ISSN: 2321-7782 (Online)
Volume 2, Issue 8, August 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

Combating Congestion Problem in Wireless Sensor Network using Combined Dominating Set Technique

Shuchi Sharma[1]
Department of Computer Science and Engineering
Punjab Institute of Technology (PTU-Main Campus)
Kapurthala – India

Mansi Gupta[2]
Assistant Professor
Department of Computer Science and Engineering
Punjab Institute of Technology (PTU-Main Campus)
Kapurthala – India

Anand Nayyar[3]
Assistant Professor
Department of Computer Science and Applications
KCL Institute of Management and Technology
Jalandhar – India

Abstract: ***Wireless Sensor Network, consist of small nodes with sensing, computation and communication capability. These sensor nodes are small tiny devices which are gathered to transfer data from one node to another. Due to failure in these sensor nodes packet may get dropped in the network due to which throughput get decreased and retransmission of data packet from sender node to receiver node leads to energy consumption which in return cause delay in data packet delivery at sender end. The main categories are data centric, hierarchical and location based. Every algorithm or technique have common objective to less delay, less energy consumption and better network lifetime. After examining these parameters and various techniques, we introduce a new technique named Combined Dominating Set (CDS). The main aim of our technique is to avoid congestion and to increase link stability. A comparison has been made between existing technique and the proposed technique i.e. Mint-Route, TADR and CDS on the basis of delay, energy consumption and the network lifetime.***

Keywords: ***TADR Combined Dominating Set Technique (TADR-CDS); Wireless Sensor Network; link stability; Mint-Rout; Traffic Aware Dynamic Routing (TADR).***

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have been widely spread in the research area over the last decades. Wireless Sensor Networks are deployed for many mission-critical tasks, such as habitat monitoring, health monitoring, image sensing and physical game. Wireless sensor network contains number of sensor nodes, which are small in size. The sensor nodes will be deployed in the remote area, such as the high mountain area, battle fields and the satellite in the outer space, in which case recharging is not feasible. Thus, the main motive for WSNs is on the low energy consumption within the sensor nodes which may be constrained in terms of a small memory and a low computing capability. A wireless sensor network (WSN) consists of the autonomous sensor node to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion, light etc. The huge use of Wireless Sensor Network sometimes leads to problem of energy constraint which in terms leads to limited lifetime of sensor node. This limited lifetime of a sensor node lead to node failure, which can interrupt the entire system. Every sensor node sustains three modes- sleep, active and idle. In sleep mode, the nodes shutdown the radio to save the energy, in active mode nodes consume energy when receiving or transmitting data and in idle mode the nodes consume almost the same amount of energy as in active mode. The sensor network condition is worsened by medium contention, link bit errors or potential handoff operations in wireless networks. These hostile factors in the network increase the possibility of congestion in the network. Congestion occurs in the network when a link or node is carrying large amount of data that its quality of service deteriorates or diminishes. In WSN data passes through multihop routes between sensors until they reach sink node, so the

convergent nature of Wireless Sensor Network increases the susceptibility to congestion. With the occurrence of congestion in the network time delay and packet delivery ratio may deteriorates the Quality of Service (QoS). In the network many a times traffic occurred due to which congestion get arrised and it lead to packet loss and time delay in the network. Due to loss of packet in the network packet get resend to the receiver node due to which more energy get consumed which lead to energy consumption factor of WSN. Congestion in Wireless Sensor Network causes continuous decrease in the delivery ratio and an increase in energy consumption.

The congestion control for Wireless Sensor Networks should be simple to implement at an individual sensor node with minimal energy usage. Queue-based and rate-based are the most popular congestion control schemes to solve the congestion problem. The disadvantage of the queue-based schemes is that a backlog is inherently necessitated; on the other hand, the rate-based schemes can provide early feedback for congestion.

This paper is organized as follow: section II contains Motivation behind work done. Section III contains literature review. Section IV contains Existing technique. Section V contains proposed algorithm. Section VI contains experimental setup. Section VII contains performance metrics. Section VIII contains result analysis and performance evaluation. Section IX contains comparison table of existing and proposed technique. Section X contains conclusion and future work.

II. Motivation Behind Work Done

In Wireless Sensor Networks (WSNs) the congestion is quite different from that in traditional networks. Most congestion control algorithms try to alleviate or remove the congestion by reducing the rate at which the source nodes inject packets into the network. However, this traffic control scheme in the network always decreases the throughput so as to violate fidelity level required by the applications.

The main aim of this paper is to improve Traffic Aware Dynamic Routing (TADR) by improving throughput, time delay, and energy and by decreasing packet delivery ratio. Occurrence of congestion in the network degrade throughput and it also increase time delay and energy consumption in the network. To satisfy this objective and to maintain constant traffic rate we propose a technique Combined Dominating Set (CDS). This technique helps to degrade congestion by link stability between the nodes in the network. Initial step towards achieving this goal is to make sets of nodes and these combined set of nodes transfer packets in a limited range as per the receiving rate of receiver node. In this way sender node dominates receiver node.

III. Literature Review

In Wireless Sensor Network (WSN) congestion is a major issue. Due to congestion packet get dropped in the network and it lead to packet loss. Packet loss in the network causes time delay and consumption of energy by retransmitting packet from sender node to receiver node. Congestion in the network is mainly of two types link level and node level. Link level congestion is carry forwarded by MAC protocols while the node level congestion needs research and solutions further.

The ideal solution of congestion alleviation was first investigated in [2] where detection and avoidance of congestion was proposed. This solution is based on the observations on the queue usage and also the sampling approach. According to this scheme, when a sensor node meets congestion, it sends signals upstream sensor nodes to alert them. Thus the upstream nodes will push less number of packets through that route.

In [4] three mechanisms for congestion control were introduced. They are known as prioritized medium access control, limiting source rate, and hop-by-hop flow control. It decreases congestion by changing source node and nodes up the line to send fewer packets through the route. The problem with these schemes is that they have to monitor the parent nodes' sending patterns and also monitor congestion severity to ensure smooth transmitted packets in WSN.

CODA [6] presents the review on congestion detection and avoidance in Wireless Sensor Networks (WSN), where congestion is examined by sampling the wireless medium and by monitoring the queue occupancy. As soon as a sensor node

detects congestion in the network, it broadcasts a backpressure message upstream, and then the upstream nodes in the network will throttle the traffic volume to remove congestion in the network.

FUSION [5] introduces three congestion control techniques: flow control, hop- by- hop, limiting source rate, and a prioritized medium access control. FUSION alleviates congestion by throttling the transmissions of the upstream nodes and the source nodes. In its rate limiting mechanism, sensor nodes need to continuously watch their parents' sending actions to determine when to generate tokens. This continuous monitoring is too costly and consumes more energy.

SPEED [7] handles congestion by redirecting the incoming traffic around the hot spot in the network. The rerouted path, however, may not have a large channel capacity to accommodate the incoming traffic, leading to congestion.

In [12] a distributed congestion control scheme based on hop-by-hop automatic repeat request in many-to-one routing scenarios where the Congestion Control and Fairness (CCF) routing scheme uses packet service time at the node as an indicator of congestion. The limitation or drawback of CCF is that it wants the network topology to be static or near static. Siphon [13] presents some virtual sinks (VS) with a wide range multiracial within the network. When the versus finds the redirection bit enabled, it direct the packets using its own long range communication network toward the physical sink, bypassing the underlying sensor network routing protocols to avoid congestion.

IV. EXISTING TECHNIQUES

The existing techniques are Mint-Route and Traffic Aware Dynamic Routing (TADR).

A. Mint route- Mint-route is also known as benchmark routing protocol. Mint- Route [2] is network layer approach that develops a metric based on link quality for selecting path towards sink node. Mint-Route discovers a route to forward the packet to sender node rather observing demerits of that route selection. That route selection may cause congestion due high link usage.

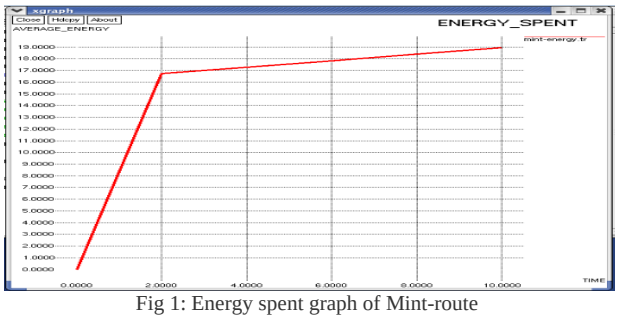

Fig 1: Energy spent graph of Mint-route

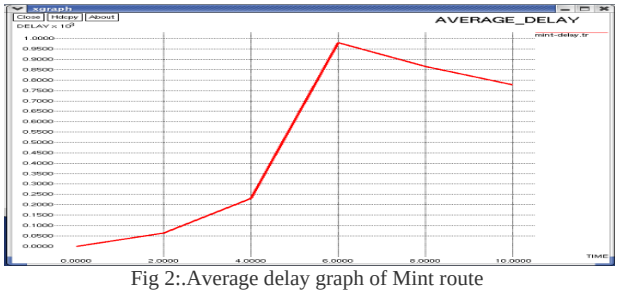

Fig 2:.Average delay graph of Mint route

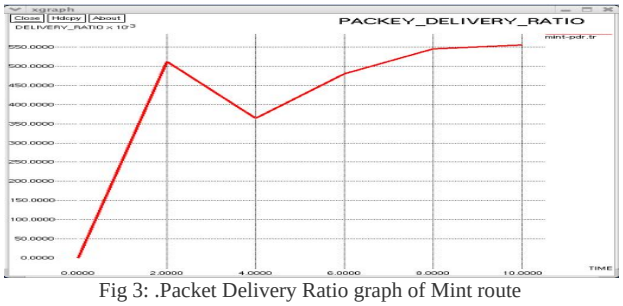

Fig 3: .Packet Delivery Ratio graph of Mint route

In our simulation we generated above mentioned graphs. The figures Fig 1, Fig 2, Fig 3 shows the graph line of energy spent, average delay and packet delivery ratio respectively of the Mint route technique. These graphs generated for 50 nodes in the network and Time is taken on X-axis.

B. Traffic Aware Routing Algorithm- In Traffic Aware Dynamic Routing, congestion get removed or traffic get decrease by dynamic routing. In this technique multiple paths get observed by dynamic routing. TADR [1] identifies alternative routes with multiple paths where nodes are either idle or less overloaded. TADR also faces some problem such as end-to-end delay at the time of congestion and energy consumption.

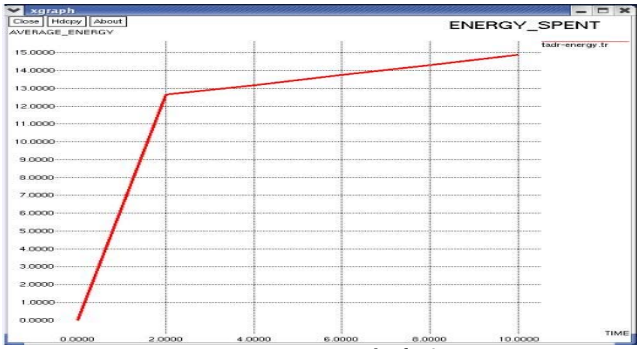

Fig 4:.Energy spent graph of TADR

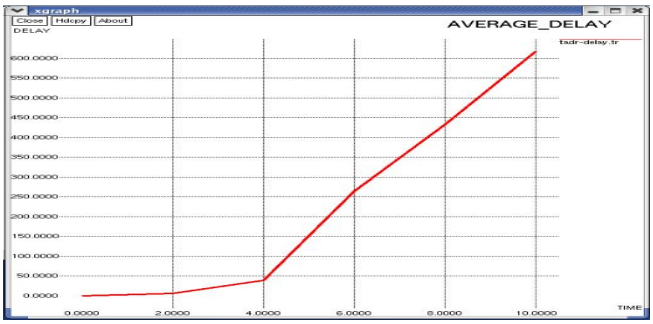

Fig 5:Average delay graph of TADR

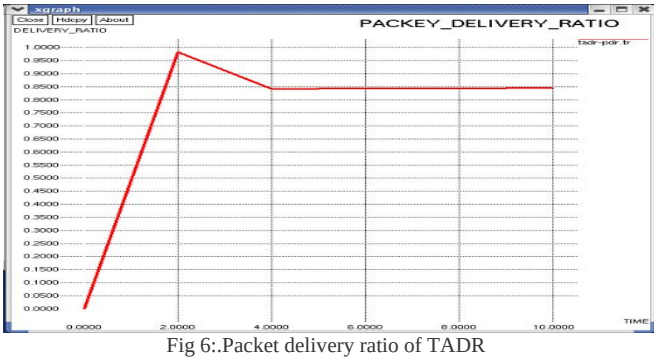

Fig 6:.Packet delivery ratio of TADR

TADR is dynamic aware routing. In this protocol sensor nodes have dynamic positions and they transfer the data packets with the traffic awareness, so that congestion should not get occurred. But in mint-route sensor nodes does not have knowledge about traffic in the network and they transfer the packet in to the neighbour node just by detecting the mini route of nearest node. This may cause congestion problem in the network and lower down the efficiency of nodes. That is why TADR is better than Mint-route.

In our implementation we get simulation results and above mentioned graphs we generated. The figures Fig 4, Fig 5, Fig 6 shows the graph line of energy spent, average delay and packet delivery ratio respectively of the TADR. These graphs generated for 50 nodes in the network and Time is taken on X-axis.

V. PROPOSED ALGORITHM

Traffic Aware Dynamic Routing (TADR) [1] is based on the philosophical concept that network congestion control does not mean reducing throughput. The congestion control mechanism should increase the overall throughput of Wireless Sensor Network. Congestion arises in the network due to excess of packets. Congestion problem in the network cause end to end delay and energy consumption due to which link stability should not get maintained.

To overcome this problem a new technique name TADR Combined Dominating Set (TADR-CDS) technique. The main aim of this technique is to avoid congestion by providing link stability to the nodes.

i. Initially all nodes in the network are assigned node_ids.

ii. Sender node will forward data packet to receiver node throughput intermediate nodes (neighbour nodes). Nodes are based on the factors like threshold, delay, constant bit rate (cbr) and packet size.

iii. Source node sends request message (RREQ) to receiver node. Sender node starts transmitting data packet after receiving reply message (RREP) from receiver side.

iv. If sender node does not get reply message (RREP) from receiver node then it update and retransmit the request message (RREQ).

v. Just by exchange of RREP and RREQ message sender node come to know about the neighbour nodes and sets of nodes get formed.

vi. If reply message (RREP) is received by sender node then data packet transmission will take place. If RREP message is not received by sender node then receiver node resends the RREP message and after getting acknowledgement data packet gets transmitted.

TADR-CDS technique helps in combating congestion. It provides link stability due to which our simulated results regarding parameters like delay, energy and pdr improves as compare to the Mint route and TADR.

VI. EXPERIMENTAL SETUP

The performance of this technique gets analyzed against some parameters like throughput, time delay, packet delivery ratio (pdr) and energy. The simulation results of this technique are analyzed under NS2 simulator. The main aim of our paper is to maintain link stability by using technique named Combined Dominating Set (CDS) in TADR. The main objective is to decrease delay, and to increase throughput and to maintain packet delivery ratio compare to TADR. Both techniques are simulated under same parameters. Parameters are shown in the table to understand and to analyze the performance of the CDS technique.

TABLE 1 PARAMETERS OF SIMULATION

Name of Parameters	Parameters
Channel type	Wireless channel
Radio propagation model	Two Ray Ground
Antenna type	Omni Antenna
Link Layer Type	Link Layer
Interface Queue Type	Queue/Drop Tail/PriQueue
Max packet in ifq	200
Network interface type	Phy / WirelessPhy
MAC type	Mac/802_11
Number of mobile nodes	50
Routing protocol	TADR
Grid size	500 X500

VII. Performance Metrics

The performance of protocols can be measured by a variety of metrics.

- Energy consumption: Energy consumption refers as the total energy consumed at the sink node. Basically, it is the ratio of total energy consumed to the number of packets received by the sink node. The average energy consumption per packet received by the sink node reflects the energy efficiency of the protocols.
- Delay: Delay refers the average time difference between the data packet sent by source node and the time received by destination node.
- Packet Delivery Ratio: It is the ratio of the number of delivered data packets to the destination.

VIII. Result Analysis and Performance Evaluation

We analyze and evaluate the performance of our technique. We plot the graph of various parameters against simulation time using 50 nodes.

In Fig 7 50 sensor nodes in the sensor network of 500 X 500 areas shows the packet transferring. If congestion arises in the network then packet loss will happen. Packet loss in the network cause delay by retransmitting the packet and this leads to energy consumption at sender's end.

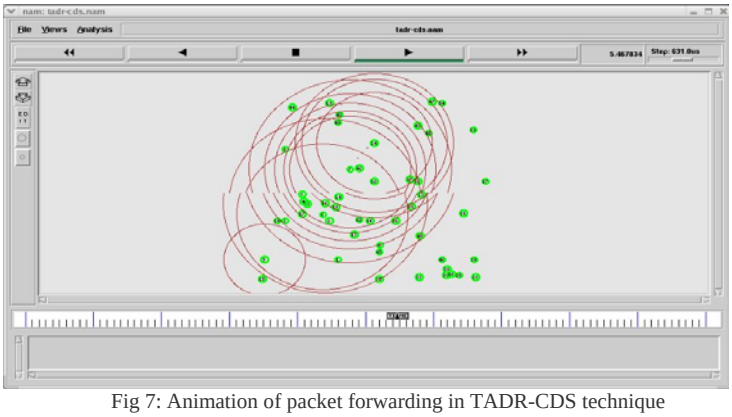

Fig 7: Animation of packet forwarding in TADR-CDS technique

Fig 8 shows TADR-CDS technique is having less energy consumption as compare to Mint-Route and TADR. Mint-route has the maximum consumption of energy. TADR also have the consumption of energy due to computational overhead.

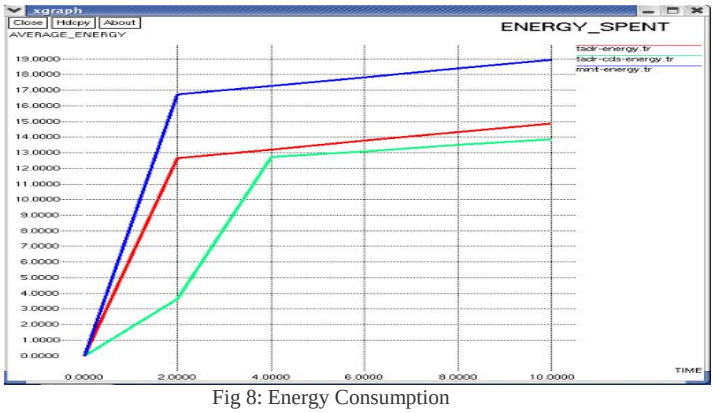

Fig 8: Energy Consumption

Fig 9 shows TADR-CDS technique has less delay than other techniques (Mint-Route and TADR). Mint route have the worst delay and TADR is also affected by delay because of congestion network, node failure and low link stability.

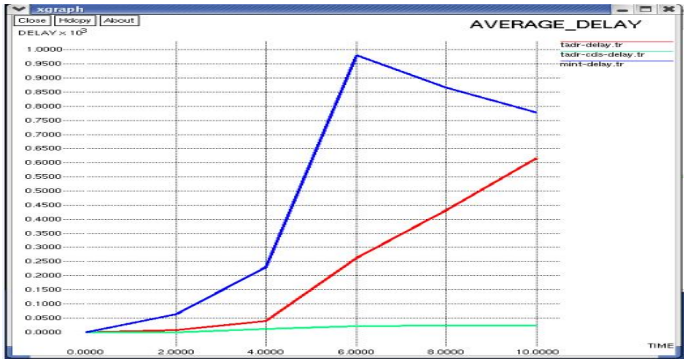

Fig 9: Average Delay

Fig 10 shows the packet delivery ratio graph. In this graph TADR-CDS have good packet delivery ratio. At the end the value of TADR-CDS declines as compare to TADR. Overall this technique (TADR-CDS) shows better result in packet delivery ratio.

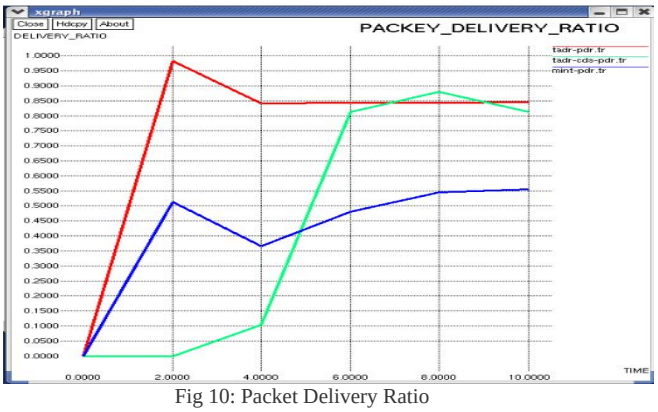

Fig 10: Packet Delivery Ratio

IX. COMPARISON TABLE

TABLE II COMPARISON TABLE

Parameters	**Mint route**	**TADR**	**TADR-CDS**
	It forward packet without observing route.	Dynamically route the traffic.	Set of nodes work in a combined form.
Congestion occurred	Very easily, because route chosen by the sender node may have conflicts.	Oftenly and cause end to end delay and energy consumption.	No because of link stability
Protocol used	AODV	TADR	TADR
Throughput	Average value in our simulation	Good result of throughput	Lowest value of throughput
Delay	Maximum delay between nodes	Average value of delay	Very low
Energy consumed	More energy consumption as compare to other	Average energy consumption	Less energy consumption
Packet Delivery Ratio	Low pdr	Average pdr	Average pdr
Link stability	No	No	Yes

X. Conclusion and Future Work

In the new era of development of wireless sensor network, research in various filed growing rapidly. In this paper we summarize the various parameters which got affected by the occurrence of congestion in the network. We presented a comprehensive survey of routing techniques in Wireless Sensor Network. In Mint route technique data packet get forwarded to another node without observing demerits of that route selection. Due to which probability of congestion occurrence increases. TADR identifies alternative routes with multiple paths where sensor nodes are either idle or less overloaded. To alleviate congestion in the network we propose a new technique called TADR Combined Dominating Set (TADR-CDS). With this new technique we minimize delay and energy consumption.

In future TADR Combined Dominating Set (TADR-CDS) technique can be used to improve other factors which cause congestion in the network. As now this technique TADR-CDS is working on link stability, due to which delay get improve and then we get an improved technique to alleviate congestion. In future researcher can pursue their work to increase throughput.

References

1. Jae-Hwan ChanG and Leandros Tassiulas "Maximum Lifetime Routing in Wireless Sensor Networks" IEEE/ACM Transaction on Networking, Vol. 12, No. 4, August 2004, pp:609-619.
2. Fengyuan Ren Tao He, Sajal K.Das and Chuang Lin "Traffic Aware Dynamic Routing to Alleviate Congestion in Wireless Sensor Network " IEEE TRANSCTIONSON PARALLEL AND DISTRIBUTED SYSTEMS , VOL.22, No.9, SEPTEMBER 2011,pp:1585-1599.
3. Aniketr M. Junghare, Balaji M.Patil, Deepali M. Shimpi "An Improved Traffic Aware Dynamic Routing to Relieve Congestion in Wireless Sensor Network" IJETAE, Volume 4, Issue 1, January 2014, pp. 356-362.
4. Ki-II Kim and Min-Jing Baek "Improving Mintroute Protocol at Different Scenarios" Appl.Math.Inf.Sci.6 No.2S 2012, pp.619S-625S.
5. B.Hull, K. Jamieson, and H.Balakrishan, "Mitigtaing Congestion in Wireless Sensor Networks" Proc. Int'1Conf. Embedded Networked Sensor Systems (SenSys'04), 2004, pp.134-147.
6. C.Y. Wan, S.B. Eisenman, and A.T. Campbell, "CODA: Congestion Detection and Avoidance in Sensor Networks", Proc. ACM Int'1Conf. Enbedded Networked Sensor Systems (SenSys'03), pp.266-279, 2003.
7. T.He, J.Stankovic, C.Lu and T.Abdelzaher, "SPEED: A Stateless Protocol for Real-Time Communication in Sensor Networks", Proc. IEEE Int'1 Conf. Distributed Computing Systems, 2003.
8. M.Zawodniok and S. Jagannathan, "Predictive Congestion Control Protocol for Wireless Sensor Networks", IEEE Transaction Vol.6, No.11, pp.3955-3963, Nov.2007.
9. C.Wang, B.li, K.Sohraby, M.Daneshmand, and Y.Hu, "Upstream Congestion Control inWireless Sensor Networks through Cross –Layaer Optamization" IEEE J. Selection Area in Comm, Vol.25, no.4, pp.786-795, May 2007.
10. M. Zawodniok and S. Jagannathan, "Predictive Congestion Control Protocol for Wireless Sensor Networks", IEEE Transanction Wireless Comm, Vol.6, No.11, pp.3955-3963, Nov-2007.
11. Shuchi Sharma and Anand Nayyar "Mint-Route to Avoid Congestion in Wireless Sensor Network" International Journal of Emerging Trends & Technology in Computer Science, Volume 3, Issue 2, pp. 91-94March – April 2014.
12. C.Ee and R.Bajcsy, "Congestion Control and Fairness for Manyto- One Routing in Sensor Networks", Proc ACM Int1Conf. Embedded Networked Sensor Systems. 2004.
13. C.Wan, S. Eisenman, A.Campbell, and J.CrowCroft, "Sipjon: Over-Load Traffic Management Using Milti-Radio Virtual Sinks in Sensor Networks", Proc.ACMInt'1 Conf. Embedded Networked Sensor Systems, pp.116-129, 2005.

Author(s) Profile

Shuchi Sharma has completed her B.Tech degree in Information and Technology from Rayat Bahra College of Engineering and Nano Technology for Women Hosiarpur, Punjab. She is currently pursuing her M.Tech CSE (Networking System) from Punjab Technical University Main Campus Jalandhar.

Mansi Gupta (B.Tech and M.Tech). She has completed her M.Tech from Lovely Professional University Jalandhar. She is currently working in Punjab Institute of Technology (PTU Main campus) as an Assistant Professor in department of Computer Science.

Er. Anand Nayyar (MCA, M.Phil, M.Tech, MBA). He is currently pursuing his Ph.D in Computer Science from Desh Bhagat University, Mandi Gobindgarh. A certified professional in many International Certifications like Comptia A+, CCNA, MCP, MCSA, MCSE, MCTS, MCITP, MCSD.net, CEH, RHCT, RHCE, OCP, Tally Certified Professional, Project Management, AutoCAD, DTP, Web Development, Google Certified Power Searcher and many more. He has published more than 200 Research Papers and published more than 10 Books on Computer Science. He has reviewed more than 1300 Research Papers for various journals, national and international conferences. He has guided 8 M.Tech (CSE) & (ECE) students and 5 MCA students. He is a part of more than 200 Research Journals as Editorial Board member and Review Board Member and has been associated with more than 150 National and International Conferences as Advisory Board and Reviewer Committee Member. He is a more of more than 45 International & National Research Societies as Life Member. He has been awarded Best Faculty Award, Bharat Shiksha Ratan Puraskar, Best Citizen of India, ISTE Best Teacher Award and Young Scientist Award. He has been cited in Marquis Who's Who in the World in 2014 and Rifacimento International: Asia Reference: Who's Who in Asia.