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Bio-inspired Energy Efficient Collision Free Sleep Scheduled Transmission in Wireless Sensor Network

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***Abstract* - Energy Conservation is the need of the hour to prolong the Lifetime of a Wireless Sensor Network (WSN). Collision, idle listening and Over hearing are the major sources of Energy inefficiency. In the recent years Bio-systems have been an inspiration for Self-organized sleep scheduling transmission in WSN. Inspired by the Behavior of Anuran family species we in this paper have implemented Self-organized sleep scheduling transmission technique on a Physical test bed. Experimental results of Self-organized sleep scheduled transmission are compared with Random transmission to conclude that the Energy consumption of the battery is less in the proposed technique.**

Keywords – WSN; Evolutionary Technique; Sleep Scheduling; Energy Conservation; Collision Free.

I. INTRODUCTION

WSNs have incredible research interest due to their applications in Civil and Military field. WSN is a large collection of small wireless devices that are spatially dispersed all over the region to be monitored and they systemize themselves to perform a self-organized network. Each such sensor node has a Radio transceiver with an internal Antenna or an external Antenna, a Microcontroller and an Energy source which is a battery. Communication module of the sensor node is one which consumes most of the Energy [1]. Energy conservation is a challenging task in WSN to prolong the Network Lifetime. Sensor nodes are deployed in such areas where the battery once drained can neither be recharged nor replaced. Hence optimal utilization of the battery becomes very important. Bio-systems have been an inspiration for self-organized sleep scheduling techniques to control the power consumption of batteries [2] [3].

In this paper, inspired by the behavior of Anuran family species we have implemented Self-organized sleep scheduling technique for the sensor nodes that communicate to a Sink. The rest of the paper is organized as follows: In section II related papers are discussed that motivates this paper. Section III gives a brief description of source contributing to Energy Inefficiency. Section IV explains the Bio-inspired Frog calling behavior with sleep scheduled technique and its incorporation in WSN. Section V gives the Test bed Configuration and Flow diagram of Energy utilization.. Section VI shows the Experimental result analysis. The graphs show the comparison of Energy utilization for different node densities with and without sleep scheduling. Finally section VII concludes the paper highlighting the Future work.

II. RELATED PAPERS AND MOTIVATION

There are several Bio-inspired Evolutionary techniques like Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Queen Bee Algorithm, Elephant Swarm Optimization, Genetic Algorithm etc. used to address the challenges of WSN [3]. Few of them addressing the Energy Efficiency are discussed here which provides motivation for our work. In paper [4], the authors propose to solve the Energy Efficient Coverage problem Using ACO algorithm with three types of Pheromones. Paper [5] presents a Routing algorithm based on ACO that obtains a balanced transmission among the nodes to reduce the Energy consumption. The authors of paper [6] propose an artificial Ant colony approach for Surveillance and Target tracking by distributed sensor wake-up control in WSN. The three advantages of this paper are distributed implementation, robustness and non-requirement of Node Localization. In paper [7] the authors create Energy efficient clusters in WSN using Queen Bee algorithm that improves the Network Lifetime. The authors of Paper [8] and [10] propose a Phase control method for Self- organizing, sleep scheduling scheme inspired by Satellite behavior of Frogs. Such papers inspired us to explore Bio-inspired Evolutionary techniques for Energy conservation. This work incorporates the calling behavior of Anuran family species for a Collision Free Sleep scheduled transmission in MAC layer on a WSN Test Bed.

III. SOURCES CONTRIBUTING TO ENERGY INEFFICIENCY

Energy conservation is a challenging task and a very important issue in the design of MAC protocol for sensor nodes. Collision, idle listening and Overhearing are the major sources contributing to Energy inefficiency. Collision occurs when two or more sensors communicate simultaneously over a single communication medium. The packet lost in collision has to be retransmitted which contributes to extra Energy consumption. Idle listening happens when a sensor node keep listening for a traffic that is not sent. Hence there is an extra Energy that is consumed to listen the silent channel or the communication medium which results in Energy Inefficiency. The third source is overhearing which happens when a sensor node receives a packet that was destined to some other node.

These sources that contribute to Energy inefficiency can be reduced by incorporating by Sleep scheduling techniques for the communication of sensor nodes in WSN [12].

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IV. BIO-INSPIRED SLEEP SCHEDULING

Bio-inspired Sleep scheduled technique can be observed in Anuran family species where the Frogs listen to their neighbour before calling in order to avoid the overlapping of calls which leads to interference. Every Male Frog calls for certain period of time and then goes silent for some time by listening to other Frogs . Thus the Energy is conserved as there is no overlap of calls that help in successful transmission of their call to a female Frog Figure 1 depicts a scenario of Frogs calling simultaniously in a Random fashion. The listener Frog is unable to identify the calls as there exists call overlap and a failure in communication. Energy of the Frogs is wasted as the calling is not successful. Figure 2 depicts a scenario of Self-organized Sleep scheduled Calling of Frogs. Every Frog before calling listens to its neighbours and if such a call is already in progress, it goes silent for a period of time and again continues to listen to its neighbour before calling in order to avoid interference [8][9][10][11]. Thus the Frogs Conserve Energy by going silent. When more number of sensor nodes access a common medium for communication with the Sink Collision exits with waste of Energy. In this paper we have incorporated the Frog calling behavior in WSN for Energy efficient, Collision Free transmission in MAC layer of WSN. Self-organized sleep scheduling for transmission of data is implemented on a Physical Test bed using Sensor Motes.Here the sensor nodes are considered as Male frogs and the sink as a Female Frog.

Fig.1. Random calling by Frogs

Fig. 2. Self-organized Sleep scheduled calling by Frogs

V. TEST BED CONFIGURATION AND FLOW DIAGRAM

No. of Nodes	:	3, 5 and 10 Nodes
Geographical location	:	Indoor Setup
Area covered	:	Maximum of 5 meters

We in this work, have made an effort of incorporating Frog calling behavior for Self- organized transmission and made a comparative analysis with Random transmissions using iSense WSN hardware test bed. In random transmission the source nodes will send the data randomly without any scheduling which results in Collisions and Energy wastage, creating traffic at the sink node without any proper management of messages to establish a successful transmission. This results in failure of data transmission and increased Power consumption of the battery for retransmission. This Self-organized transmission is shown in our earlier paper [13]. The source nodes that transmit on a common medium are made to listen to their neighboring nodes. The source node generates a request message and checks if the receiver already contains a requests message. If so, then it goes to sleep for Fifteen seconds and wakes up to retry again. By doing so there would be a Collision Free transmission and also conservation of Energy to improve the Network Lifetime. This is illustrated in the Flow diagram shown below in Figure 3.

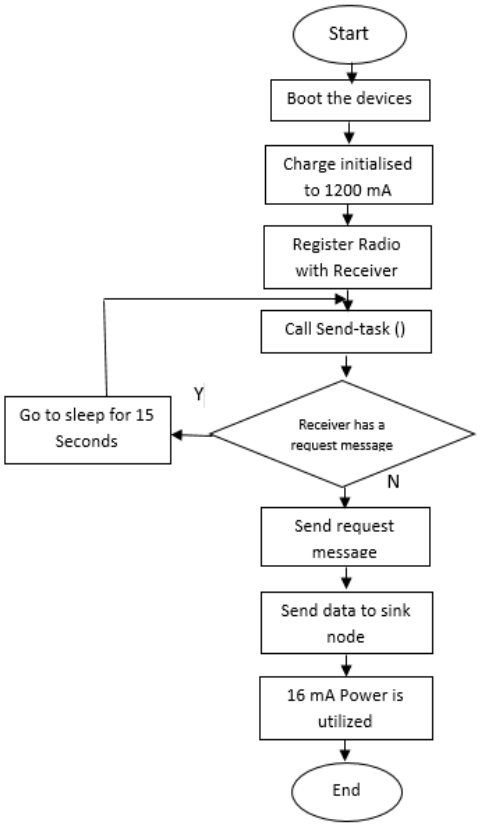

Fig. 3. Self-Organized Sleep scheduled Transmission in WSN

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VI. RESULT ALALYSIS OF ENERGY UTILIZATION

Figures 4a, 5a and 6a shows the aggregate Energy Utilization at source nodes for a 3-nodes, 5-nodes and 10-nodes Scenario respectively, considering one node as Sink. The graphs represents the Energy utilization at the source nodes for every 10 seconds. Figure 4b, 5b and 6b shows the graphs of Energy utilization at Sink node in 3-nodes, 5-nodes and 10-nodes for every 10 seconds respectively. The graph of Charge vs Time has been plotted for Random & Scheduled transmission. Analyzing the graphs we can see that the Energy utilization for self-organized sleep scheduling technique is less when compared to that for Random transmission.

3-Nodes Scenario

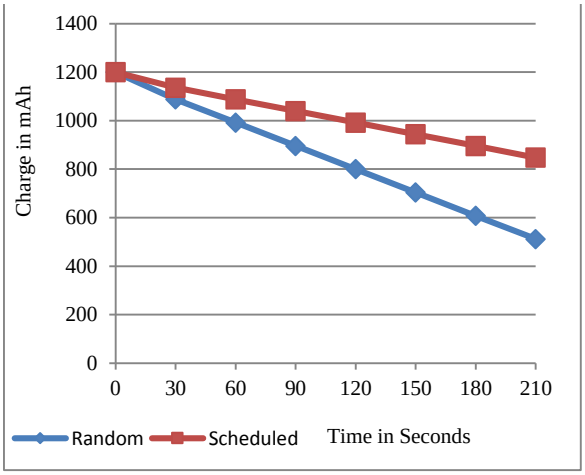

Fig. 4a. Energy utilization of Source vs. Time in seconds

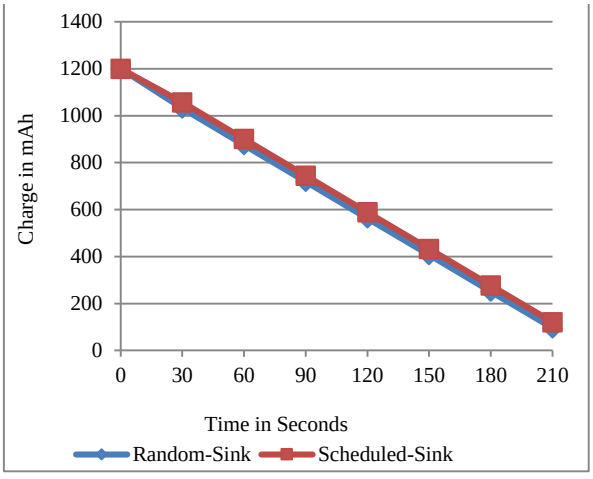

Fig. 4. Energy utilization of Sink vs. Time in seconds

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5-Nodes Scenario

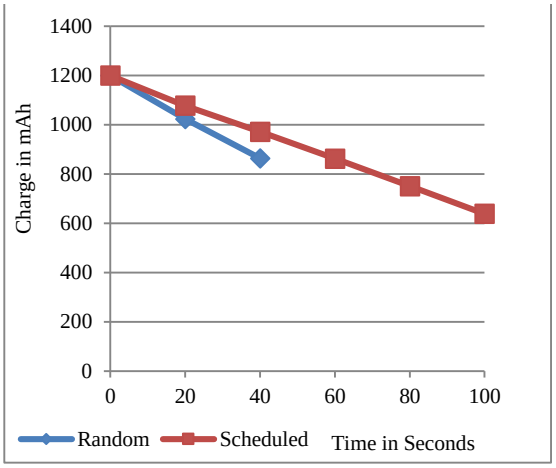

Fig. 5a. Energy utilization of Source vs. Time in seconds

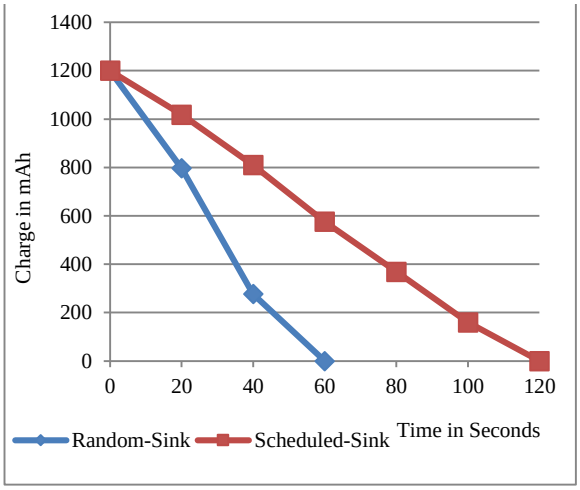

Fig. 5b. Energy utilization of Sink vs. Time in seconds

10-Nodes Scenario

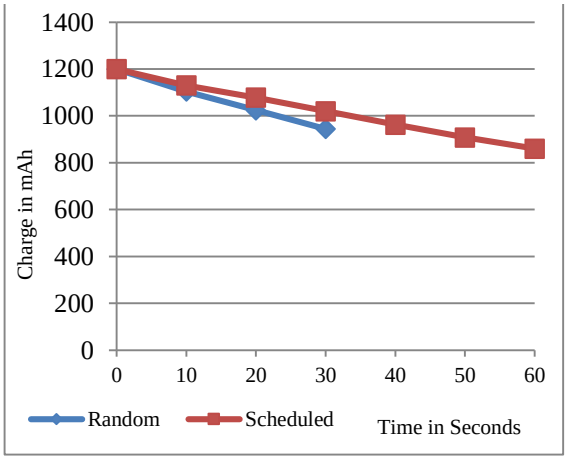

Fig. 6a. Energy utilization of Source vs. Time in seconds

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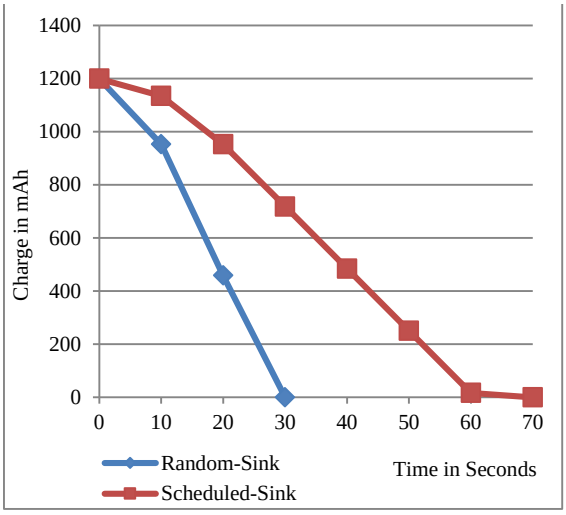

Fig. 6b. Energy utilization of Sink vs. Time in seconds

VII. CONCLUSION

As the Energy Conservation is the need of the hour to prolong the Network Lifetime, we in this paper have implemented an Energy efficient Self-organized, Sleep Scheduled transmission in MAC layer of WSN. The proposed technique is evaluated on a Wireless Sensor Test Bed for different Scenarios and the Experimental results show that there is a fair improvement when compared to Random transmission. This work can further be extended with Simulation for a Network Scenario comprising of large number of nodes using Collision Free, Schedule based Distributed TDMA MAC protocols [14].

REFERENCES

[1] Jennifer Yick, Biswanth Mukherjee, Dipak Ghosal, "Wireless Sensor network: survey". Computer networks (2008), 52, pp. 2292-2330.
[2] Md. Akhtaruzzaman Adnan, MohammdAbdurRazzaque, Ishtiaque Ahmed, Ismail Fauzi Is nin,"Bio-mimic OptimizationStrategies in Wireless Sensor Networks: A Survey". Sensors 2014, 14, pp. 299-235.
[3] Vidya Honguntikar, G. S. Biradar, "Optimization techniques incorporating Evolutionary model n Wireless Sensor Network", A Survey. IOSR-JCE, E-ISSN: 2278-0661, p-ISSN: 2278-8727, vol.1 6, Issue 5, Sept-oct, 2014, pp 19-24.
[4] Joon-Woo Lee, Byoung-Suk Choi, Ju-Jang Lee, " Energy –Efficient Coverage of Wireless Sensor Networks using Ant colony optimization with three types of Pheromones", IEEE Transactions on Industrial Informatics, vol. 7, No. 3, August 2011.
[5] Hong-Chi Shih, Shu-Chuan Chu, John F. Roddick, Mao-Hsiung Hung, Jeng-Shyang Pan, " Power Reduction of Wireless Sensor Networks using Ant Colony Optimization", International Conference on Computational Aspects of Social Networks, 2010.
[6] Yaan Liang, Jiannong Cao, Lei Zhang and Quan Pan, " A Biologically-inspired Sensor wakeup Control Method for Wireless Sensor Networks", IEEE Transactions on Systems man and cybernetics Part C, 09/2010.
[7] Z. Pooranian,, A. Bharati and A. Movaghar, " Queen-bee Algorithm for Energy Efficient Clusters in Wireless Sensor Networks", World Academy of Science and Technology 73 2011.
[8] Akira Mutazono, Masashi Sugano, Masayuki Murat :"Energy efficient Sleep Scheduling in Wireless Sensor Networks inspired by Satellite Behavior of Frogs", 8th IEEE International Conference PERCONWorkshops, March 29th–April 2nd2010, pp- 450-455.
[9] Hugo Hernandez, Christian Blum, "Implementing a model of Japanese Tree Frogs' Calling Behavior in Sensor Networks", A study of possible improvement, GECCO'11, July 12-16, 2011, ACM 978-I-4503-0690.
[10] Akira Mutazono, Masashi Sugano, Masayuki Murata, "Frog Call-Inspired Self-Organizing Anti-Phase Synchronization for Wireless Sensor Network", ISATTransactions on Computers and IntelligentSystems, vol. 1, no. 2, pp. 86-93, Dec.2009.
[11] Capernica, Robert R, "The Evoked local response of the Bull frog". MIT Press, Cambridge MA (110p), 1965.
[12] Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks-Technology, Protocols and Applications", Second edition, Reprint 2013.
[13] Vidya Honguntikar, G. S. Biradar, " Anuran inspired Collision Free Self-organized Transmission Scheduling in Wireless Sensor Network", Proceedings of IEEE International Conference on Control and Robotics Engineering, April 02-04, 2016.
[14] Pijuskumar pal, Punyasha chatterji, "A survey on TDMA-based MAC protocols for Wireless sensor network" IJETAE, ISSN 2250- 2459, vol. 4, issue 6, 2014.