Major steps of presented approach are

1. Network Model Creation
2. Congestion Model Generation
3. Congestion Prediction and Elimination using BatFuzzyBee

3.1.1 Network Model Creation

The model of the presented work has four regions. Each region contains a number of nodes. Among these nodes one region head is selected based on weight. The rest of all nodes in each region is called Region Member(RM). The members can send data to their Region Head(RH). All region heads are interconnected. So they can communicate with each other. To collect the data from all region, mobile sinks are used. In this work, these mobile sinks are called batbees. It is shown in Fig. 3.

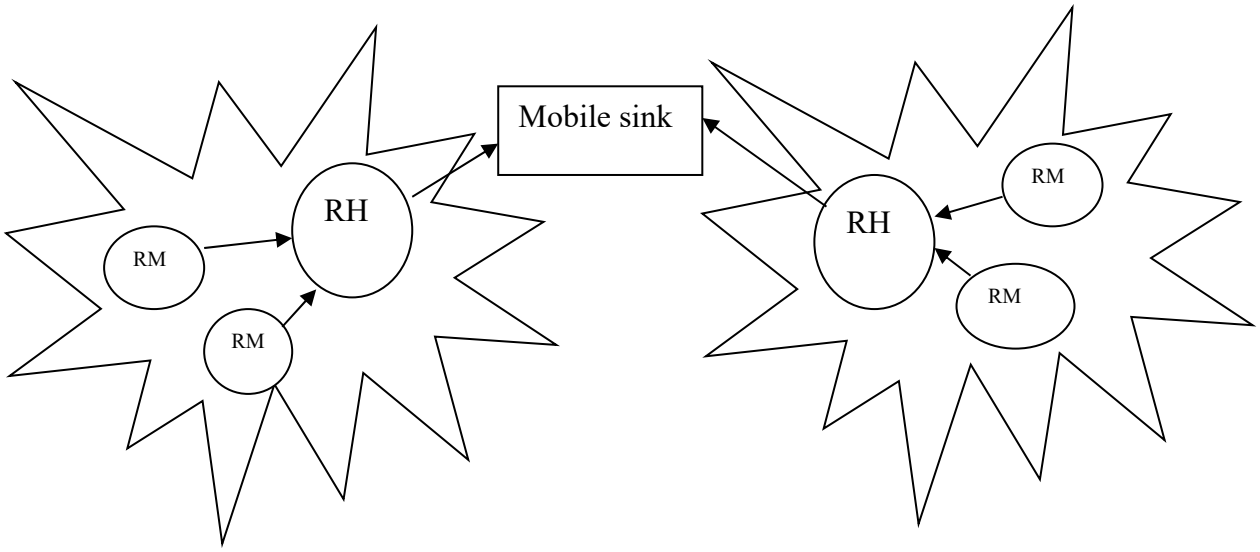

Fig 3: Network Model creation of Proposed Work

3.1.2 Congestion Model Generation

Congestion is a state of traffic congestion and consequently it affects the quality of service in the network. The major reason for WSN congestion is due to the load imbalance where the device node load outdo the available buffer capacity. An ideal environment for congestion needs to be created for the purpose of predicting congestion. So this work creates a pattern of congestion by following the two steps.

a) Traffic Generation

b) Traffic Distribution

a) Traffic Generation

This uses a region based WSN. Node aggregation forms regions. In a given region, multiple nodes will act as RM, which is responsible for collecting environmental data. A node will act as RH. All RM transmits the collected data to RH. The RH in turn connects to a storage device. Each region has RHs. When the transmission rate of RM exceeds the receiving capacity of RM, the data transmitted by RH must be in range. Therefore, the RM queue size is also an important factor. If the size of the queue is not enough, traffic congestion occurs.

b) Traffic Distribution

In WSN, when the number of packets arrives, increasing the network capacity or node, congestion occurs in the network. In this work, the DSR protocol is used to create traffic segments. It is a representative of the dynamic protocol for remote vector transmission. DSR is a reaction routing protocol. It means that the path is not created until it is required by the node that will send the data to the destination. Nodes do not store information about each other until the first packet is requested to be sent to the destination. The Fig.4 is showing the traffic distribution scheme.

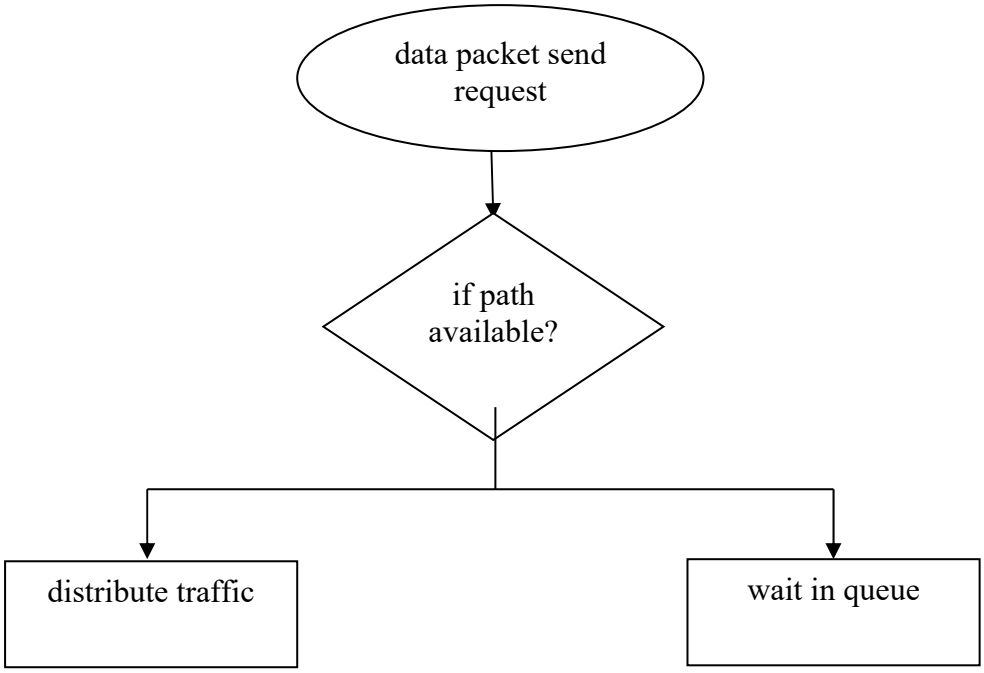

Fig 4: Traffic distribution

3.1.3 Congestion Prediction and Elimination by BatFuzzyBee

In this work, BatFuzzyBee approach is used for prediction and controlling congestion. This is a combination of bat, bee optimization algorithms. The Bat optimization was incorporated with bee for better design, which improves the performance of the algorithm .

The simulated BatFuzzyBee algorithm is described as follows:

Algorithm : BatFuzzyBee

Step 1: Start creating parameters of the optimization algorithm. Each head of the cluster is considered a batbee.
Step 2: Determine the suitability of heads of all cluster and the most suitable is determined as the best.
Step 3: The cluster head is optimally scaled by adjusting the frequency, speed and position.
Step 4: The cluster head moves around when a random number is generated.
Step 5: First a random number is selected to select the new cluster head, and when the random number is greater than the quantity and suitability of the newly selected cluster head, it proves to have better efficacy than the previous cluster head.
Step 6: Batbee ranks and determines the best currently.
Step 7: The above steps are repeated until the stop criteria are reached.

Further for congestion find the fitness value and compare with congestion control rate. If the congestion is there, then congestion prediction flag value is 1, otherwise CPF is 0. BatfuzzyBee provides best efficient solution for congestion problem.

4. Experimental Results

The presented system is implemented through NS2. Performance metrics like Packet Delivery Ratio (PDR), Average Throughput (AT), Detection Accuracy, Energy consumption, loss of packet, network lifetime are analysed and results are presented. To demonstrate this, a scenario is applied where the value of the proposed BatFuzzyBee based congestion management strategy is compared with other congestion control approaches by altering the number of nodes upto 50. Hence it is justified that performance of the of BatFuzzyBee is better than Lion , Bee, and LionFuzzyBee methods in controlling congestion in WSN.

.

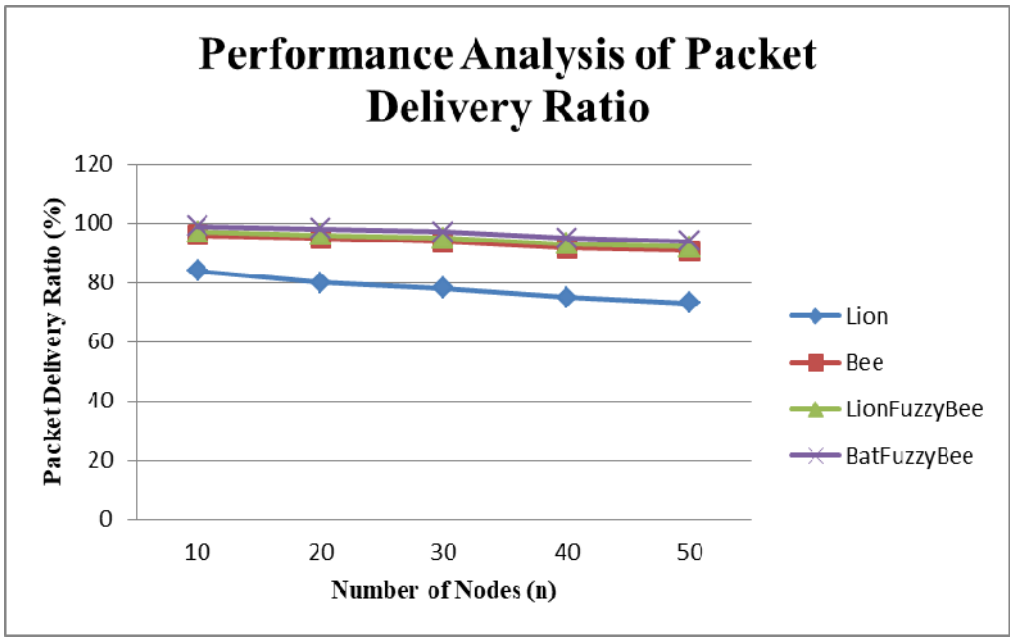

Fig 5: Evaluation Output of Packet Delivery Ratio

.

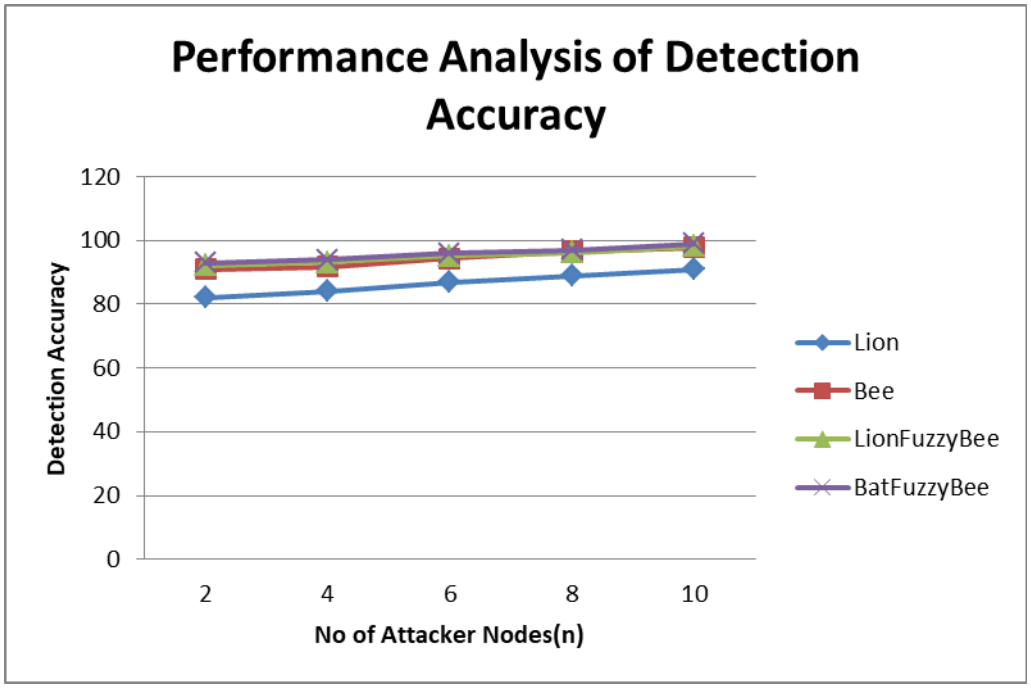

Fig 6: Evaluation Output of Detection Accuracy

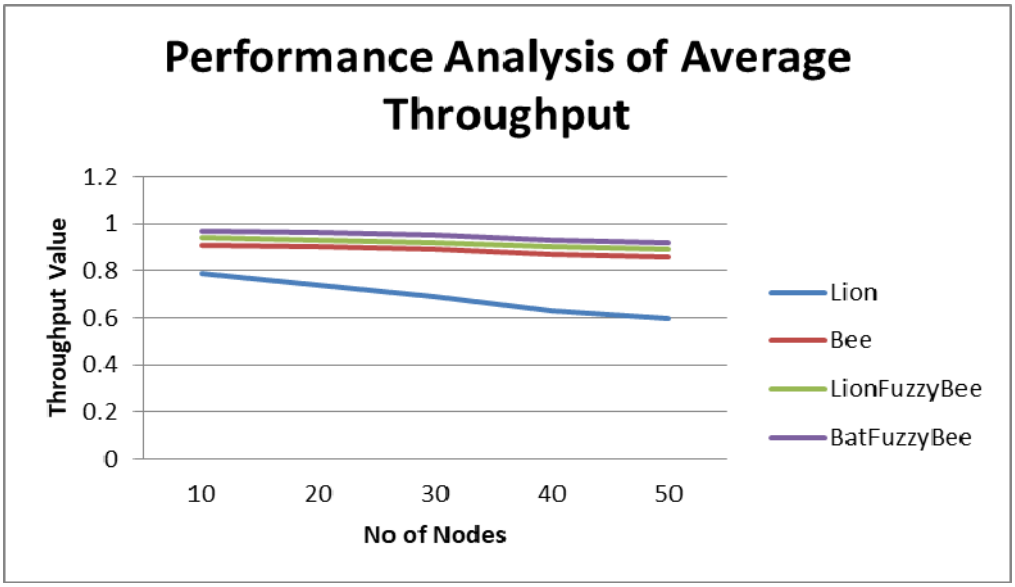

Fig 7: Evaluation Output of Average Throughput

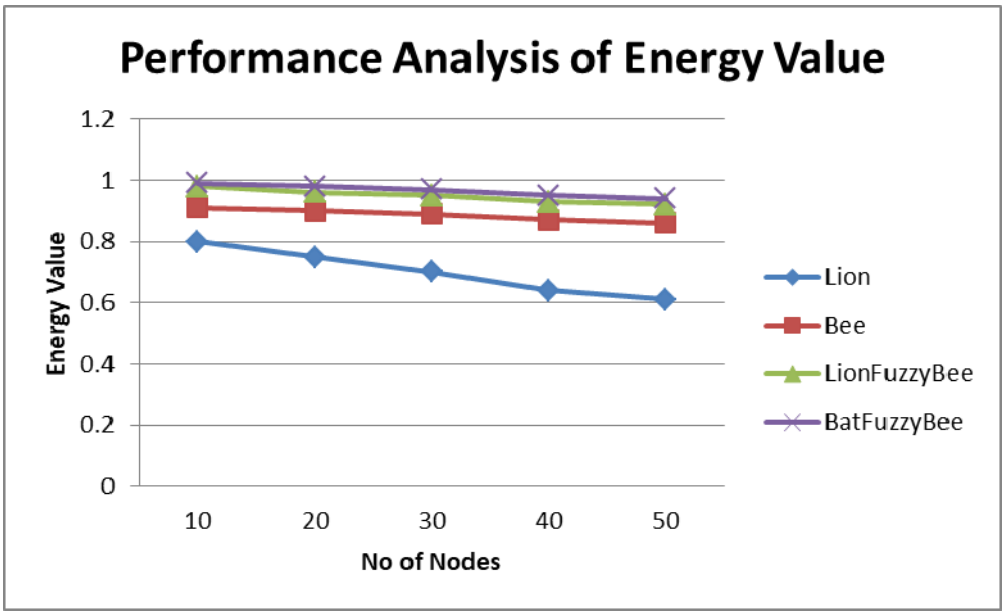

Fig 8: Evaluation Output of Energy Value

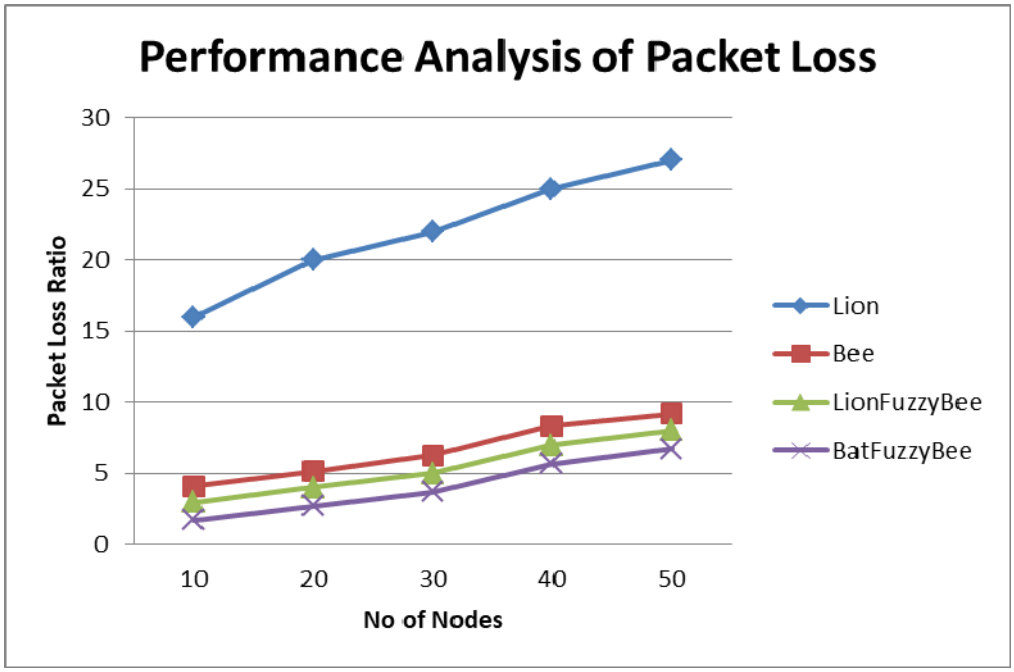

Fig 9: Evaluation Output of Packet Loss

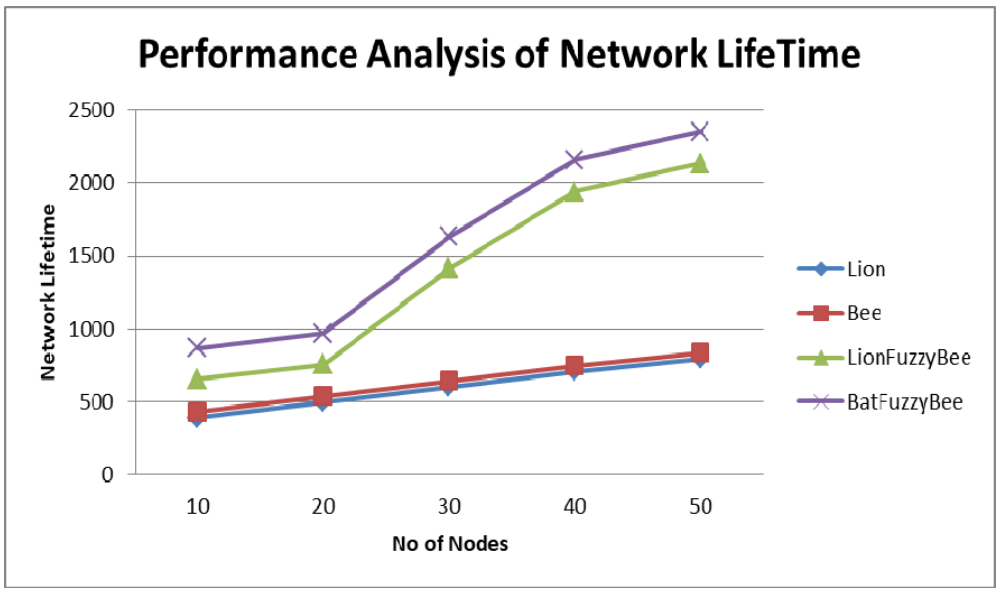

Fig 10: Evaluation Output of Network Lifetime

5. Conclusion

WSN congestion management is a challenging area. Resource constraints make the task of developing congestion management techniques more difficult and complex. This article has proposed a BatFuzzyBee method. BatFuzzyBee techniques are classified as central and distributed strategies based on primary and secondary design objectives. This technique is thoroughly discussed and evaluated using the various performance and design indicators used to measure congestion. The experimental output has justified that congestion areas are predicted with more accuracy using BatFuzzyBee. Any change in network utility need to be analysed which is dependent on how congestion area is designed . BatFuzzyBee has achieved highest network life time due to reduction of energy loss and packet loss through elimination of congestion.

References

[1] Garcia, Miguel, et al. "Saving energy and improving communications using cooperative group-based wireless sensor networks," Telecommunication Systems, 52(4), pp: 2489-2502, 2013.
[2] Lee, J.H.; Jung, I.B. Adaptive-compression based congestion control technique for wireless sensor networks. Sensors 2010, 10, 2919–2945.
[3] Dervis Karaboga, "Artificial Bee Colony Algorithm", 2010, Scholarpedia, 5(3):6915.
[4] Tran, K.P. and Huong, T.T., 2017, October. Data driven hyperparameter optimization of one-class support vector machines for anomaly detection in wireless sensor networks. In Advanced Technologies for Communications (ATC), 2017 International Conference on (pp. 6-10). IEEE.
[5] Gholipour, M., Haghighat, A. T., & Meybodi, M. R.. Hop-by- Hop Congestion Avoidance in wireless sensor networks based on genetic support vector machine. Neurocomp, 223, 63-76. 2017.
[6] Deng, F., Guo, S., Zhou, R. and Chen, J., 2017. Sensor multifault diagnosis with improved support vector machines. IEEE Transactions on Automation Science and Engineering, 14(2), pp.1053-1063.
[7] Kemal Akkaya, Mohamed Younis "A survey on routing protocols for wireless sensor networks", IEEE Comm Magazine on AdHoc Networks, pp.325–349, 2005.
[8] Shieh, C.S., Sai, V.O., Lee, T.F., Le, Q.D. and Lin, Y.C., 2017. Node Localization in WSN using Heuristic Optimization Approaches, International Conference on Networking and Network Applications,2016
[9] Yin, Y.F.; Yuan, H.L.; Zhang, B.L. Dynamic behavioral assessment model based on Hebb learning rule. Neural Computing and Applications, 2017, 28, 245–257.
[10] Sun, P.L.; Niu, L.G. Adaptive congestion control algorithm based on predictive control. In Proceedings of the IEEE Conference Publications, 2008, pp. 644–648.
[11] Al-Aboody, N.A. and Al-Raweshidy, H.S., 2016, September. Grey wolf optimization-based energy-efficient routing protocol for heterogeneous wireless sensor networks. In Computational and Business Intelligence (ISCBI), 2016 4th International Symposium on (pp. 101-107). IEEE.
[12] Li, G.H.; Li, J.Z.; Gao, H. ε-Approximation and Weighted Fairness Guaranteed Congestion Control Algorithm for Wireless Sensor Networks. 2011, 34, 2197–2210.
[13] Sun Hua, Congestion Control Based on Reliable Transmission in Wireless Sensor Networks. Journal of Networks, 2014, 9, 762–768.
[14] Gu, D.; Zhang, W. Design of an H∞ based PI controller for AQM routers supporting TCP flows. In Proceedings of the 48th IEEE Conference, 15–18 December 2009; pp. 603–608.
[15] Li, L.W.; Yang, H.Y. Congestion Control Strategy Based on RED Algorithm in Wireless Sensor Network. Comput. Simul. 2012, 3, 13–16.
[16] Zhao, S.J.; Wang, P.P.; He, J.H. Simulation Analysis of Congestion Control in WSN Based on AQM. In Proceedings of the 2011 International Conference on Mechatronic Science, Electric Engineering and Computer (MEC), 19–22 August 2011; pp. 197–200.
[17] X. Wang and K. Kar, "Distributed algorithms for max min fair rate allocation," in ALOHA networks, Proc Allert Conf, 2004.
[18] Li, X.L.; Chu, Z.G. Design of Wireless Sensor Network Congestion Control Algorithm Based on Active PI Model and Improved Quantum Particle Swarm Optimizing Algorithm. Comput. Meas. Control 2014, 22, 3656–3658.
[19] Liqiang Tao, Fengqi Yu , "ECODA: enhanced congestion detection and avoidance for multiple class of traffic in sensor networks." IEEE transactions on consumer electronics, 56.3 2010.
[20] C. Caione, D. Brunelli, and L. Benini, "Distributed compressive sampling for lifetime optimization in dense wireless sensor networks," IEEE Transactions on Industrial Informatics, vol. 8, no. 1,2012.
[21] Kaur, R. and Arora, S., 2017. Nature inspired range based wireless sensor node localization algorithms. International Journal of Interactive Multimedia and Artificial Intelligence, 4(6), pp.7-17.
[22] Wan, Chieh-Yih, Shane B. Eisenman, and Andrew T. Campbell. "CODA: Congestion detection and avoidance in sensor networks." Proceedings of the 1st international conference on Embedded networked sensor systems, ACM, 2003.
[23] Zhu, L., Zhang, Z., & Xu, C. Secure data aggregation in wireless sensor networks. In Secure and Privacy-Preserving Data Communication in Internet of Things(pp. 3-31). Springer Singapore,2017.
[24] Chen, H. M., Cui, L., & Zhou, G. (2017). A Light-Weight Opportunistic Forwarding Protocol with Optimized Preamble Length for Low-DutyCycle Wireless Sensor Networks. Jour of Comp Science and Tech, 32(1), 168-180.
[25] Rajakumar, R., Amudhavel, J., Dhavachelvan, P. and Vengattaraman, T., 2017. GWO-LPWSN: Grey wolf optimization algorithm for node localization problem in wireless sensor networks. Journal of Computer Networks and Communications, 2017
[26] Selim Yilmaz and Ecir U. Kucuksille, "Improved bat algorithm (IBA) on continuous optimization problems," Lecture Notes on Software Engineering, 2013,1(3), pp: 279-283.
[27] Kang, Jaewon, Yanyong Zhang, and Badri Nath. "TARA: topology-aware resource adaptation to alleviate congestion in sensor networks." IEEE Transactions on Parallel and Distributed Systems ,18.7, 919-931, 2007