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Energy Efficient Fuzzy Based Dynamic Routing Protocol in Wireless Sensor Network

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Abstract*: A wireless sensor network is a collection of tiny nodes, which are deployed in the given environment to sense the events. The sensed events are transmitted to the base sensor through multi hop communication for the energy efficient purpose. Routing is an very important activity for WSN where source node transmits the information to destination node using multi hop communication. Due to the inherent characteristics of WSN, there exist frequent topology changes in WSN. Most of the existing routing protocols follow only static routing. In order to overcome the issues of existing system, a novel secure dynamic routing protocol is proposed, where the optimal route can be established even in case of topology change in WSN. The proposed protocol is implemented in NS3 simulation. This simulation results justifies that the proposed protocol will improve the energy consumption using routers and increases packet delivery ratio, throughput and reduces delay.

Keywords* : : Wireless Sensor Network, fitness function, energy optimization, life time, efficient routing.

I. INTRODUCTION

Wireless sensor network is a distributed and collection of sensor nodes which senses event in an environment. The sensed events are transmitted to base station for the further processing. The unique characteristics of wireless sensor networks are self organizing and in-network and collaborative processing. Self organizing is a behavior of WSN where regardless of how many nodes disconnect, still an Ad.hoc connection is established from the remaining nodes. The another unique characteristics of WSN is in-network and collaborate processing where nodes collaborate which each other to transmit the secured data to source to destination using store and forward approach. Due to the resource constraints nature of WSN, providing energy efficient secured routing is a major concern. The main aim of energy efficient routing is to distance the optimal routing path so that energy speed on both transmission and reception of the both data packets and control packets. Apart from energy optimization providing secure routing is a major concern. The nodes in wsn are vulnerable to various security attacks [14] [15] which are caused through injection of malicious data along with payload or data packets When the malicious data is injected, with the normal data, the malicious data compromises the network and nodes fails to provide intended services [18] motivated from all these observations.

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In this paper a novel dynamic based secured routing protocols is proposed when can able to provide dynamic based secured routing in wireless sensor network.

II. LITERATURE SURVEY

Various authors have proposed different solutions for energy efficient [16] [17] secured dynamic routing.

Salah Abdblghari et. Al[1] have studied the performance and suitability comparison between the dynamic routing protocols which they are, Enhanced Interior Gateway Routing Protocol(EIGRP), Open Shortest Path First(OSPF) and Routing Information Protocol(RIP). The result shows that Open Shortest Path First (OSPF) is rapid and better reliable than Routing Information Protocol (RIP) and Enhanced Interior Gateway Routing Protocol(EIGRP) which is achieved by using packet Tracer simulation program.

Emad Alnawafa et. al[2] have analyzed two techniques which are Digital Mobile Radio(DMR) and Split Multi-path Routing(SMR). He proposed a new technology for the WSN that depends on the area leveling. They have used two types of data routing techniques such as inter-cluster routing and intra-cluster routing. Finally, they have analyzed that are Digital Mobile Radio (DMR) is better in providing high performance in optimizing energy by comparing with other existing protocols.

Lin Lin et. Al[3] proposed an energy balanced routing protocol called Energy Balaced Routing Protocol(EBRP) to obtain the fuzzy rules for different size of networks. He designed a specific Genetic Algorithm to solve this. Hence, the energy consumption of the network is reduced and balanced. They have used FND (First Node Dies) round as the fitness function to achieve their goal. The simulation results that proved Energy Balaced Routing Protocol (EBRP) has the best energy balanced effect and longest life time for different sizes of networks compared with other existing protocols. Leela priya et.al[4] have observed different approaches for energy effective routing based on routing approach, and on-demand distance vector. The trust layered system has been used to check for energy efficiency. By comparing with existing protocols, the energy efficient routing algorithm have performed better than other existing protocols. Deyu Lin et.al[5] have used mathematical model to achieve traffic load equilibrium. They have used OCS (Optimal Cluster Size) algorithm to calculate optimal cluster size. The evolutionary game model is employed to restrain node's behavior. The simulation results have proved that the proposed protocol performs better than other existing protocols. Manish Bhardwai et.al[6] have proposed a protocol of sensitive power Unbiased Dynamic Routing Protocol in wireless sensor networks.

The existing protocols are failed to provide high performance in throughput and delay points. The advantages are the performance of the entire network is increased by using the proposed protocol.

Dethe et.al[7] have introduced a novel hybrid fuzzy ABC algorithm with fuzzy logic to optimize the CH selection. Energy Consumption and life span are the more important factors in heterogeneous WSN for increasing the energy consumption in order to increase the life span of network. The simulation result proves that the proposed algorithm has the network's life span. Moreover, it reduces the delay and packet loss in compared with other routing algorithm.

Aarthi Kochhar et.al[8] have analysed the Medium Access protocol and Power Efficient and delay Aware medium Access Protocol for Sensor Networks algorithm. They have suggested that Power Efficient and delay Aware medium Access Protocol for Sensor Networks algorithm can used for delay sensitive application and provides good throughput. They also analyzed that the proposed algorithm gives 30% more round than Leach, Leach SM has 83% more than Leach.

Baranidharan et.al[9] have introduced a modified cluster-chain based energy efficient routing protocol which is capable of increasing the network life time, through energy efficiency and very less propagation delay. They have analyzed that the proposed protocol has advantage in efficient routing, efficient data dissemination and gathering when compared with other routing protocols. They plan to focus on fault tolerance and security is needed to be enhanced further.

Ankit jai et.al[10] have done the comparative study on various protocols like flat routing, hierarchical routing, on demand based routing and location based routing protocols. He analyzed that, directed diffusion is better than Software Process Improvement Network in flat routing. Leach is not recommended for large networks due to its single hop routing techniques. In on demand routing protocols, Ad hoc On Demand Vector performs better in providing good time and efficiency at different levels of nodes communication in network rather than Dynamic Source Routing and Destination Sequenced Distance Vector routing.

C. Sivakumar et.al [11], have proposed a novel Linear Programming algorithm to improve the energy efficiency of WSN by reducing the delay arising the network. The comparison of the proposed LP with conventional protocols says that Load Balancing algorithm provides an outstanding performance in terms of robustness and reduced overhead. The technique is not prominently concentrated on packet drops in WSNs. However, the future work can be improved by reducing the errors arising due to increased packet drops in WSNs through a linear error control technique.

Chitralingappa et.al [12] has explored three protocols of WSN to assess its properties against its functionalities. The main intention of the Temporally Ordered Routing Algorithm has the limit control message propagation in the highly dynamic mobile computing environment. In Hybrid Energy Efficient Distributed Clustering, each cluster node need to select a cluster head, based on residual energy and to increase energy efficiency and prolong network lifespan. The third protocol International Nuclear Security Education Network will protect against various attacks which are possible on non-secure routing protocols in sensor networks, e.g., the spoofed routing information attack, sinkhole attacks, wormhole attack and Sybil attack.

Dr. A. Prakash et.al [13] has proposed a routing protocol for WSN which aims in reducing the congestion and energy consumption by using load balancing. The proposed protocol Enhanced Load Balancing Routing Protocol checks the disjoint links for the enhancing the quality of service. involves detection of congestion, notifying of congestion to the neighbor nodes, congestion avoidance and adjustment of the load. The simulation result have uses the benchmark performance metrics throughput, average end-to-end delay, packet delivery ratio, and energy consumption for the performance evaluation purpose.

Shio Kumar Singh et.al [14] have surveyed a sample of routing protocols by taking into account several classification criteria, including location information, network layering and in-network processing, data centricity, path redundancy, network dynamics, QoS requirements, and network heterogeneity. Although some efforts have been devoted to the design of routing and data dissemination protocols for 3D sensing applications, we believe that these first-step attempts are in their infancy, and more powerful and efficient protocols are required to satisfactorily address all problems that may occur.

III. SYSTEM AND DESIGN

Figure 1 explains the architecture of the proposed system. System initialization phase generates public and private key which are used by the WSN or node.

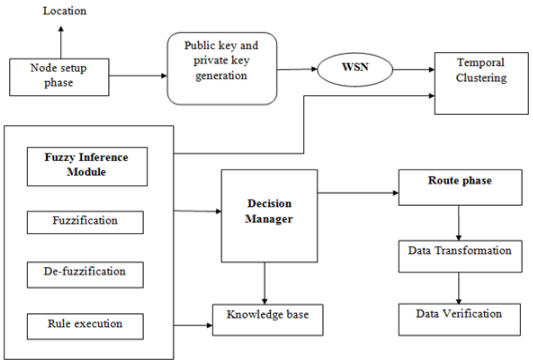

Figure 1 : System Architecture

The deployed nodes forms a group of clusters in clustering module phase. After the nodes are clustered the interested nodes are identified and optimal routing path is identified. The transmitted data is send to interest of nodes and in data verification phase ,the data validation is done by sensor nodes which are requested whether the validation is successful ,the nodes install the data else the data packets are rejected.

IV. PROPOSED SYSTEM

1) System Initialization Phase:

In the System Initialization and set up phase, key pair is the first step to develop the secure system. In this phase, the key pair's namely public key and private key is generated by RSA algorithm.

GROUP BASED RSA ALGORITHM:

Step 1: Choose two random large prime numbers p, q from generator (h) such that p≠q.

Step 2: Calculate N=p*q such that p*q --->512 bits.
Step 3: Choose x, y from z*p, where z*p is set of invariable prime numbers.
Step 4: Compute $e=x^p.y^q$ mod pq.
Step 5: Generate P_u $K=N^x.e^y$
Step 6: Compute $d=N^{xp}.e^{pq}$.mod q
Step 7: Private key = $e.d.mod(p-1)^x$ $(q-1)^y$

2) Intelligent temporal clustering phase:

` In Intelligent temporal clustering phase, Fuzzy logic is used to select cluster heads among the sensor nodes present in a cluster. The parameter of sensor nodes such as distance, energy, and degree of connectivity are considered in cluster head selection. Each sensor node is assigned a cluster head coefficient value based on the fuzzy rules used. The sensor node having high cluster co-efficient is chosen as cluster head. The main aim of Intelligent temporal clustering phase is to produce the optimized energy consumption.

Table 1 gives the fuzzy input membership function variable:

Distance	Residential energy	Degree of connectivity
Low (0)	Low (0)	Weak (0)
Medium(1)	Medium(1)	Medium (1)
High(2)	High(2)	High (2)

Fuzzy output probability values :

1. For the value of zero, it is considered as Not optimal
2. For the value of one, it is considered as Weak routing path
3. For the value of two, it is considered as Medium routing path

The generated fuzzy rules to perform efficient clustering is given as follows:

1. If distance is low (0) and residential energy is also low (0) and degree of connectivity is weak (0), then it is Not optimal routing path.
2. If distance is low (0) and residential energy is also medium (1) and degree of connectivity is high (2), then it is Weak routing path.
3. If distance is low (0) and residential energy is also medium (1) and degree of connectivity is high (2), then it is Medium routing path.
4. If distance is low (0) and residential energy is also medium (1) and degree of connectivity is medium(1), then it is Higher medium routing path.
5. If distance is medium (1) and residential energy is also low (0) and degree of connectivity is medium (1), then it is Medium routing path.
6. If distance is medium (1) and residential energy is also medium (1) and degree of connectivity is weak (0), then it is weak routing path.
7. If distance is high (2) and residential energy is also low (0) and degree of connectivity is medium (1), then it is Weak routing path.
8. If distance is high (2) and residential energy is also medium(1) and degree of connectivity is high(2), then it is Medium routing path.

3) Intelligent routing phase:

In Intelligent routing phase, the main aim is to discover the optimal routing paths. The proposed algorithm for discovering optimal routing is given as follows:
Proposed Routing algorithm:
Input: Deployed clustered nodes in WSN.
Output: Identifying the optimal routing path.
Step 1: Begin
Step 2: Initialize the routing process for every nodes present in the network.
Step 3: Calculate hop distance ($S_{CH,}$ D_{CH}) where S_{CH} is the source cluster head node and D_{CH} is the Destination node.
Step 4: End

Table 2

Distance	Residential Energy	Degree of Connectivity	Probability of optimal routing
Low	Low	Weak	Not optimal
Low	Medium	High	Weak routing path
Low	Medium	High	Medium routing path
Low	Medium	Medium	Higher Medium routing path
Medium	Low	Medium	Medium routing path
Medium	Medium	Weak	Weak routing path
High	Low	Medium	Weak routing path
High	Medium	High	Medium routing path

For every nodes in WSN
Step 1: calculate Residential Energy ($S_{CH,}$ D_{CH}) of (Average residential energy ($S_{CH,}$ D_{CH}) <= threshold)
Step 2: Select the route Ri for routing process else
Step 3: Search for the route Ri wich is optimal
Step 4: End

Initialize priority route Pi
Step 1: Pi=Distance (Ri) + Average Residential Energy (Ri)
Step 2: Store priority route Pi
Step 3: End for
Step 4: Stop

4) Data transmission phase and verification phase:

In data transmission phase and verification phase, the data packets are encrypted with source node public key and transmit the packets to destination node by using multi hop communication. The message format used in data transmission phase is $S_N \rightarrow (h(D_p, P_uK), d_N)$ where

S_N →source node,
h→one way hash function,
D_p → data packets
P_uK→public key,
d_N →destination node.

In data verification phase, upon receiving the data packets, the destination nodes ensure the connection of the data packets by validating with their private key. If validation is successful, the destination node will receives the data packets else the data packets will be disconnected.

$D_N \rightarrow h(P_RK, D_P)(S_N)$ where

D_N →destination nodes,
h→ one way hash function,
D_p→data packets, and
S_N→source nodes.

V. EXPERIMENTAL SETUP AND SIMULATION PARAMETERS

The feasibility of proposed protocol is implemented by using network simulator

Table 3. Simulation Parameters

Network simulator	NS2 version (2.33) Mannasim framework
Simulation area	1000m*1000m
Density of nodes	200-250
Transmission range	50-100m
Physical layer	Phy/wirelessphy-mica2
Radio Propagation model	Two ray model
Environment	Urban
Node initial energy	100J
Transmission power (tx)	1.2J per packet at maximum power
Receiving power (rx)	0.36J per packet at maximum power
Simulation duration	60 minutes
No of trails	60
Packet size	50 - 500 bytes

VI. RESULTS AND DISCUSSIONS

The performance of FFBRP is evaluated by using the performance metrics like node energy consumption, node life time, packet delivery ratio.

A. Node Energy Consumption

Figure 1 gives the Node Energy consumption of proposed system then it compares with other existing protocols. From the graph, It is clear that, the proposed protocol has sender node Energy consumption. Because proposed protocol provides clustering of nodes using ring based approach and transmit the data with intelligent routing. By doing so, the proposed protocol is able to reduce the redundant transmission and retransmission of both data packets and control packets. Hence the proposed system has better node life time compared with other existing protocols.

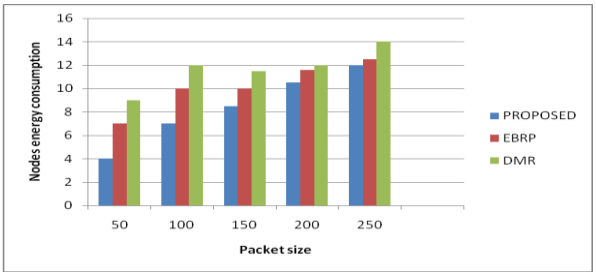

Figure 1 Node Energy consumption

B. Node Life time

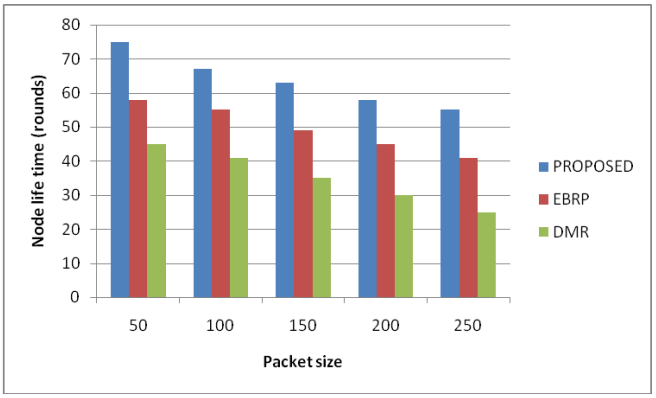

Figure 2 Node life time

Figure 2 gives the nodes life time of proposed system then it compares with the other existing protocol. This protocol identifies the malicious nodes and removes it from the routing path. By means of Intelligent secured routing, Moreover the proposed protocol reduces the packet drop. By identifying the Malicious nodes and reducing their input. Hence, proposed protocol has better node life time compared with the existing protocol.

C. Packet delivery ratio

Figure 3 gives the packet delivery ratio of proposed system then it compares with the other existing protocol. The packet delivery ratio of proposed protocol is better because proposed protocol provides security against malicious nodes and prevents them dropping of packets. Hence the proposed protocol has better packet delivery ratio compared with other existing protocols.

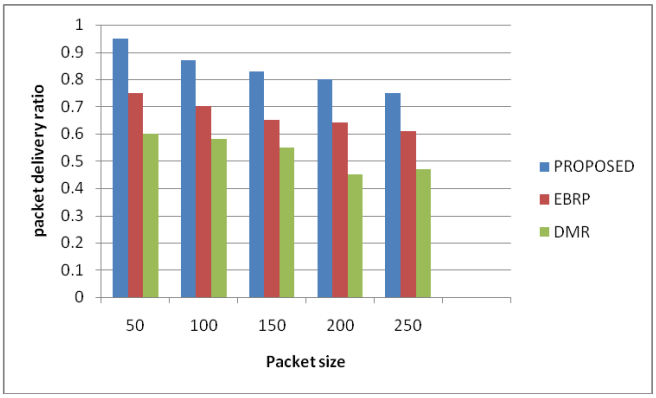

Figure 3 Packet delivery ratio

VII. CONCLUSION AND FUTURE WORK

In this paper, a novel energy efficient and dynamic routing protocol has been proposed to provide security during data delivery. The proposed protocol is implemented using NS2 simulator. The simulation results justifies that the proposed protocol has better node life time and optimized node energy consumption and better packet delivery ratio. Future work of the proposed system can be done by enhancing this protocol for nodes.

REFERENCES

1. Abdulghani, S. and Hazim, S. (2019). Performance Evaluation of the WSN Routing Protocols Scalability.
2. Alnawafa, E. and Marghescu, I. (2019). : New energy efficient multi-hop routing techniques for wireless sensor networks: static and dynamic techniques.
3. Li, L. and Li, D. (2018). An Energy-Balanced Routing Protocol for a Wireless Sensor Network. Journal of Sensors, 2018, pp.1-12
4. Priya, L. (2018). Energy efficient routing models in wireless sensor networks. International Journal of Science and Research (IJSR), 5(2), pp.2115-2118.
5. Lin, D., Wang, Q., Lin, D. and Deng, Y. (2015). An Energy-Efficient Clustering Routing Protocol Based on Evolutionary Game Theory in Wireless Sensor Networks. International Journal of Distributed Sensor Networks, 11(11), p.409503.
6. Bhardwaj, M., Ahlawat, A. and Bansal, N. (2018). Maximization of Lifetime of Wireless Sensor Network with Sensitive Power Dynamic Protocol. International Journal of Engineering & Technology, 7(3.12), p.380.
7. D, N. and C.G, D. (2018). Improvements in Routing Algorithms to Enhance Lifetime of Wireless Sensor Networks. International journal of Computer Networks & Communications, 10(2), pp.23-32.
8. Kochhar, A. and Sharma, S. (2016). Routing Protocols for Wireless Sensor Networks. International Journal of Science and Research (IJSR), 5(1), pp.1069-1073.
9. Pandita, D. and Malik, R. (2018). A Survey on Clustered and Energy Efficient Routing Protocols for Wireless Sensor Networks. International Journal of Trend in Scientific Research and Development, Volume-2(Issue-6), pp.1026-1030.
10. Jain, A. (2018). Various Routing Protocols for Wireless Sensor Networks. International Journal for Research in Applied Science and Engineering Technology, 6(1), pp.1430-1435.
11. Aditya Iche and Mrs. M R Dhage (2019). An improved location based routing protocol for wsn using novel location proximity algorithm. International Journal of Engineering Research and, V4(10).
12. Pandita, D. and Malik, R. (2018). Wireless sensor networks: routing protocols on challenging and security issues. International Journal of Trend in Scientific Research and Development, Volume-2(Issue-6), pp.1026-1030.
13. Enhanced load balancing routing protocol to reduce energy consumption in wireless sensor networks. (2019).
14. Alnawafa, E. and Marghescu, I. (2019). : New energy efficient multi-hop routing techniques for wireless sensor networks: static and dynamic techniques.
15. SVN santhosh kumar, Yogesh Palanichamy, Energy efficient and secured distributed data dissemination using hop by hop authentication in WSN, wireless networks, 24 (4), pp 1343-1360, 2018.
16. Rakesh Rajendran, SVN Santhosh Kumar, Yogesh Palanichamy, Kannan Arputharaj, "Detection of DoS attacks in cloud networks using intelligent rule based classification system", 22 (1),pp 423-434, 2019.
17. M Selvi, K Thangaramya, Ganapathy Sannasi, K Kulothungan, H Khannah Nehemiah, A. Kannan, "An Energy Aware Trust Based Secure Routing Algorithm for Effective Communication in Wireless Sensor Networks", pp 1-16
18. Santhosh Kumar SVN, M. Selvi, A Gayathri, Ruby D, A Kannan, "Energy Efficient Rule based intelligent routingusing Fitness Functions in Wireless Sensor Networks", international Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol 8 (12),PP.5414-5420.

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