Middle-East Journal of Scientific Research 24 (Techniques and Algorithms in Emerging Technologies): 115-120, 2016
ISSN 1990-9233;

DOI: 10.5829/idosi.mejsr.2016.24.TAET23332

Gene Based Energy and Bandwidth Optimized Routing for Differentiated Services in Wireless Sensor Network

R. Nithya, K. Prasanth and P, Geethanjali

Department of IT, K.S.Rangasamy College of Technology, Tamilnadu, India

Abstract: Wireless networks are computer networks which are not linked by cables. The application of wireless network helps enterprises to stay away from the expensive method of cables into buildings or as a linking between various equipment locations. Wireless networks are vulnerable to many causes. Organization on similar WSN platform needs various Quality of Service (QoS). QoS metrics in WSN are low delay and high data integrity. It is complex to satisfy both metrics simultaneously in WSN applications. The existing work presented IDDR by developing a virtual hybrid potential field. IDDR divides packets of usages with various QoS necessities by the weight assigned to every packet and routes the packets in sink through various paths. High Data Integrity finds the extra buffer gap from inactive or under-loaded paths. The method cache the extreme packets dropped for consequent transmission. IDDR develops a possible field by the depth and queue length information to identify under-utilized paths. The packets with heavy integrity condition are moved to the subsequent hop with lesser queue length. Implicit Hop-by-Hop Rate Control is provided to create effective packet caching. However, the method unaddressed the problems of bandwidth and energy based differentiated routing service in WSN and delay minimization needs higher bandwidth capacity. Energy procedure maximized during multipath routing minimized sensor network life time. Energy drain rate of the sensor nodes are maximized by achieving high data integrity. To overcome these drawbacks, the proposed work presents Gene Based Energy and Bandwidth Optimized Routing for Differentiated Services in WSN to develop an Energy and Bandwidth Optimized WSN Routing using inherent gene properties with Genetic Algorithm (GA). It creates the bandwidth efficient quality of routing service in sensor network.

Key words: Quality of Service (QoS) · Integrity and delay differentiated routing · WSN platform

INTRODUCTION

In a fire monitoring application, result of a fire alarm must be reported to sink at once. Habitat monitoring applications advent of packets is suitable to provide a delay but sink must collect most of the packets. Also concurrently it enhances fidelity for high-integrity and reduces the end-to-end delay level when the network is crowded. The method helps to concurrently develop the reliability for high-integrity applications and reduce the end-to-end delay for delay-sensitive ones. Sharing the theory of potential field from the control of physics develop a novel potential routing algorithm known as the integrity and delay differentiated routing (IDDR). IDDR naturally prevents the disagreement between high integrity and low delay. The high-integrity packets are cached under loaded paths all along with which packets will undergo a large end-to-end delay due to many hops. The delay-sensitive packets travel in a shorter path to reach the sink as quickly as possible. By using the Lyapunov drift theory, it is proved that IDDR is steady. And also, the outcome of series simulations is conducted on the TOSSIM platform to explain the effectiveness and possibility of the IDDR method.

Literature Review: In this paper [1] Wireless sensor network (WSN) provides the accessibility of low-cost sensor nodes with efficient sensing in different physical and environmental conditions, data processing and wireless communication. Variation of sensing capabilities effects in profusion of application areas. But, the features of wireless sensor networks need more successful methods for data forwarding and processing.

Corresponding Author: R. Nithya, Department of IT, K.S. Rangasamy College of Technology, Tamilnadu, India.

In this paper [2], the author studies the design issues of sensor networks and provides a classification and comparison of routing protocols. This comparison tells the essential features that require to be taken into consideration while designing and estimating new routing protocols for sensor networks.

The scope of this paper [3] is to evaluate, analyze and compare three routing protocols (EAR, FEAR and BEER) that balance energy consumption, through a mathematical model and simulations. Obtained results show that FEAR allows fair energy efficient utilize and improves the sensor network lifetime more than EAR. BEER produces the two protocols and balances energy utilization among sensor nodes better than FEAR and EAR.

In this paper [4] the author identifies the routing problems for wireless sensor networks. Wireless sensor networks comprise of set of sensor nodes, sink or gateway sensor node. The main issue in the wireless sensor networks is gathering the records from sensor nodes and sending data to the sink node or data attention centre (gateway) at the correct time.

This paper [5] presents an efficient design of wireless sensor networks, the huge sensor networks allows the applications that connect the physical world to the virtual world. By networking huge numbers of tiny sensor nodes, it is feasible to attain data about physical phenomena that fails to find in additional conventional ways.

In this thesis [6] the author presents an operating system and three productions of a hardware platform modeled to address the needs of wireless sensor networks. The operating system also called TinyOS utilizes an event based execution model to maintain for fine grained concurrency and integrates high efficient component model. TinyOS utilizes a hardware construction that has a single processor time allocated among both function and protocol processing.

In this paper [7], the author provides a survey of the state-of-the-art routing techniques in WSNs. The author initially describes the design challenges for routing protocols in WSNs after that an inclusive survey of dissimilar routing techniques. In general, the routing techniques are ordered into three categories based on the fundamental network structure, hierarchical and location-based routing. In addition, routing protocols classified into four operations such as multipath-based, query-based, negotiation-based, QoS-based and coherent-based depending on the protocol operation.

The author [8] propose a survey of Wireless sensor network, it is organized into three different problems types such as, (1) internal platform and underlying operating system, (2) communication protocol stack and (3) network services, provisioning and deployment. The author analysis the most important development in these three categories and delineate new challenges.

This paper [9] presents a Measurement-Based Optimization Technique for analyzing Bandwidth-Demanding Peer-to-Peer Systems. However, these analyses also expose two key insights that possible to exploit by applications. Initially, for adaptive applications constantly modify communication peers, the basic techniques are very effective in adaption process. Then, the author obtains basic techniques are very complementary and possibly combined to identify a high-performance peer.

In this paper [10], the author provides an algorithm for continuous bandwidth optimization in networks maintaining advance reservations such as Grid computing environments or QoSaware MPLS networks. The requirement for such re-optimization occurs when resources for incoming reservation needs are assigned by fast dynamic routing with simple path selection algorithms. Although this is often necessary to satisfy time constraints for responding reservation requests, it certainly leads to network inefficiencies because of the fact resulting uneven load distribution to bottlenecks within the network.

The author [11] propose a computationally efficient *exact* approximation algorithm for univariate Gaussian kernel based density derivative estimation to reduce the computational complexity from $O(MN)$ to linear $O(N+M)$. The author applies the system to calculate the optimal bandwidth for kernel density estimation. It explains the speedup achieved on this problem using the "solve-the-equation plug-in" method and on exploratory projection pursuit techniques.

In this paper [12], the author proposes to select two bandwidths concurrently that evaluate the difference of two function based on minimizing a version of the AMSE. This approach is general sufficient to cover estimation problems associated to densities and regression functions at interior and boundary points. The author presents a detailed treatment of the sharp regression discontinuity design.

The author [13] proposes a Kernel Estimator and Bandwidth Selection for Density and its Derivatives. The univariate kernel density estimation (KDE) is a non-parametric way to determine the probability density function f(x) of a random variable X. It is a fundamental data smoothing problem in which inferences about the population are built based on a finite data sample. These techniques extensively used in different inference procedures such as signal processing, data mining and econometrics.

The main idea of this paper [14] is to improve efficient communication in WSN. This paper provides efficient two algorithms namely, Shortest Path Routing (SPT) and Multicasting in Wireless Mesh Network. SPT provides communication by identifying the shortest path in a tree and push the packet throughout this path. Because failures are present in the network, the SPT algorithm refuses the failure by sending an ICMP messages to enhance congestion ratio and rerouting of the packets. While MCT algorithm forwards the packets on the foundation of least number of transmissions.

In this paper [15] proposed a heuristic algorithm to address the issues in polynomial time and provides near optimal tree. Initially the author identifies the some related work and solves the problem. Then, the new algorithm is designed by its pseudo code and the proof of its complexity and correctness by showing that it also obtains a feasible tree. In addition the heuristic algorithms are observed and compared with the proposed algorithm through simulation.

Energy Efficient and Bandwidth Optimized Routing for Differentiated Services in WSN: This work designs an Energy and Bandwidth Optimized WSN Routing using inherent gene properties with Genetic Algorithm (GA). The Genetic Algorithm creates the bandwidth efficient quality of routing service in sensor network. In Genetic algorithm, every gene has propose two properties namely,

- Exposed
- Implicit

The Gene populations are constructed to identify bandwidth capacity of the routing path in the sensor network at different cases. The Implicit property is employed to stored information of the bandwidth capacity of route path. In explicit property, the current bandwidth capacity of information is stored at corresponding route. To identify the optimal route path for transmission with information of bandwidth capacity route path.

A new collection of gene population is generated for energy optimization by storing energy drain rate and consumption rate of all the sensor nodes in the network. Energy information containing gene population are subjected to genetic operation (i.e., selection, cross over and mutation) to improve the energy optimal gene sets. New gene population can optimize energy usage of sensor nodes on routing and data transmission to reduce energy drain rate. Therefore, this improves sensor network lifetime.

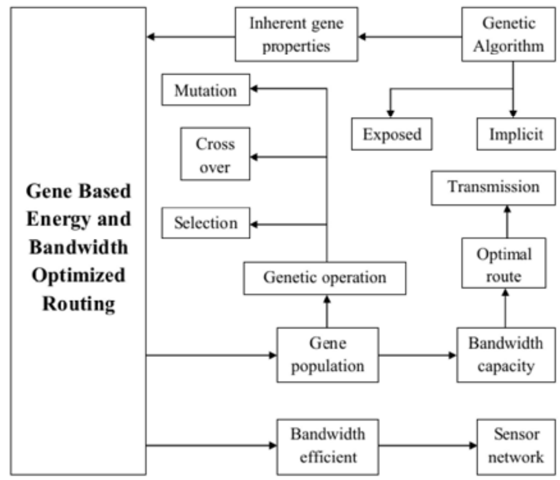

Fig. 1: Architecture Diagram of Gene based energy efficient and bandwidth optimized routing

The main advantages of proposed work to improve the differentiated routing service on both bandwidth and energy consumption and provide optimal bandwidth consumption in sensor network. This in turn, increase the sensor network life time and reduce the energy drain rate of the sensor nodes.

The proposed scheme is divided into three phases namely:

- WSN with Differential Services
- Bandwidth Optimization with Gene Property
- Gene Operation for Optimal Node Energy

WSN with Differential Services: Wireless sensor network (WSN) give differential services for a wide range of application. WSNs consist of thousands small sensor nodes are arranged in a physical environment used for examination of interested events. Sensors in the local area of events observed and account back to the sink. A sink sensor node connects with laptop, base station. Then, Sensor nodes provide differential services i.e,

- Traffic control
- Battlefield
- Habitat monitoring and
- Intruder tracking

Target tracking for WSN developed centralized approach for routing path. As number of sensor increases in WSN that unable to sent more messages to the sink and uses extra bandwidth during routing.

Bandwidth Optimization with Gene Property: Property of Gene is used to optimize bandwidth consumption in WSN target tracking to improve quality of routing service. The Gene property is composed into two variations namely exposed Property which is activated on action event of target tracking and Intrinsic Property in hidden state, which exposed on specific event of WSN. In addition, Gene population is produced with different sets of both exposed and intrinsic properties. All genes are effectively estimating the bandwidth capacity of the routing path in WSN. The Implicit property of gene stores the information of the bandwidth capacity and explicit property stores current bandwidth capacity. With objective of identifies the optimal route for target tracking to reduce path length and maximize network lifetime.

Gene Operation for Optimal Node Energy: The Gene operations are formed to optimize node energy for target tracking with produced set of gene population to estimate energy drain rate and consumption for all every sensor nodes in WSN. Then Genetic algorithms are executed with gene population such as selection, cross over and Mutation. With the aim of gene operation is to improve the node energy optimality on the sensor nodes. The different set of gene population occurs to handle node energy level in WSN on routing and data transmission. This in turn, optimized gene reduces energy drain rate and improves lifetime of the sensor network

Performance Metrics: In this section evaluate the performance of Gene Based Energy and Bandwidth Optimized Routing for Differentiated Services in WSN. One of the major contributions of this work is provide bandwidth efficient quality of routing service in sensor network. The performance metrics of the parameters is number of differentiated services, number of Sensor Nodes, Routing Bandwidth Capacity, Energy Consumption Rate, Energy Drain Rate of Sensors and Sensor Network Life Time.

The performance metrics are:

- Bandwidth Routing Capacity
- Energy Consumption Rate
- Energy Drain Rate of Sensors
- Sensor Network Life Time

Bandwidth Routing Capacity: The bandwidth refers to the routing capacity through or physical communication path in a communication system that measures the maximum throughput of a network. Higher the bandwidth, more efficient the method is said to be and is measured in terms of bits per second (bps).

Table 1: No. of Sensor Nodes Vs Bandwidth Routing Capacity

	Bandwidth Routing Capacity(bps)	
No. of Sensor Nodes	IDDR (Existing)	GEBOR (proposed)
10	12	15
20	15	18
30	19	23
40	21	25
50	23	29

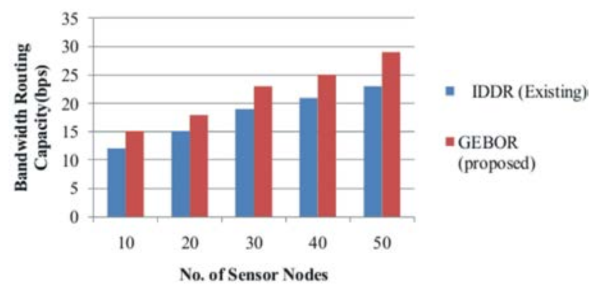

Fig. 2: No. of Sensor Nodes Vs Bandwidth Routing Capacity

Figure 2 Demonstrate the Bandwidth Routing Capacity. X axis represents No. of Sensor Nodes whereas Y axis denotes the Bandwidth Routing Capacity using both integrity and delay differentiated routing (IDDR) and our proposed Gene Based Energy and Bandwidth Optimized Routing (GEBOR). When the No. of Sensor Nodes increased, the Bandwidth Routing Capacity is also increased accordingly. The Bandwidth Capacity is demonstrated using the existing IDDR and proposed GEBOR method. Fig 2 shows better performance of Proposed GEBOR provides Bandwidth Capacity compared to existing IDDR method. The Gene Based Energy and Bandwidth Optimized Routing scheme achieves 18 % high performance of Bandwidth Capacity when compared with existing system.

Energy Consumption Rate: The path node moderators in the network are selected based on the gene characteristics series on energy consumption. Energy Consumption rate (EC) is defined as the product of sensor nodes, power (in terms of watts) and time (in terms of seconds). The energy consumption is measured in terms of Joules (J).

Table 2: No. of Sensor Nodes Vs Energy Consumption Rate

	Energy Consumption Rate(J)	
No. of Sensor Nodes	IDDR (Existing)	GEBOR (proposed)
10	65	56
20	69	57
30	71	61
40	72	65
50	75	67

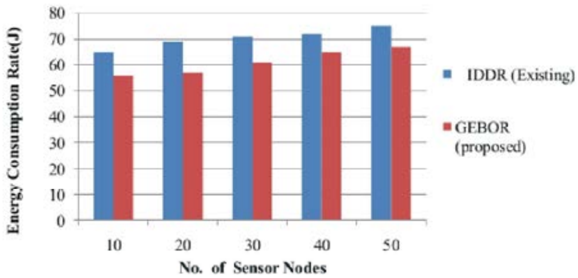

Fig. 3: No. of Sensor Nodes Vs Energy Consumption Rate

Figure 3 Demonstrate the Energy Consumption Rate. X axis represents No. of Sensor Nodes whereas Y axis denotes the Energy Consumption Rate using both integrity and delay differentiated routing (IDDR) and our proposed Gene Based Energy and Bandwidth Optimized Routing (GEBOR) technique. When the No. of Sensor Nodes increased, Energy Consumption Rate gets decreases consequently. The Energy Consumption Rate is illustrated using the existing IDDR and proposed GEBOR Technique. Fig 3 shows better performance of Proposed GEBOR method in terms of Sensor Nodes than existing IDDR and proposed GEBOR. The Gene Based Energy and Bandwidth Optimized Routing scheme achieves 15% Energy Consumption variation when compared with existing system.

Energy Drain Rate of Sensor: The energy drain rate of the gene character series are identified depending on the staying energy and the draining speed of the nodes in the network. The node energy drain rate is estimated depending on the genes (nodes) staying energy and the time.

Table 3: No. of Sensor Nodes Vs Energy drain rate of sensor

	Energy drain rate of sensor (%)	
No. of Sensor Nodes	IDDR (Existing)	GEBOR (proposed)
10	152	145
20	156	149
30	159	152
40	162	155
50	165	158

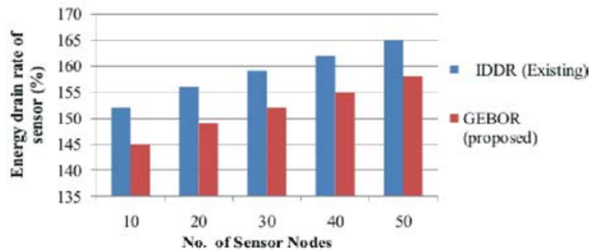

Fig. 4: No. of Sensor Nodes Vs Energy Drain Rate

Figure 4 Demonstrate the Energy drain rate of sensor. X axis represents the No. of Sensor Nodes whereas Y axis denotes the Energy Consumption Rate using integrity and delay differentiated routing (IDDR) and our proposed Gene Based Energy and Bandwidth Optimized Routing (GEBOR) technique. When the No. of Sensor Nodes increased, Energy drain rate of sensor gets decreases accordingly. The Energy drain rate of sensor is illustrated using the existing IDDR and proposed GEBOR Technique. Fig 4 shows better performance of Proposed GEBOR method in terms of Sensor Nodes than existing IDDR and proposed GEBOR. The Gene Based Energy and Bandwidth Optimized Routing scheme achieves 4% of Energy drain rate of sensor when compared with existing system.

Sensor Network Life Time: One of the important design challenges in designing a Wireless Sensor Network (WSN) is to improve the network lifetime, as each sensor node of the network is provided with a limited power battery. The lifetime of the network is calculated depending on the number of nodes in the wireless sensor networks. It is measured in terms of percentage (%).

Table 4: No. of Sensor Nodes Vs Network Life Time

	Network Life Time (%)	
No. of Sensor Nodes	IDDR (Existing)	GEBOR (proposed)
10	26	34
20	28	38
30	31	42
40	34	46
50	38	49

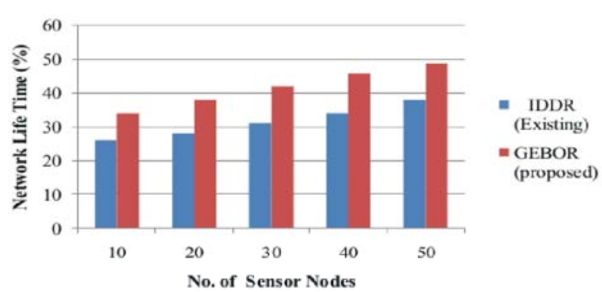

Fig. 5: No. of Sensor Nodes Vs Network Life Time

Figure 5 Demonstrate the Network Life Time. X axis represents No. of Sensor Nodes whereas Y axis denotes the Network Life Time using both integrity and delay differentiated routing (IDDR) and our proposed Gene Based Energy and Bandwidth Optimized Routing (GEBOR). When the No. of Sensor Nodes increased, the Network Life Time is also increased accordingly. The Network Life Time is showed using the existing IDDR and proposed GEBOR method. Fig 5 shows better performance of Proposed GEBOR provides Network Life Time compared to existing IDDR method. The Gene Based Energy and Bandwidth Optimized Routing scheme achieves 24% high performance of Network Life Time when compared with existing system.

CONCLUSION

This paper proposes an Energy and Bandwidth Optimized Routing for Differentiated Services in WSN using inherent gene properties with Genetic Algorithm (GA). Initially, Gene populations are carried out to identify bandwidth capacity of the routing path in the sensor network at different instances. This in turn, increase the sensor network life time and reduce energy drain rate of the sensor nodes. The performance of planned Gene Based Energy and Bandwidth Optimized WSN Routing are done with following metrics through the NS2 simulator.

REFERENCES

1. Singh, S.K., M.P. Singh and D.K. Singh, 2010. Routing Protocols in Wireless Sensor Networks – A Survey, International Journal of Computer Science & Engineering Survey (IJCSES), 1(2): 63-83.
2. Biradar, R.V., V.C. Patil, S.R. Sawant and R.R. Mudholkar, 2009. Classification and Comparison of Routing Protocols in Wireless Sensor Networks, Special Issue on Ubiquitous Computing Security Systems, 4: 704-711.
3. Yessad, S., L.B. Medjkoune and D. Aissani, 2014. Comparison of Routing Protocols in Wireless Sensor Networks, The International Workshop on Verification and Evaluation of Computer and Communication Systems, pp: 135-142.
4. Krishnaveni, P. and J. Sutha, Analysis of routing protocols for wireless sensor networks, International Journal of Emerging Technology and Advanced Engineering, 2(11): 401-407.
5. Perillo, M.A. and W.B. Heinzelman, 2004. Wireless Sensor Network Protocols, Department of ECE, University of Rochester, pp: 1-35.
6. Hill, J.L., 2003. System Architecture for Wireless Sensor Networks, spring, ASPLOS, pp: 1-196.
7. Al-Karaki, J.N. and A.E. Kamal, 2004. Routing Techniques in Wireless Sensor Networks: A Survey, IEEE Wireless Communication, pp: 1-37.
8. Yick, J., B. Mukherjee and D. Ghosal, 2008. Wireless sensor network survey, Elsevier, Computer Networks, 52(12): 2292-2330.
9. Eugene, T.S., Y. Chu, S.G. Rao, K. Sripanidkulchai and H. Zhang, 2003. Measurement-Based Optimization Techniques for Bandwidth-Demanding Peer-to-Peer Systems, IEEE INFOCOM, pp: 1-11.
10. Schmidt, S. and J. Kunegis, 2007. Scalable Bandwidth Optimization in Advance Reservation Networks, Proceedings of 15th IEEE International Conference on Networks, pp: 95-100.
11. Raykar, V.C. and R. Duraiswami, 2006. Fast optimal bandwidth selection for kernel density estimation, Proceedings of the Sixth SIAM International Conference on Data Mining, pp: 522-526.
12. Arai, Y. and H. Ichimura, Optimal Bandwidth Selection for Differences of Nonparametric Estimators with an Application to the Sharp Regression Discontinuity Design, pp: 1-52.
13. Guidoum, A.C., 2015. Kernel Estimator and Bandwidth Selection for Density and its Derivatives, University of Science and Technology Houari Boumediene, pp: 1-22.
14. Rathee, G., N. Singh and H. Saini, 2015. Efficient Shortest Path Routing (ESPR) Algorithm for Multicasting in Wireless Mesh Network, International Journal of Computer Technology & Applications, 6(1): 111-115.
15. Mokbel, M.F., W.A. El-Haweet and M.N. El-Derini, 1999. A Delay-Constrained Shortest Path Algorithm for Multicast Routing in Multimedia Applications, Proceedings of IEEE Middle East Workshop on Networking,