

**AN EFFICIENT AND RELIABLE APPROACH FOR
DETECTION AND PREVENTION OF CONGESTION IN
WIRELESS SENSOR NETWORKS**

Dissertation submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

By

MANPREET KAUR

Registration No. 11613290

Supervisor

ARUN MALIK



School of Computer Science and Engineering

Lovely Professional University

Phagwara, Punjab (India)

Dec 2017

@ Copyright LOVELY PROFESSIONAL UNIVERSITY, Punjab (INDIA)

ALL RIGHTS RESERVED



TOPIC APPROVAL PERFORMA

School of Computer Science and Engineering

Program : P172::M.Tech. (Computer Science and Engineering) [Full Time]

COURSE CODE : CSE548

REGULAR/BACKLOG : Regular

GROUP NUMBER : CSERGD0044

Supervisor Name : Arun Malik

UID : 17442

Designation : Assistant Professor

Qualification : M.Tech

Research Experience : 5 years

SR.NO.	NAME OF STUDENT	REGISTRATION NO	BATCH	SECTION	CONTACT NUMBER
1	Manpreet Kaur	11613290	2016	K1637	7696235814

SPECIALIZATION AREA : Program Methodology and Design

Supervisor Signature: Arun Malik

PROPOSED TOPIC : An Efficient and Reliable Approach for Detection and Prevention of Congestion in Wireless Sensor Networks

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	Parameter	Rating (out of 10)
1	Project Novelty: Potential of the project to create new knowledge	7.40
2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	7.20
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	7.40
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	7.60
5	Social Applicability: Project work intends to solve a practical problem.	7.00
6	Future Scope: Project has potential to become basis of future research work, publication or patent.	7.60

PAC Committee Members		
PAC Member 1 Name: Gaurav Pushkarna	UID: 11057	Recommended (Y/N): Yes
PAC Member 2 Name: Er.Dalwinder Singh	UID: 11265	Recommended (Y/N): Yes
PAC Member 3 Name: Harwant Singh Arri	UID: 12975	Recommended (Y/N): Yes
PAC Member 4 Name: Balraj Singh	UID: 13075	Recommended (Y/N): Yes
PAC Member 5 Name: Raj Karan Singh	UID: 14307	Recommended (Y/N): NA
PAC Member 6 Name: Harleen Kaur	UID: 14508	Recommended (Y/N): NA
PAC Member 7 Name: Sawal Tandon	UID: 14770	Recommended (Y/N): NA
PAC Member 8 Name: Tejinder Thind	UID: 15312	Recommended (Y/N): Yes
DAA Nominee Name: Kuldeep Kumar Kushwaha	UID: 17118	Recommended (Y/N): NA

Final Topic Approved by PAC: An Efficient and Reliable Approach for Detection and Prevention of Congestion in Wireless Sensor Networks

Overall Remarks: Approved

PAC CHAIRPERSON Name: 11024::Amandeep Nagpal

Approval Date: 04 Nov 2017

11/23/2017 11:08:55 AM

ABSTRACT

A wireless sensor network (WSN) is a one category of wireless network which plays a crucial role in many application areas like industrial process monitoring, health care monitoring, military supervision etc. To reduce energy consumption of the network, whole network will be divided into fixed size clusters. The cluster heads are selected in each cluster with energy and distance parameters. WSN basically comprises of base stations and numerous sensor nodes that are placed in the geographical areas. These sensor nodes collect the information from areas and sends to the base station (sink node). When there are large numbers of sensor nodes are busy in transmitting data towards sink node then there is possibility of congestion in the network. Congestion has a significant role in reducing performance of the network or failure in network. So it is necessary to become aware of congestion and manage the congested resources in wireless sensor networks for enhancing the network performance. Thus, particular considerations are compulsory to build up more sophisticated methods to avoid, detect, and resolve congestion. Different approaches have been introduced in the past few years some include routing protocols aided with congestion detection and control mechanism. In the base paper, adaptive congestion avoidance technique is proposed which reduce chances of congestion in the network. In this research, the bio-inspired techniques are applied which select optimal path from source to destination and reduce chances of congestion. The proposed technique leads to increase network throughput and reduce energy consumption in the network.

DECLARATION

I hereby declare that the research work reported in the dissertation proposal entitled "AN EFFICIENT AND RELIABLE APPROACH FOR DETECTION AND PREVENTION OF CONGESTION 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. Arun Malik. 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.

Signature of Candidate

Manpreet Kaur

11613290

CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation/dissertation proposal entitled “AN EFFICIENT AND RELIABLE APPROACH FOR DETECTION AND PREVENTION OF CONGESTION IN WIRELESS SENSOR NETWORK”, submitted by Manpreet Kaur at **Lovely Professional University; Phagwara, India** is a bonafide record of her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

Signature of Supervisor
Arun Malik

Date:

Counter Signed by:

1) Concerned HOD:

HoD's Signature: _____

HoD Name: _____

Date: _____

2) Neutral Examiners:

External Examiner

Signature: _____

Name: _____

Affiliation: _____

Date: _____

Internal Examiner

Signature: _____

Name: _____

Date: _____

ACKNOWLEDGEMENT

Though only my name appears on the cover of this dissertation, a great many people have contributed to its production. I owe my gratitude to all those people who have made this dissertation possible and because of whom my graduate experience has been one that I will cherish forever. My deepest gratitude is to my advisor, **Mr. Arun Malik**. I have been amazingly fortunate to have an advisor who gave me the freedom to explore on my own and at the same time the guidance to recover when my steps faltered. He taught me how to question thoughts and express ideas. His patience and support helped me overcome many crisis situations and finish this dissertation.

Most importantly, none of this would have been possible without the love and patience of my family. My family has been a constant source of love, concern, support and strength, all these years. This accomplishment would not have been possible without them. Thank you.

Manpreet Kaur

TABLE OF CONTENTS

CONTENTS	PAGE NO.
Inner first page – Same as cover	i
PAC form	ii
Abstract	iii
Declaration by the Scholar	iv
Supervisor’s Certificate	v
Acknowledgement	vi
Table of Contents	vii
List of Figures	ix
CHAPTER 1: INTRODUCTION	1
1.1 WIRELESS SENSOR NETWORKS (WSN)	1
1.2 CHALLENGES OF WSN	2
1.3 QUALITY OF SERVICE (QoS)	5
1.4 CONGESTION IN WSN	7
CHAPTER 2: REVIEW OF LITERATURE	10
CHAPTER 3: RESEARCH OBJECTIVE	19
3.1 PROBLEM FORMULATION	19
3.2 OBJECTIVES	20
CHAPTER 4: SCOPE OF STUDY	22

CHAPTER 5: RESEARCH METHODOLOGY	23
3.4 TOOL DESCRIPTION	23
3.5 RESEARCH METHADODOLOGY	23
CHAPTER 6: EXPECTED OUTCOMES	25
CHAPTER 7: CONCLUSION	26
REFERENCES	27

LIST OF FIGURES

FIGURE NO.	FIGURE DESCRIPTION	PAGE NO.
Figure1.1	Traditional wireless sensor network	1
Figure1.2	A basic QoS model	5
Figure1.3	Congestion in WSN	9
Figure1.4	Node level Congestion	9
Figure1.5	Link level Congestion	10
Figure3.1	Path establishment	20
Figure3.2	Packet loss at congested node	20
Figure5.1	Proposed flowchart	24

CHAPTER-1

INTRODUCTION

1.1 Wireless sensor network (WSN)

The gathering of various sensor nodes which exchange information with each other in order to form a network is known as wireless sensor network. The communication is performed over the wireless medium in which the important data is transmitted. The communication might be performed either by the radio frequencies, infrared or other wireless media. There is no wired communication present within these networks. An ad-hoc network is generated by deploying these sensor nodes in a random manner such that they can perform communication amongst themselves [2]. Various conditions are monitored at different locations by the sensor nodes. The surrounding information includes the calculation of temperature, humidity, pressure, soil, noise and so on. These conditions can help in providing basic knowledge regarding the surroundings of the network [3]. The spatially distributed autonomous devices that can monitor the conditions at various locations are called the sensor nodes. They help in sensing, processing and communicating the important information to each other. A sensor module, a battery, a processor and a radio module are the basic components of the sensor node. There are numerous sensing nodes which have multi functioning sensor nodes of low power.

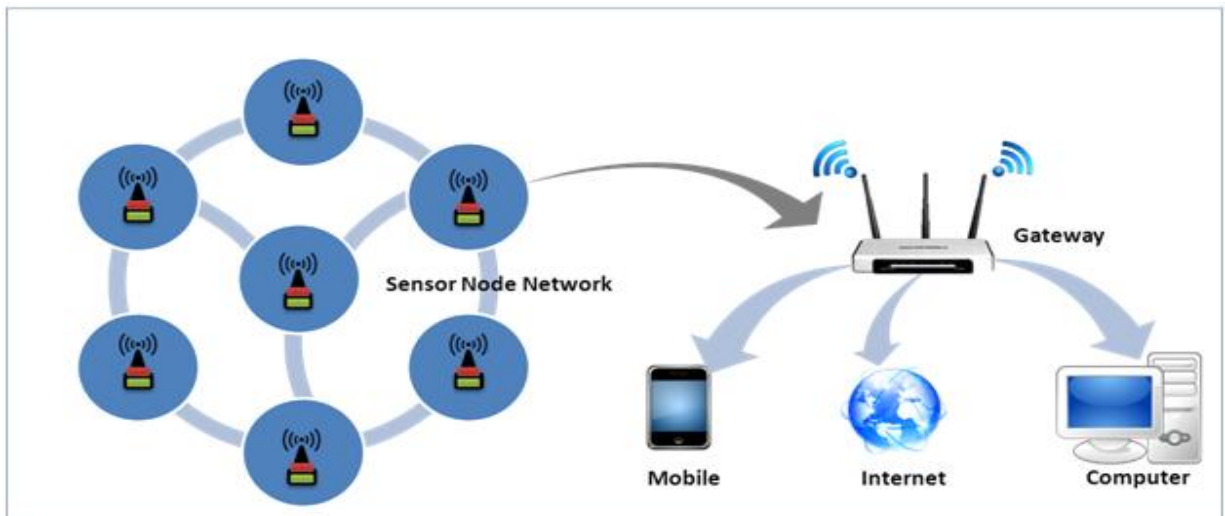


Fig. 1.1: Traditional Wireless Sensor Network [1]

There is less computational and sensing capability which is to be provided to the sensing environment by these nodes. The special events are identified by these self-powered sensor nodes and the data is further processed to the base station through wireless communication mode. In case there is no direct link present amongst the nodes to communicate with each other, it means that there may be some another path using intermediate nodes or these nodes are not in the range of each other. Here, with the help of nodes present in between the two communicating nodes, which are otherwise known as intermediate nodes, the communication can be performed. This type of communication is known as multi-hop type of communication. The requests are served here in a cooperative manner by the sensor nodes. Since there is distributed correspondence gave among the sensor nodes, due to which WSN is known as decentralized kind of system. The deployment of network does not need of any previously established infrastructure. The nodes can be added or removed from the network as per the requirement of the user within the WSNs. The network topology can be dealt with the help of some modifications made within the network. A sink is referred to as the node that collects the information from the complete network. With the help of internet the sink is connected to the external services to which the information is transmitted within some time limits [2]. The sensor nodes are little in size and they are inexpensive. As the sensor nodes are tiny in size, have less energy, bandwidth and computational speed there are very less number of resources utilized within the network. The size of the batteries of these sensor nodes is small due to this, lifetime of nodes becomes limited. Thus, the efficient management of energy within these networks is a major concern.

1.2 Challenges of WSN

There are numerous technical challenges that are being faced within the sensor networks. Some of these challenges are explained below:

- **Ad hoc deployment:** The sensor nodes which have no infrastructure are deployed within certain locations. The connectivity and distribution of the nodes in order to monitor the complete area is completely dependent on the sensor nodes themselves. These sensor nodes try of cover the complete area in which they are deployed and monitor it in order to gather any important information [4].

- **Unattended operation:** The reconfiguration of the sensor nodes that are deployed within the network can occur as per the need. Also, there are various changes occurring within the network as well which can be handled with the help of these configurations [5].
- **Untethered:** There is no connection of the sensor nodes with any external energy source within these networks. Within a sensor node, there is only a finite source of energy which can help in performing the processing and communication within the network similar to that of the battery power. Within the energy consumption, the processing is dominated by the communication method. Thus, there is a need to reduce the communication in order to utilize the limited energy in proper manner [6].
- **Dynamic changes:** The nature of the wireless sensor networks is dynamic and they are self-configurable as well. The changes within the network can be adopted easily by the sensor nodes when more number of sensor nodes enters the network or any node failure occurs.
- **Fault tolerance:** The maintenance of infrastructure in such a manner that when one node is dead, the other nearby nodes of the network is not affected is known as fault tolerance. In order to keep the network unaffected, there are various adaptive protocols present within the network.
- **Security issues:** In wireless networks, the number of threats and attacks are getting increased on their wired partners and some of them affect the network in drastic way. In case of wireless sensor network, the used transmission medium is unguided that makes it more vulnerable to different security threats than for wired guided medium of transmission. The eavesdropping more effects the wireless communication in which data is broadcasted to it. The wireless ad hoc networks are affected by different security issues and threats that also influenced wireless sensor network [7].
- **Synchronization and Localization:** There is need to synchronize the data acquired by all nodes in some applications and essential service in sensor networks to be considered is clock synchronization. In the network a common timescale is expected to be given in time synchronization. The conducted future framework has been predicted and data is correctly breakdown after being prepared by worldwide clock in a sensor framework. In

order to synchronize the nodes it is unimportant to broadcast a clock that results in transmission delay. In WSN there is no important test.

The sensor's relative portion is only utilized in case of sensor nodes localization that is not important to test in case of sensor networks. The abusing received sign strength markers, arrival time, arrival time difference or the angle at which electromagnetic waves arrives, methodologies are made by researchers as it is critical research area. In order to increase precision use of distributed algorithms prove to be very effective.

- **Short Range Transmission:** WSNs need to consider about range of short transmission that reduces the probability of being eavesdropped. The eavesdropping probability gets increased in case of long range transmission that requires high transmission power. There is need of high power due to sending data between nodes so that data reach at destination and taking care of point to point communication [8].
- **Energy consumption:** The energy consumption is a noteworthy test in WSN. As the sensor nodes are little in size and furnished with a predetermined number of power source. The sensor nodes are dependent on the battery which is extremely hard to replace because of the physical constraints. Because of this reason a considerable lot of researchers are concentrating on the configuration of power aware protocols and algorithms. As the ease deployment is one acclaimed advantage of sensor network.
- **Quality of Service (QoS):** The quality of service is defined by the delivery of data from end-to-end node, reliability and conserving energy. Wang defined that the QoS can be termed as measurement of service quality offered to the user by application and it perceived by the user in the community of networking. For the improvement in field coverage and signal transmission the above mentioned technique is used. The care of quality of service (QoS) and coverage uniformity has to be taken regularly. The QoS can also be defined as a ratio between covered area by sensors and total field area. The area is supposed to depend upon the node placement of nodes with respect to and coordinates in the coverage field. The QoS is observed through energy consumption by the low-powered sensor nodes.

1.3 Quality of Service (QoS)

The Quality of Service (QoS) of WSN is still a key research topic for researchers from different perspectives. There is no particular interpretation of QoS; different applications have different parameters for it. In general term QoS is defined as a quality which is perceived by different users or application. In terms of networking community, QoS is considered as a capability of network to provide service quality to end user of application.

The below Fig. 1 shows a general model for network QoS taken from [9] . When transmission of packets takes place between source and destination then there is need of service requirements to fulfill it that is defined by QoS. The packet loss, throughput, delay, jitter, bandwidth etc., are the parameters defined by QoS in traditional information network.

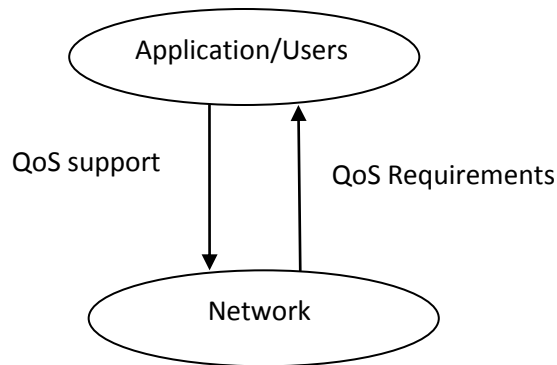


Fig. 1.2: A basic QoS model redrawn from [9].

The data accuracy, coverage, aggregation delay, network lifetime and coverage are depends on different application that of traditional network are the main requirements of QoS in case of WSN. The application domain differences and network properties makes WSN different from traditional network.

The Integrated Services, Differentiated Services type of QoS solutions are mainly used in traditional networks and there use in WSN will be difficult because of some reasons given below:

- In sensor nodes resource constraints are very limited

- Sensor nodes are placed randomly and in large scale
- In WSNs the used communication protocols are different for every application and are data centric

In WSNs there is issue of low QoS due to which it becomes a key topic for researchers and they have propped number of techniques to get rid from this issue. In terms of routing protocols the network layer based QoS has been proposed in [10], support QoS based on Cross layer and Middleware layer based QoS support are different proposed approaches by different researchers in order to increase WSNs QoS.

In wireless sensor networks, for handling QoS there are some design considerations given below:

- **Bandwidth limitation:** The required QoS can be achieved by securing the bandwidth in WSN and it has become a key issue in it. In sensor networks the main source of traffic is elastic and inelastic traffic mixtures [11]. The inelastic traffic is mainly comes from trade off in quality of image and video. The QoS requirements are need to be met by splitting the traffics that have multiple independent routes.
- **Removal of redundancy:** The data generated in sensor networks can have large amount of redundancy that can be eliminated by simply adding aggregation function in case of unconstrained traffic [12]. In case of QoS traffic it is difficult and very complex to add data aggregation. Very high energy resources can be consumed by images and video streams comparison which require large computation. To make QoS data aggregation feasible in terms of computation there is need of both rules of system and sensor level.
- **Energy and delay trade-off:** In wireless sensor network, the use of multichip routing is standard as the radio transmission power is proportional to squared distance or higher order in case of noisy or non flat terrain environments. As we increase the number of hops the delay of packets also increases which results in reducing data collection consumed energy.
- **Buffer size limitation:** In terms of storage capabilities and processing sensor nodes have very limited resources [13]. The incoming packets are forward to next hop after being stored in intermediate nodes that relies on multi-hop routing. In WSN addition of multiple packets will gives some advantages while the buffer size of nodes is enough for

use. In cases in which delay jitter is need to be considered in those cases there is need to buffer larger data and need of long sessions in QoS multi-hop routing. When data is travelling in Sam or different routes the delay variations will be increase for packets in small size buffer.

- **Support of multiple traffic types:** In terms of data routing, multiple issues arise by addition of heterogeneous set of sensors. The surrounding environment temperature, pressure and humidity need a large number of different sensors in different applications. The moving objects videos and images are captured and tracked that helps in detecting motion through acoustic signatures [14]. In normal sensors functionality can be included on demand or these special sensors can be deployed independently.

1.4 Congestion in WSN

A thousand of nodes are there in one WSN that scarred in large area and can contains one or more sinks they further used for collecting and transmitting the information. The data traffic is light that results light load in network but by detection of events load becomes heavy and results in increase data traffic that leads to congestion. The Congestion is a most challenging issue in WSN it can encounter in network due to high data rate, densely distributed nodes [15]. This problem will leads to loss of packets, inefficiency and lack of fairness that shows that there is need to control congestion in order to improve system QoS in terms of throughput, link utilization, packet delivery ratio and delay etc. In network, when available capacity increases at any point due to injected traffic load will lead to congestion. The main sources of congestions are concurrent transmission, buffer overflow, packet collision and many to one nature. The size of WSN buffer is very limited that make it more critical to consider the problem of buffer overflows that occurs when load of incoming traffic get increased from the rate of outgoing traffic. The capacity of buffer is overwhelm by packets that are accumulated so even at low rates the issue of buffer overflow can occur due to many to one nature of network. In WSN the packets are taken from multiple nodes and sent to one single node.

Different kind of applications needs different kind of sensory data so these applications produce different requirements in QoS and reliability. On the basis of specific applications the

traffic can be distributed either query driven or continuous or event driven or can be hybrid. These kinds of applications can be following:

Continuous sensing applications (time driven):- Many real world applications need continual sensing of data to get actual values for e.g. mobile social networking applications and nuclear station monitoring etc. If the load on the network increases the instead of doing continuous sensing we can do periodic sensing but with a specific periodicity which satisfies the requirements of network.

Event based applications: - These kinds of applications sense the network at the occurrence of any event. Let's take a real example; considering the battleground observation application scenario, each node starts sensing its neighbouring nodes after constant interval. Each node sends its samples to the base-station at the detection of any event which can result in congestion.

Query-driven applications: These applications are opposite to event driven applications. In event driven applications the sensing nodes start sending the data after the event has occurred but in case of these kinds of applications, sink node polls and queries the sensor nodes to provide answer.

Hybrid applications: Hybrid applications scenarios are going to be widespread in the upcoming years. Such kind of applications, frequently huge amount of data is produced with the constantly sensed data. Let's take an example scenario of structural health monitoring system, in this structural vibration is measured in a continuous manner by each sensor at a certain rate. Upon detection of an anomaly which is significant, the sensors generate data and release it at a very higher rate. This may result in occurrence of congestion.

For mitigating congestion in WSN the functionality follows, in general, there are basically three steps:

- Congestion detection
- Congestion notification
- Rate adjustment

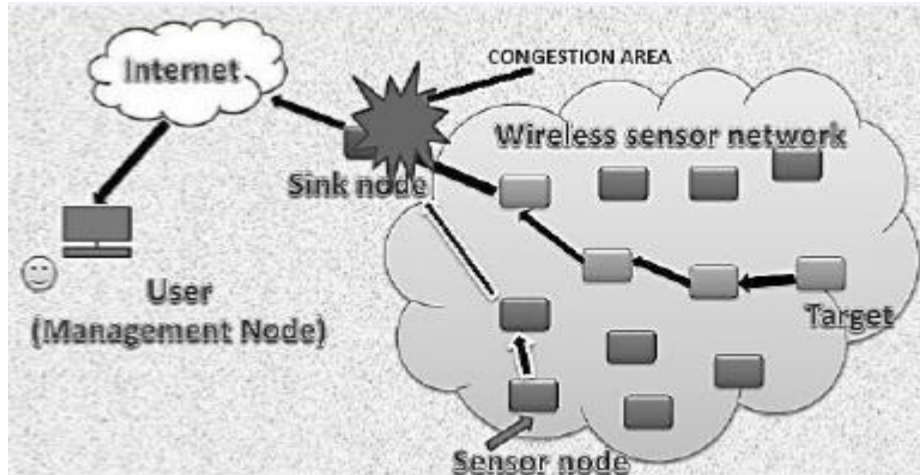


Fig. 1.3 Congestion in WSN

There are two types of congestion given below [16]:

- **Node level congestion:**

This kind of congestion event is general in traditional working networks. In this packet service rate while congestion is less than packet arrival rate which caused overflow of the buffers used and can result in congestion in the network. Due to this type of congestion power wastage and loss of packets increases in WSNs. Thus this congestion mostly occurs at nodes which are closer to the sink node. Therefore, network availability and network lifetime are more affected by this kind of congestion.

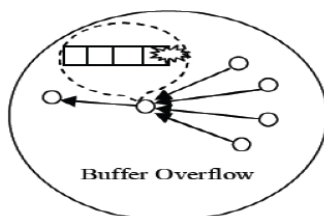


Fig. 1.4: Node level collision

- **Link-level congestion:**

In many areas when various sensor nodes which are within range of each other sends the data at same time then this kind of congestion mostly occurs. Due to this, number of packets that goes from buffer of one node can fail to arrive at the next node which leads to minimize the packet delivery rate at the sink node causes congestion. This kind of congestion increases the both

energy waste and packet delay by decreasing the connection utilization and overall throughput of the network.

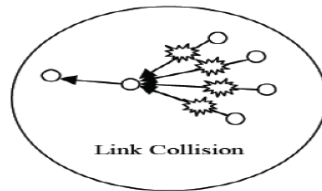


Fig. 1.5: Link level collision

The system energy efficiency and QoS get degraded due to both types of congestion [17]. There is need of proper QoS metrics, fair throughput should be there at each sensor node, and maximum energy efficiency are the main objective of congestion control protocols.

CHAPTER-2

LITERATURE SURVEY

Rashmi M. Kittali, et.al, (2016), has recommended congestion control as a very crucial area of interest in case of wireless sensor networks (WSNs). The increase in transmission of data by sensor nodes results in reduction in throughput. So, there is need of sophisticated techniques to handle network congestion. While designing such type of a mechanism there is need of various constrained resources of the WSN. There are number of techniques for avoidance and detection of congestion by different researchers. The traditional algorithm of flooding and gossiping results in loss of data. In this paper [18], authors have presented a novel approach based on dynamic routing for congestion control that help in tacking traditional approach issues. In case of proposed work, whenever congestion is experienced by packet traversal a packet is rerouted to new path (an alternate path). There is congestion detection, alternate path computation and re-routing the packets on new path are three phases of proposed work. The free space in buffer can be used to detect congestion in the path and alternate path is computed based on available bandwidth, hop distance and residual energy on the path. They have used C for simulation results and considered route discovery time, congestion ratio and delay as performance parameters.

Anuja A. Kadam, et.al, (2016), has analyzed the use of WSN in medical data transmission, military application like different applications that have distinctive attributes and prerequisites. Because of this issue this becomes very difficult to fulfill the prerequisites of hardware and software. The data is transmitted using two types of nodes such as sensor and sink node in WSN. The transmission rate, required data transfer capacity, packet loss and delay demands are the different problems that have to face while transmitting signals using WSN. The network lifetime, capacity of storage, supply of energy and power of computation also comes under energy requirements. The congestion is considered as a major problem while transmitting data in WSN which is the overloading buffer state that outcomes in loss of information packets and transmission delay. In case of medical application congestion and delay in data can cause a passing of patient. In this paper [19], authors have given a review on various techniques for

controlling congestion in wireless sensor network. The existing systems drawbacks need to overcome by designing a new system that removes all those drawbacks.

Sagar Motdhare, et.al, (2016), has presented the reason of congestion in WSN and tries to reduce it using mobile sink. The wireless nodes energy utilization has been improved adding a restricted amount of hops to land at mobile sink (MS). In this paper [20], authors have considered packet delay, packet loss as well as throughput as a parameter to study. The congestion unsympathetically affects the presentation of wireless sensor networks that has to be lowered to increases the sensor network life span. The mobile sink (MS) approach used in the planned scheme is very much successful in reducing the congestion in the sensor network. In the presented model, the sink is mobile not stationary. By making use of simulation, the efficiency of the scheme considered is presented in terms of congestion reduction in wireless sensor network. In real time, user may face certain problems to make use of a Mobile Sink. The future scope of this model can be applying various routing protocols to the planned schemes and finding out that, which routing protocol is best in reducing the overcrowding in WSN.

J. Jean Justus, et.al, (2016), has recommended the use of wireless sensor network for monitoring and sensing the incorporated environment. In WSN the main reason behind congestion is transference of packet in the unsuitable path from sender to receiver. An additional load has been occurring in network because of congestion so; it has become a challenge to reduce the resources and number of deployed nodes that control congestion. In past few years number of researchers has proposed a new routing protocol that helps in detecting and controlling congestion in WSN. For controlling the congestion in WSN, there is have to find location and route information of each node in network. In this paper [21], authors have proposed a hybrid Dynamic Alternative Path Selection (DalPaS) approach for congestion control in WSN. The node in the network helps in performing data aggregation that reduces the congestion between the routing paths in the network. They have also proposed an epidemic algorithm in order to evaluate hybrid WSN performance.

Jasleen Kaur, et.al, (2015), have analyzed that WSN is the key for researchers in the networking field. They are battery operated network and number of challenges has to face while using it. There are hardware motes devices in WSN that senses some events that are happening near to it. A radio/antenna is attached to sensor nodes that are used to communicate the sensed

data via wireless medium. There is physical layer, MAC layer; network layer and application layer four layers that are discussed in WSN. In this paper [22], authors have discussed some protocols that can be used to remove the issue of information loss that occur in the network due to congestion. The sending nodes data transmission rate reduction and route change can resolved the above mentioned problem and rate control approach is mostly used by different protocols. The explicit (ECN) or implicit (ICN) are the two ways to send warnings of congestion. The intermediate node feedback and sink based feedback are two divided categories of congestion controls protocols.

Ranjan Dasgupta, et.al, (2015), has concluded that ad hoc network which is the type of Wireless Sensor Network (WSN) have limited computational power sensor nodes along with radio transceiver. The life of sensor nodes battery is short is the main limitation of it that restrict resources of energy. The network and sensor nodes life can be increased by conserving more power of battery that plays an important role in sensor nodes. While designing network system there is need to perform different techniques to optimize energy. The researchers have worked on problem of reducing energy consumption that result in increase in lifetime of network. A lot of research has been on minimizing the collision of packet and controlling the congestion but very little work has been done on avoiding sensor network congestion. In this paper [23], authors have described congestion avoidance (CA) topology network in which each wireless sensor is deterministically deployed throughout the sensing area. The K-map or K-graph has been used to propose a new CA tree that helps in congestion avoidance. The need of transmitting the data will be reduce by reduction in collision of packets using proposed network that ensures free multi hop data routing. The sink packet loss ratio, network end-to-end delay has been improved that results in increase lifetime of network along with maximizes energy efficiency.

Arpan Kumar Dubey, et.al, (2015), have analyzed that many research domains have been inspired by WSNs and congestion is taken as a major issue faced in such networks that results in heavy loss in data transmission. The heavy traffic, link failure, node failure and many more are some of the reasons that cause congestion. In order to combat network congestion different techniques has been proposed by different researchers. In this paper [24], authors have proposed a technique for prediction of the congestion even before it happens and control the situation before it gets worse. The traffic rates of sources are adjusted to control congestion in the

network. As the control signal is received the transmission rate is changed by source nodes. The proposed algorithm is specially developed to manage congestion situations created by self similar traffic. The simulated Pareto distribution is self similarity in network traffic. The buffer ratio of nodes is analyzed to detect congestion in the network. The simulation outcomes demonstrate that the proposed algorithm is better than existing techniques in terms of packet delivery ratio and average number of packets dropped.

Shuvajyoti Pal, et.al, (2015), has analyzed that high data rate and large traffic loads in WSN causes congestion that has negative impact on performance. This leads sensor nodes to consume more energy and there is increase in delay. Sink node should receive the higher priority information packets with minimum delay relative to packets that have low priority. A routing scheme based on priority which also takes delay into account is proposed in this paper and is called DAPR that reduces congestion in wireless sensor networks. Each sensor node makes use of a model based on queuing according to the proposed mechanism that differentiates data packets based on their priority. Then this data is transmitted in such a manner that sink node receives packets having high priority with minimum delay. DAPR makes use of multipath routing technique. This enables it to lessen congestion at some points in the network. It helps in load-balancing across several sensor nodes and minimizes energy consumption at nodes which increases lifetime of the network. Experimental inferences depict that this protocol lessens the end-to-end delay, sensor nodes consume less energy savings and failure of any node has less impact as compared to EQSR and MCMP protocols.

Mohit M. Chitlange, et.al, (2015), has seen that more popularity has been gained by WSN due to its wide application range. The different environment and industries aspects have been motored using WSN is more cost effective. In terms of computational power and energy constraint resources WSN is restricted. The different researchers have worked on congestion is it is a very critical issue in WSN. The network performance gets degraded by congestion and it also reduces the lifetime of nodes battery which is a limited resource. In order to improve Quality of Service (QoS) and network lifespan there is need to reduce the congestion. In this paper [26], different QoS parameters are shown by the authors by taking different node densities. The 5 UDP agents have been used in simulation scenario which generates traffic, single destination node, and other common nodes. The simulation results show that the limit is of 45

nodes, as the nodes increases value of 45 PDR and throughput continues diminishing. Because of congestion in particular zones of system, more energy is devoured bringing about diminishment of system lifetime.

Mukhdeep Singh Manshahia, et.al, (2015), have analyzed that various researchers have drawn their concentration on the congestion problem in WSN. The main task is to find a particular path from source to destination which should be optimized and also according to the residual energy of the nodes. Many algorithms have been developed and their advantages and disadvantages are also discussed. In this paper [27], a bio inspired technique is proposed which is based on the echolocation of bats for controlling the congestion in the WSN. Through simulation outcomes it is concluded that with increase in the number of hop count the buffer size gets decreases. Echo-aide bat algorithm (EABA) is basically suitable for discrete and continuous problems, and applied in the applications which are mostly developed with the wireless sensor networks to enhancing the performance of the algorithm.

Sunitha G P, et.al, (2014), have analyzed that traffic in WSN have pattern of many to one in which sensing data is transmitted from multiple source nodes to single sink node. The WSN highly constrained in terms of bandwidth, processor and memory so large traffic results in packet loss. The differential service is provided to individual classes of traffic by system. In this paper [28], authors have proposed a new mechanism for congestion control that is based on pre-emptive multiple queue. They have used large number of buffers for detection of congestion and for providing QoS for high priority traffic. The reduced packet delay, reduced packet drop ratio and high system utilization can be achieved using new proposed mechanism. The proposed mechanism performance can be predicted using developed analytical model that calculate the different parameters including throughput of system, packets dropped and mean queue length. They have performed analytic and simulation on proposed mechanism in order to demonstrate the efficiency of that model. The analytical model has been developed using Markovian process and mechanism performance has been evaluated using NS-2.

Qian Peng, et.al, (2014), have recommended the use of proposed congestion control mechanism based on concept of cross layer design that helps in solving the congestion problem that occurs while sending large amount of data. The AODV protocol has been used to realize the multipath

routing protocol has helps in congestion control with active avoidance of congestion. They have also implemented actualized constant recognition and alleviative congestion by applying cross-layer configuration based communication data between MAC layer and Routing layer. In this paper [29], proposed mechanism has been tested by performing simulation test on it. The outcomes demonstrate that proposed multipath directing convention with congestion control component has a few focal points in packet conveyance proportion, end-to-end postpone and standardized overheads. The proposed technique can guarantee the trustworthiness quality, legitimacy of administration and keep energy utilization to drag out the working lifetime of wireless sensor networks.

Sara Ghanavati, et.al, (2013), has concluded that in WSNs congestion is a vital issue that occurs because of much node concentration and source to sink communication patter. The congestion control causes loss of packets as well as excessive energy consumption and delay. So, it is important to concern about high quality of service, to develop a better way for congestion evaluation and control to increase the lifetime of network. In this paper [30], authors have projected an algorithm based on type-2 fuzzy logic that helps in detecting and controlling level of congestions in WSN. The network congestion control delay and loss rate of packets like local information is considered in proposed algorithm. The best deployed nodes transmission rates and levels of deployed nodes congestion can be estimated by using that system which contains two different parts. According to the output, the transmission rates of intermediate nodes will be adjusted. The simulation results of proposed algorithms show that it performs better in terms of network lifetime and packet loss as compared to existing protocol.

Gajendra Sanjay Vyas, et.al, (2013), have analyzed that wireless sensor network contains number of sensor nodes that are distributed in specific area. All the environment condition of surrounding has been sensed by nodes and the used sensor becomes active for monitoring events. A more prominent significance has been given to travel data and this substantial information created by source node because of produced event causes congestion in the sensor network. Due to congestion the performance of the network degrades because of buffer overflow, energy consumption, packet dropped. For sending the data successfully from nodes to sink node the problem of congestion must be controlled. To controlling the congestion, either reduces the rate of packets at source node or increase the availability of more resources. But by reducing the

source rate can degrade the network. In this paper [31], authors have proposed a technique which controls the resources in the network for controlling the congestion. From the results it is clear that it has better performance in case of throughput and packet delivery.

Shijun Zhao, et.al, (2011), has recommended the use of newly introduced technique into WSN which is AQM algorithm that avoid congestion. Earlier the active queue management (AQM) was being used in wired networks that help in controlling congestion. The powerful simulation script has been compiled for evaluating the execution of three AQM algorithms including RED, REM and PI in the WSN network and then source code has been modified using NS-2 and simulated using it. In this paper [32], a proposed mechanism simulation outcome demonstrates that in WSN, RED and REM have their inconveniences separately in the part of queue length and throughput. The execution of PI is moderately fair but due to features of WSN link there still exist queue shake. It has been seen that RED algorithm unraveled full queue leaving in bottleneck nodes, yet can't control the normal queue length, which is moderately high esteem.

Codruta Istin, et.al, (2010), has considered traffic surveillance realized using wireless networked sensors of video camera that are scattered along the road. The most important data has been sent to the sink after monitoring the particular area of interest. The vehicles obstruct the Field of View (FoV) in case of situation of intense traffic. In this paper [33], authors have proposed an algorithm that keeps up scope by a dynamic sensor administration based on redundancy concept. The obstruction of sensors get worse after detecting the traffic congestion so, redundancy value is adjusted by algorithm that helps in increasing the number of active sensors. They have analyzed the performance of proposed algorithm and have been that method dependability has been proved using Monte Carlo simulation. Trustworthiness of the algorithm isn't represented just by keeping up scope at a certain level yet in addition by the way that scope is recouped progressively by a proficient sensor administration. Besides, vehicles those are out and about speak to dynamic impediments that deter the FoV of the sensors. This viewpoint is settled by the utilization of repetition that makes the calculation skilled to keep up a decent scope level even in congestion activity circumstances. Also, regardless of whether repetition happens, the cost of the system does not rise in light of the fact that exclusive the ideal sensors are dynamic.

M. Maimour, et.al, (2009), has considered congestion control and previously they have considered scalar sensor nodes which just report events in the extent of a couple of bytes. The data escalated streams like video streams for reconnaissance applications in inescapable wireless multimedia sensor networks have been considered to address congestion control. In this paper [34], authors have proposed a new framework for efficiently handling the information intensive streams in WSN by putting many techniques collectively. They have addressed multipath routing capability for controlling the congestion. The most of packet losses are introduced through radio medium that occurs not just because of buffer overflow also by conflicts on the radio channel and proposed a new efficient congestion detection mechanism. The path diversity advantage has been considered by using light weight load repartition mechanism. This should have to keep until the sending rate not become constant that helps in keeping the quality of video very high. The proposed system performance has been tested by performing simulation on it.

CHAPTER-3

RESEARCH OBJECTIVE

In the previous chapter, the research gaps are discussed. The literature survey demonstrates that congestion is the major problem in WSN which should be solved to increase the lifetime of the network. Before designing the objectives of this research first we formulate the problem that we find in our base paper.

3.1. Problem Formulation

There is no need of centralized administrator or any fixed infrastructure in order to make temporary network that can be made by using a collection of mobile sensor nodes with interfaces of wireless network. A sensor network generally makes a wireless ad-hoc network in which each sensor node can support multi-hop routing. Hence, in the presence of congestion it becomes difficult to deliver the data. In case of AODV protocol, main problem of congestion occurs while transferring data from source to destination. In case of WSN there are number of nodes that are not controlled by centralized administrator so that's free to move in any direction. It is a self configurable system in which congestion problem take place while data are sent freely from source to destination. In case of AODV there is loss of packet along with congestion issue that can occur while transfer of data or route reply messages which degrades the performance of system. The problem of packet loss and system performance get degraded is taken as a major reason of AODV link discontinuities.

In existing work, nodes are deployed in the network and path is established from source to destination on the basis of AODV. The path establishment is based upon minimum hop count and fresh sequence number as shown in fig. 3.1

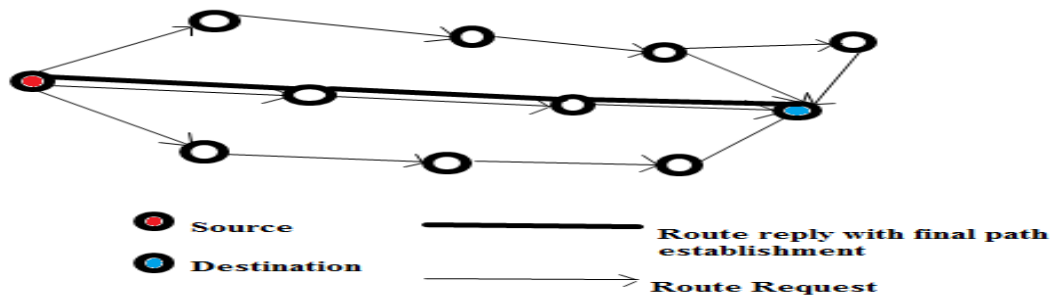


Fig. 3.1: Path establishment

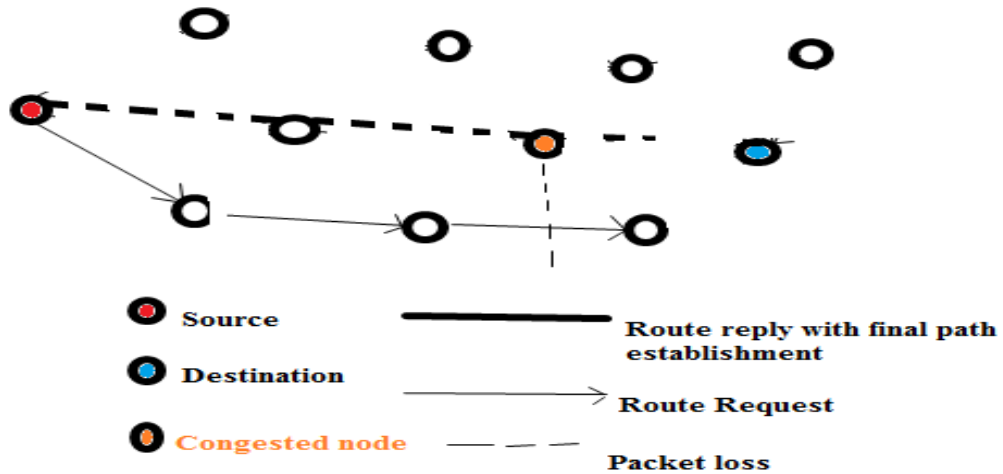


Fig. 3.2: Packet loss at congested node

There is a problem in existing work that there is no advance knowledge of congestion occur in the network so packet drop occurs. To overcome this bio inspired techniques will be used to avoid congestion control problem.

3.2. Objectives

Following are the various research objectives:-

1. To study and analyze various congestion control techniques in wireless sensor networks.

2. To propose an efficient and reliable routing protocol based on bio-inspired technique for congestion control in WSN.
3. To compare the proposed routing protocol with the existing routing protocols in terms of various parameters like delay, throughput, energy efficiency, packet loss etc.

CHAPTER-4

SCOPE OF STUDY

In the WSN one of the major issues is the occurrence of congestion in the networks. A network becomes congested when the inline traffic starts exceeding the available network capacity and can produce any of the link level congestion or node level congestion. Congestion decreases the quality of service of the network due to the effects like queuing delay, loss of packets or blocking of newly incoming traffic. The wireless sensor network is the decentralized network in which sensor nodes can send data using various hops by selecting the appropriate paths. Various routing protocols are used for deciding the paths. When an AODV protocol is used for sending the data from source to destination the problem of congestion occurs because the nodes are not aware about the congestion in advance. So for overcome this problem, a congestion avoidance routing protocol is proposed which works on the bio inspired techniques like bee colony algorithm and cuckoo search algorithm. A path is established using these protocols which avoid the congestion from occurring.

CHAPTER-5

RESEARCH METHODOLOGY

5.1 Tool description: NS2: In order to analyze the performance of the model that is deployed by the researcher, the simulation is performed. It helps in computing the performance of the proposed technique when it is applied in real time scenario. There are two types of simulators. They are event based and time based simulators. An event based simulator in which the generated events are triggered within a certain time duration is known as network simulator version two. The network models are simulated with the help of this network simulator. There are some latest versions derived for this network simulator with the advancement in research. The version with higher compatibility with Ubuntu 16.04 is NS2-2.35. Both text and animation based simulations are performed within this simulator. There are two outputs generated when the object oriented language is executed. The initial output is the .tr file which is also known as the trace file. Here the text base simulation is saved within this output. Further, the second output is in the form of .nam file. This results in providing animation based simulation. There are numerous applications that utilize this simulator as there is no other simulator which can provide both text-based and animation based simulations for various applications.

5.2 Research Methodology

In order to establish a path from source to the destination, the proposed reactive routing protocol is utilized. The most prominently used and highly efficient routing protocol for establishing a path is the AODV routing protocol. The performance of the network is minimized when congestion occurs within it. On the basis of bio-inspired techniques, the AODV protocol is enhanced in this paper. In order to choose an appropriate path the bio-inspired methods such as bee colony and cuckoo search are applied with AODV protocol. The proposed process includes three major steps in it. With the help of AODV routing protocol the path is chosen at the initial phase. The selected path is input to the second phase in which the second path is selected using the bee colony algorithm. The nodes which are common in the both paths are selected and nodes which are left behind are selected on the basis of their buffer size. In the third phase, the path is selected using cuckoo search algorithm and path of cuckoo search algorithm is compared with

the path selected in the second phase and nodes which are not common are selected on the basis of buffer size. The node which has maximum buffer size is selected as the best node for path establishment from source to destination.

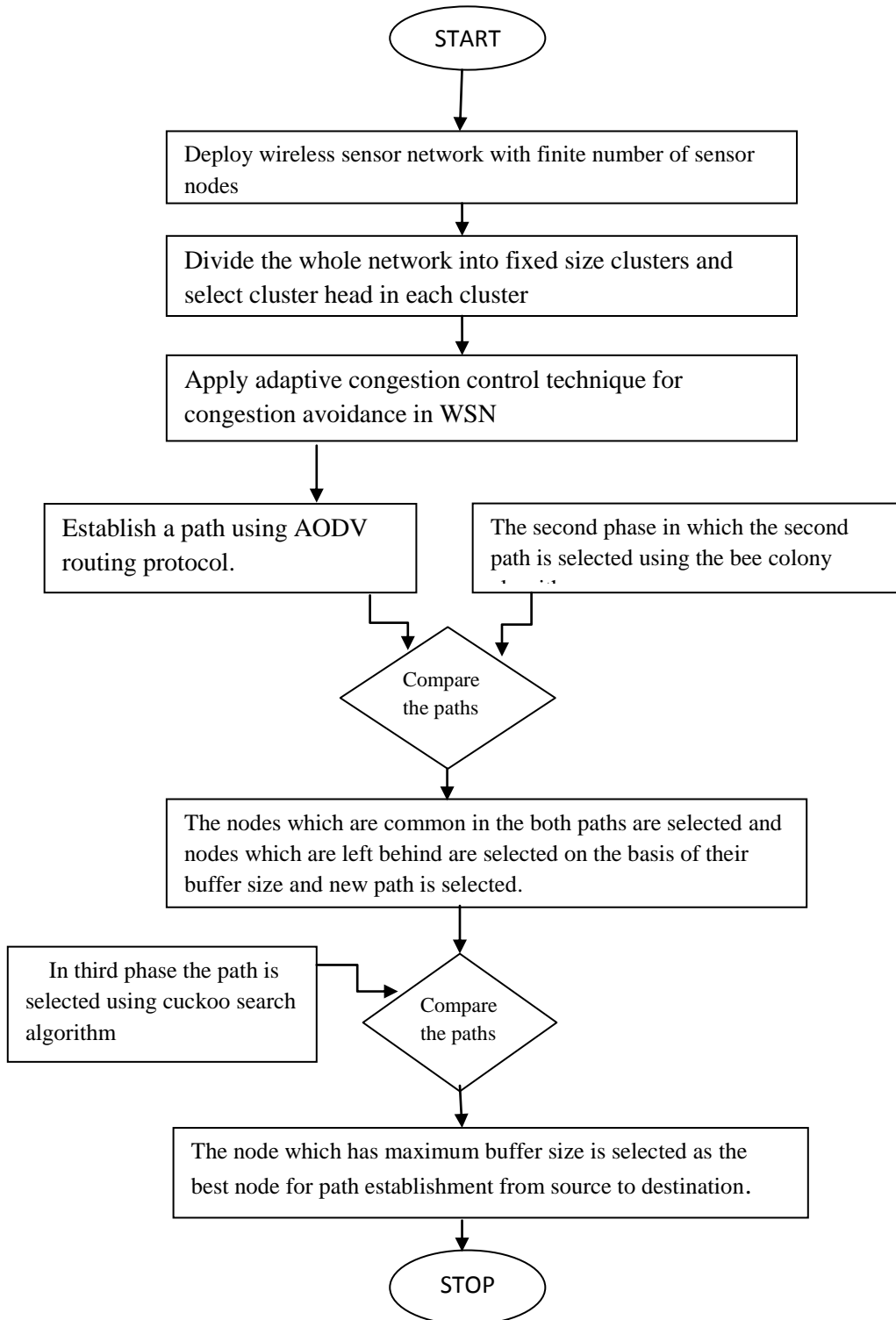


Fig 5.1: Proposed Flowchart

EXPECTED OUTCOMES

Expected Outcomes

Following are the various expected outcomes of this research:-

1. The proposed protocol will increase network quality of service in terms of network throughput, packet loss, energy efficiency and delay.
2. The proposed protocol select optimal path which increase network lifetime.
3. The proposed algorithm reduces the chances of congestion in the network.

CHAPTER-7

CONCLUSION

In this research work, it has been concluded that congestion is the problem in wireless sensor networks which reduces quality of service. In the base paper, technique is proposed which is based on adaptive congestion avoidance technique. In this research work, bio-inspired techniques will be applied in which cuckoo search and bee colony optimization will be applied for the congestion avoidance. The proposed protocol will lead to increase throughput and reduce packet loss, energy consumption.

REFERENCES

- [1] Sukhwinder Sharma, Rakesh Kumar Bansal, Savina Bansal, “Issues and Challenges in Wireless Sensor Networks”, IEEE International Conference on Machine Intelligence Research and Advancement, vol 4, pp.58-62, 2013.
- [2] A.K. Somani, S. Kher, S. Paul, and J. Chen, “Distributed Dynamic Clustering Algorithm in Uneven Distributed Wireless Sensor Network”, vol. 3, pp. 45-49, 2006.
- [3] A. Sahu, E.B. Fernandez, M. Cardei, M. VanHilst, “A Pattern for a Sensor Node”, Department of Computer and Electrical Engineering and Computer Science Florida Atlantic University, Boca Raton, vol. 2, pp. 152-157, 2005.
- [4] Gouvy, N., Hamouda, E., Mitton, N., & Zorbas, D., “Energy efficient multi-flow routing in mobile Sensor Networks”, IEEE In Wireless Communications and Networking Conference (WCNC), vol. 3, pp. 1968-1973, 2013.
- [5] Kaur, K., & Kumari, N. Evaluation and Analysis of Active RFID Protocol in Wireless Sensor Networks, vol. 3, pp. 121-129, 2010.
- [6] Jiang, L., Bing Fang, & Li., “Energy optimized approach based on clustering routing protocol for wireless sensor networks”, CCD Conference. IEEE, vol. 5, pp. 181-190, 2011.
- [7] Wang, Y., & Guo, S., “Optimized energy-latency cooperative transmission in duty-cycled wireless sensor networks”, In Mechatronics and Automation (ICMA), 2013 IEEE International Conference on, vol. 5, pp. 185-190, 2013.
- [8] Neamatollahi, P., Taheri, H., Naghibzadeh, M., & Yaghmaee, M., “A hybrid clustering approach for prolonging lifetime in wireless sensor networks”, IEEE In Computer Networks and Distributed Systems (CNDS), 2011 International Symposium on, vol. 6, pp. 170-174, 2011.
- [9] R. Iyer and L. Kleinrock, “QoS Control for Sensor Networks”, in ICC 2003, vol. 1, pp. 517-521, 2003.

- [10] Emad Felemban, Chang-Gun Lee, Eylem Ekici, "MMSPEED: Multipath Multi-SPEED Protocol for QoS Guarantee of Reliability and Timeliness in Wireless Sensor Networks", IEEE Transaction on mobile computing, vol. 5, pp. 710-715, 2006.
- [11] M.-M. Wang, J.-N. Cao, J. Li and S. K. Das, "Middleware for Wireless Sensor Networks: A Survey", Journal of Computer Science and Technology, vol. 23, pp. 305-326, 2008.
- [12] L. B. Ruiz, I. G. Siqueira and L. B. Oliverira, "Fault Management in Event-Driven Wireless Sensor Networks", Proceedings of the 7th ACM/IEEE International Symposium on Modeling, Analysis and Simulation of Wireless and Mobile Systems, Italy, vol. 4, pp. 149-153, 2004.
- [13] Q. Zhang, Y.-Q. Zhang, "Cross layer Design for QoS Support in Multihop Wireless Networks", Proceedings of the IEEE, vol. 96, pp. 64-76, 2008.
- [14] D. Chen and P. K. Varshney, "QoS Support in Wireless Sensor Networks: A Survey", Proceedings of the International Conference on Wireless Networks, Las Vegas, vol. 3, pp. 609-619, 2004.
- [15] Poojitha Gowthaman, Rekha Chakravarthi, "Survey on Various Congestion Detection and Control Protocols in Wireless Sensor Networks", International Journal of Advanced Computer Engineering and Communication Technology (IJACECT), vol. 2, pp. 15-19, 2014.
- [16] Pang,Q., Wong, V.W.S, Leung, V.C.M., "Reliable data transport & Congestion Control in Wireless Sensor Networks", Int. J. Sensor Networks, vol. 3, pp.16-24, 2008
- [17] Nvs, S. and Gopi, M., "Energy Efficient Clustering Using Jumper Firefly Algorithm in Wireless Sensor Networks", arXiv preprint arXiv, vol. 9, pp. 1405- 1412, 2014.
- [18] Rashmi M. Kittali, Mahabaleshwar S. K, "Congestion Controlled Adaptive Routing in Wireless Sensor Network", International conference on Signal Processing, Communication, Power and Embedded System (SCOPE)-2016, vol. 6, pp. 1528-1532, 2016.
- [19] Anuja A. Kadam, Dr. P. N. Chatur, "Literature Review of Congestion Avoidance System in Wireless Sensor Network", 2016 Second International Conference on Science Technology Engineering and Management (ICONSTEM), vol. 5, pp. 120-124, 2016

- [20] Jasleen Kaur, Rubal Grewal, Kamaljit Singh Saini, "A Survey on Recent Congestion Control Schemes in Wireless Sensor Network", 2015 IEEE International Advance Computing Conference (IACC), vol. 5, pp. 387-392, 2015.
- [21] Ranjan Dasgupta, Ritwick Mukherjee, Prof Dr Amitava Gupta, "Congestion Avoidance Topology in Wireless Sensor Network using Karnaugh Map", 2015 Applications and Innovations in Mobile Computing (AIMoC), vol. 3, pp. 89-96, 2015.
- [22] Arpan Kumar Dubey, Adwitiya Sinha, "Congestion Control for Self Similar Traffic in Wireless Sensor Network", IEEE Contemporary Computing (IC3), 2015 Eighth International Conference, vol. 12, pp. 1523-1531, 2015.
- [23] Sara Ghanavati, Jemal Abawajy, Davood Izadi, "A Fuzzy Technique to Control Congestion in WSN", IEEE Neural Networks (IJCNN), The 2013 International Joint Conference, vol. 5, pp. 554-552, 2013.
- [24] Arpan Kumar Dubey, Adwitiya Sinha, "Congestion Control for Self Similar Traffic in Wireless Sensor Network", IEEE Contemporary Computing (IC3), 2015 Eighth International Conference, vol. 12, pp. 1523-1531, 2015.
- [25] Shuvajyoti Pal, Indrajit Banerjee, "DAPR: Delay-Aware Priority based Routing Scheme to Alleviate Congestion in Wireless Sensor Networks", 2015 International Conference on Information and Technology, vol. 7, pp. 31-36, 2015.
- [26] Mohit M. Chitlange, Vivek S. Deshpande, "Effect of node density on Congestion in WSN", 2015 International Conference on Pervasive Computing (ICPC), vol. 9, pp. 434-438, 2015.
- [27] Manshahia, Mukhdeep Singh, Mayank Dave, and Satya Bir Singh. "Bio inspired congestion control mechanism for Wireless Sensor Networks." Computational Intelligence and Computing Research (ICCIC), 2015 IEEE International Conference on. IEEE, 2015.
- [28] Sunitha G P, Dilip Kumar S. M, Vijay Kumar B P, "A Pre-emptive Multiple Queue based Congestion Control for Different Traffic Classes in WSN", Proceedings of International Conference on Circuits, Communication, Control and Computing (I4C 2014), vol. 9, pp. 212-218, 2014.

- [29] Qian Peng, Dong Enqing, Xu Juan, Lan Xing, Liu Wei, Cui Wentao, "Multipath Routing Protocol Based on Congestion Control Mechanism Implemented by Cross-Layer Design Concept for WSN", 2014 IEEE 17th International Conference on Computational Science and Engineering, vol. 9, pp. 378-384, 2014.
- [30] Sara Ghanavati, Jemal Abawajy, Davood Izadi, "A Fuzzy Technique to Control Congestion in WSN", IEEE Neural Networks (IJCNN), The 2013 International Joint Conference, vol. 5, pp. 554-552, 2013.
- [31] Gajendra Sanjay Vyas, Vivek S. Deshpande, "Performance of Congestion in Wireless Sensor Network using Redundant Nodes", 2013 International Conference on Cloud & Ubiquitous Computing & Emerging Technologies, vol. 5, pp. 73-76, 2013.
- [32] Shijun Zhao, Panpan Wang, Junhai He, "Simulation Analysis of Congestion Control in WSN Based on AQM", 2011 International Conference on Mechatronic Science, Electric Engineering and Computer, vol. 6, pp. 197-200, 2011.
- [33] Codruta Istin, Dan Pescaru, Horia Ciocarlie , "Performance Improvements of Video WSN Surveillance in Case of Traffic Congestions ",IEEE International Joint Conferences on Computational Cybernetics and Technical Informatics (ICCC-CONTI 2010) , vol. 8, pp. 659-663, 2010.
- [34] M. Maimour, C. Pham, D. Hoang, "A Congestion Control Framework for Handling Video Surveillance Traffics on WSN", 2009 International Conference on Computational Science and Engineering, vol. 8, pp. 943-948, 2009.