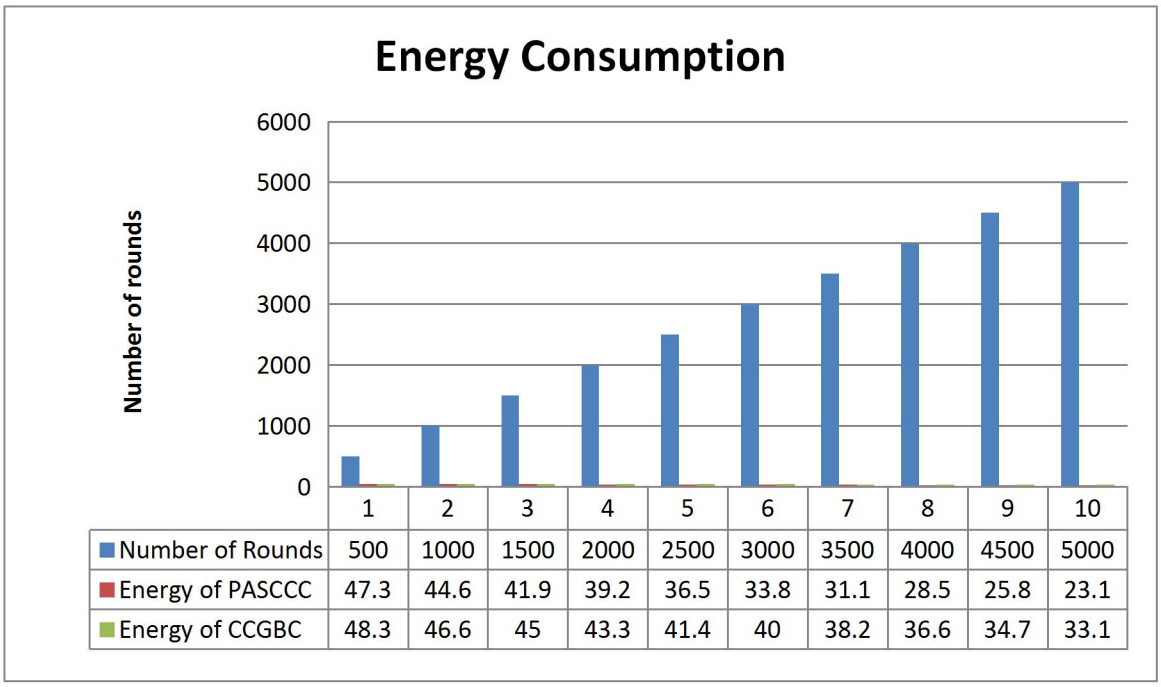


Figure 4.1: Life Time of Network

4.1.2 Residual energy

Residual energy of CCGBC was evaluated in the figure 4.2 compared with existing paper PASCCC. Figure 4.2 which is given below it is showing that the total energy was taken 50 J for each protocol. Total numbers of rounds were taken 5000. Experimental results were showing that when the round number 500 came than the residual energy of PASCCC was 47.3 J and the energy of CCGBC was 48.3 J. As the simulation starts, residual energy starts to decays as clusters heads begin to receive packets and transferred the packets forward. Residual energy was calculated using threshold cluster head and threshold base station values. Threshold cluster head value was considered to be 0.17. As the number of rounds increases, energy consumption also increased by the factor of 0.17. In case of existing work, with every round 0.17 or more energy was consumed and packet drop occurs as entire energy vanished. In order to tackle this problem, priority queue was used in our proposed paper. So with the help of priority based queue packets were maintained within queue and forward from the queue.



	1	2	3	4	5	6	7	8	9	10
Number of Rounds	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
Energy of PASCCC	47.3	44.6	41.9	39.2	36.5	33.8	31.1	28.5	25.8	23.1
Energy of CCGBC	48.3	46.6	45	43.3	41.4	40	38.2	36.6	34.7	33.1

Figure 4.2: Energy consumption in a Network

4.1.3 Data Transmission

The total number of rounds and the packets ratio from normal node to cluster head nodes and the data packets transferred from cluster head to base station. CCGBC duty cycle was less with the existing PASCCC. The total numbers of packets which was delivered to cluster head was 79690 in PASCCC and 103520 in CCGBC after 5000 rounds. In each grouping data aggregation was used to transfer the data by CH to another CH of other group. This technique was used to increase the life of the network.

Packets transferred towards the base station were required to be delivered. Higher the congestion contains more chances of the packet drop. In order to resolve the problem, priority queue was maintained. Results improved in our proposed work as listed through the following figure 4.3 which is given below.

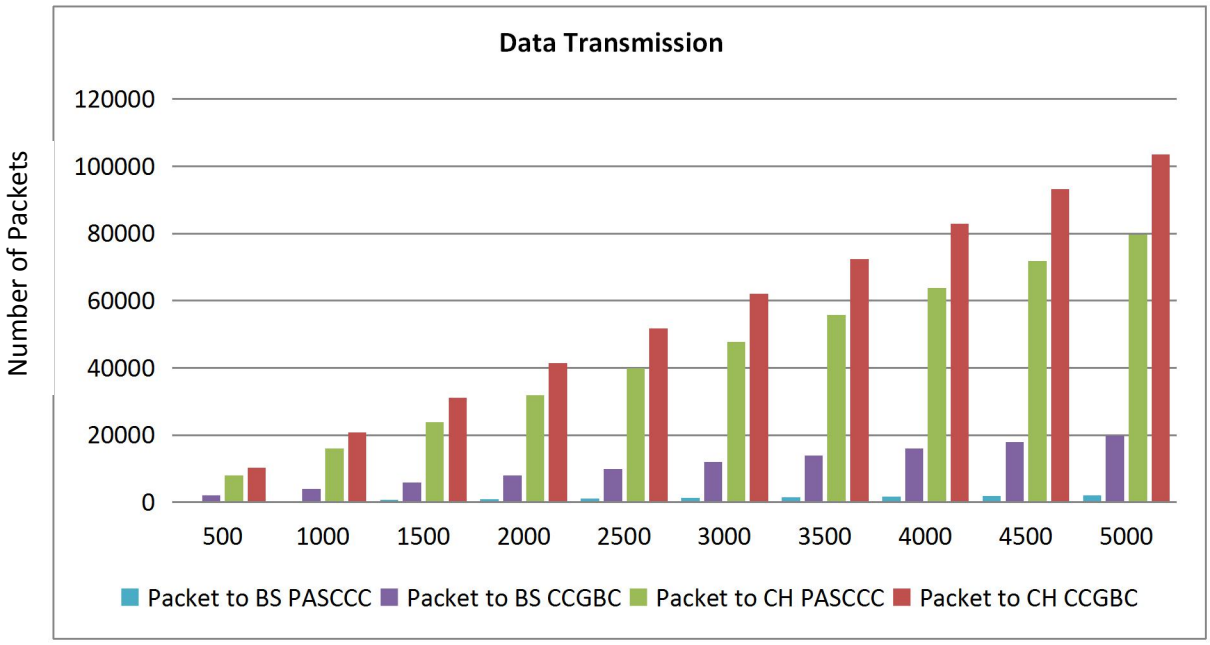


Figure 4.3: Packets deceived to Cluster head and Base station

Packets were transferred depends upon lifetime of the network. PASCCC lifetime was less hence network died before 120000 packets. Find the CH in an entire network the area of PASCCC was bigger as compare with CCGBC. Energy consumption was high in PASCCC to find the CH because the area was 100/100. On the other hand to calculate the energy was in CCGBC was less because the area was divided into small 25/25 of regions from where it finds the CH. Congestion rate was high in PASCCC on the other hand congestion was less in our proposed paper.

CHAPTER 5

SUMMARY AND CONCLUSION

In the study of PASCCC, Authors had worked on a clustering protocol which was based on priority based queue model for identifying the congestion in a network. This protocol was used in time critical application such as Plant fire detection, home automation etcetera, where sensor node had to send the data packets to the base station within the given time-stamp. A minor delay would be lost the information which was very important for base station. There were two kinds of packets arrived in a queue one was temperature based second one was humidity based. Priority of temperature packet was high. If the congestion came in a network the humidity packets were start dropping because the priority of these packets was low as compared with temperature packets. In addition to that in this protocol clustering was performed with two kinds of nodes Advanced and Normal. Energy level of advanced node was high as compare to normal nodes.

After the Analysis of PASCCC and CCGBC, We reached the conclusion that the Grid-Based inter clustering routing technique was better than the existing PASCCC technique because that was giving better result. The benefit of grid-based architecture was to prevent the packet lost and it balanced the nodes while using clustering. We had simulated the CCGBC to check the packets transmit to the base station. In addition to this the data compression with RLE compression algorithm and data aggregation using inter-clustering mechanism was enhanced the performance of CCGBC. The benefit of RLE compression was that it compresses the data before passing to another node. So, it was very beneficial for energy saving of the nodes. The benefit of inter-clustering mechanism in this CCGBC was that it saved the energy of CH node while passing the data to base station. In addition to that in Grid based Architecture packets dropping ratio was less and the energy consumption is high as compared with PASCCC.

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APPENDIX