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STUDY OF WIRELESS SENSOR NETWORKS, AN ENERGY-EFFICIENT DIRECTION-BASED PDORP ROUTING PROTOCOL

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Abstract:

Wireless sensor networks, often known as WSNs, have become an important technology in a variety of applications, ranging from monitoring the environment to providing medical care. The design of routing algorithms that are capable of making optimum use of the limited energy resources of sensor nodes while simultaneously maintaining reliable data transmission is one of the key issues that wireless sensor networks (WSNs) face. According on the findings of this research, we present a routing protocol for wireless sensor networks (WSNs) that is Energy-Efficient Direction-Based PDORP (Predictive Direction-Oriented Routing Protocol). In order to arrive at highly intelligent routing decisions, the proposed protocol makes use of the directional information that sensor nodes provide. Through the process of guessing the direction in which data is being transmitted, PDORP reduces the amount of wasteful energy consumption that is involved with multi-hop communication. In addition to this, PDORP makes use of a dynamic routing system that is able to adjust to the ever-changing conditions of the network. This ensures that the data delivery process is both resilient and reliable. In order to assess the effectiveness of PDORP, we carry out exhaustive simulations that make use of a wide range of network situations and performance measures. In terms of energy economy, packet delivery ratio, and network longevity, our findings indicate that PDORP is superior to other routing protocols that are currently in use. Additionally, PDORP demonstrates resistance to network dynamics and scalability, both of which make it suited for implementation in large-scale wireless sensor networks (WSNs). To summarize, the Energy-Efficient Direction-Based PDORP routing protocol that has been suggested offers a valuable solution that has the potential to improve the performance of wireless sensor networks (WSNs) and extend their lifespan. Possible future avenues for study might include real-world implementations and optimizations that are specifically customized to particular application domains.

Introduction:

Wireless sensor networks, also known as WSNs, have emerged as a game-changing technology that has several applications in a variety of fields, including industrial automation, healthcare, and environmental monitoring, among others. Data is collected, processed, and transmitted to a sink node or base station using wireless sensor networks (WSNs), which are made up of a large number of tiny sensor nodes that are limited in their resources and are placed in a specific region. One of the most significant issues that wireless sensor networks (WSNs) face is the development of effective routing protocols that can guarantee the transmission of data in a dependable manner while also preserving the limited energy resources of sensor nodes. LEACH, which stands for Low-Energy Adaptive Clustering Hierarchy, and PEGASIS, which stands for Power-Efficient GAthering in Sensor Information Systems, are examples of traditional routing protocols in wireless sensor networks. These protocols are primarily concerned with reducing the amount of energy that is consumed by employing methods such as data aggregation and clustering. A number of problems, including higher latency, restricted scalability, and inefficient energy efficiency, are frequently associated with these protocols. Research efforts have recently been dedicated on the development of routing protocols that take advantage of the spatial and directional properties of wireless sensor networks (WSNs) in order to overcome these problems. The goal of directional routing protocols is to reduce the amount of energy that is consumed by sending data packets along the pathways that are the most energy-efficient. These protocols take into consideration the geographical distribution of sensor nodes as well as the directionality of wireless communication networks. An novel Energy-Efficient Direction-Based PDORP (Predictive Direction-Oriented Routing Protocol) routing protocol for wireless sensor networks (WSNs) is proposed by us in this research paper. PDORP makes use of predictive algorithms in order to obtain an approximation of the direction in which data is being transmitted and to dynamically adjust routing decisions in accordance with the current conditions of the network. The purpose of the PDORP is to reduce the amount of energy that is consumed, to extend the lifetime of the network, and to improve the dependability of data transmission in wireless sensor networks (WSNs) by intelligently using directional information. In the following sections, we will present a comprehensive description of the PDORP protocol that has been suggested. This description will cover its design concepts, routing methods, and performance evaluation. In addition, we conduct comprehensive simulations to evaluate the performance of PDORP in a variety of network settings and compare it to other routing protocols that are already in use. Last but not least, we make some concluding thoughts on the relevance of energy-efficient routing protocols in extending the capabilities of wireless sensor networks (WSNs), as well as prospective applications, future research paths, and recommendations.

SYSTEM ASSUMPTIONS

The network that we have assumed to exist is one that has a limited number of sensor nodes that are randomly distributed throughout a two-dimensional region. All of the nodes are homogenous, and each of them possesses an initial energy ei that is greater than zero. Due to the fact that all of the nodes only have one hop of communication, they all employ radio transmission over limited ranges. In order for transmission to take place between two nodes, it is necessary for the residual energy of the nodes to be either more than or equal to the threshold level of electricity. We made use of the route loss model that is given in [26], which is the model that is most commonly used for theoretical analysis and doing network simulations. For the computation of power reception by the remote node for distances of dist meters defined as under, we have utilized the same equation that was employed in [19]:

$$P_r(dist) = P_i * \left(\frac{dist_i}{dist}\right)^{\alpha}$$

Here, Pi is the received signal power at the distance $dist$ from a transmitter and α is the path loss exponent that varies in between 2 - 6.

There are a few more assumptions that we have made about our model, and they contain the following:

- The transmission power of the node may be modified by the node itself, and the received signal strength (RSS) can be simply determined.
- Through the utilization of directional antennas, both the transmission and reception of packets are successfully completed.
- Nodes are naïve about their location.

- Nodes are able to send and receive packets because they are aware of their neighbors and can communicate with them.
- Each and every sensor node is aware of the direction in relation to the local north.

METHOD

In the next part, we will go into depth about the network modeling as well as the suggested routing mechanism known as PDORP. We were able to establish a network with randomly distributed nodes N (500) by utilizing algorithm 1, which is referred to as "Network creation." The land that is one thousand square meters has been taken by us. We computed the distance d of each of the nodes from their neighbors in the fourth phase of this method. We then compared the distance of each node to the threshold th value of distance. This was done so that the nodes could only be linked if their distance was either less than or equal to the threshold value. With the help of this approach, we have ensured that all of the nodes are connected with a distance value that is as close to zero as possible.

Algorithm1. Network creation

1. Network. height=1000
2. Network. Width=1000; N=Total_ Nodes.
3. For each **n** in N

counter = 1;

$\mathbf{xloc(n') = 1000 * Random.}$

$\mathbf{yloc(n') = 1000 * Random.}$

Node. name(n') = conuter; counter = counter + 1;

Endforeach

4. Cov_set = [ ]; //it would contain the limited area node.

for i =1 to N

cov_count=2;

for j=1: N

if(i!=j) // A node cannot compute distance to itself

$$\mathbf{d = \sqrt{((x(i) - x(j))^2 + y(i) - y(j))^2}; = \frac{Network.width*20}{100};} \quad (6)$$

if (d ≤ th) cov_set(i, 1) = i;

cov_set(i, cov_count) = j;

cov_count = cov_count + 1:

end if end for end for

An method that specifies the placement of nodes over the whole network is presented above. When the planned network is 1000 by 1000, the creation of the network takes happen with the coverage set equal to 1. The snapshot of the network formation is shown in Figure 2.

Algorithm.2: Path Finding

1. For i=1 : Network. Simulation. Rounds

2. Source=Initialize. Source;

3. Source. Id=Node.name(source); Path=[ ]; Path element =2; Path[1]=Source;

4. Source. Packet. count=1000;

5. Destination. Id=Node.name(Destination);

6. Current_cov_set_ source=cov_set (source.Id,:) dest_ found=0; possible_ nodes=[ ];

7. While(dest _found!=1) 8. For each all n in current_cov_set

If(x(all n)>xloc(Source.Id) && (x(all n)-xloc(Destination.Id) < 0

Possible_nodes[possiblenoedcount] = all n; Possiblenodecount+=1;

Endif

9. Selection=possiblenodecount*Random;

10. Selected_node=Possible_nodes[selection];

11. Possible_Nodes=[ ]; Path(Path element) = selected_Node

12. END

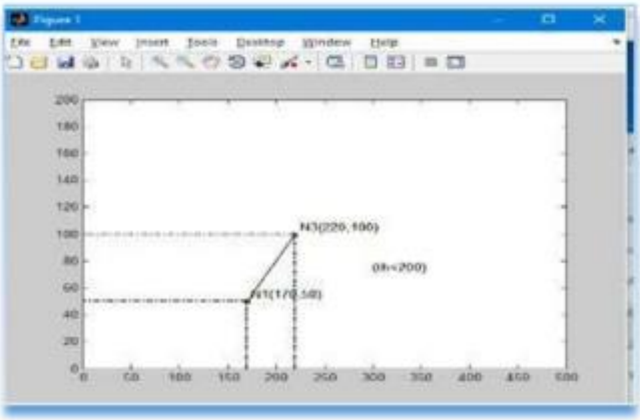

Figure 1 Network Creation

(The X axis represents the number of rounds, and the Y axis represents the number of nodes) In order to construct a route for the transmission of data, the method 2 (Path finding) is utilized to locate the most efficient path among the extensive coverage set of nodes. Transmission will take place if both the source node and the destination node are included in the coverage set; else, path finding will be performed once again. Figure 2 depicts the connection that was chosen between a source node and the alternative nodes that are heading in the direction of the destination.

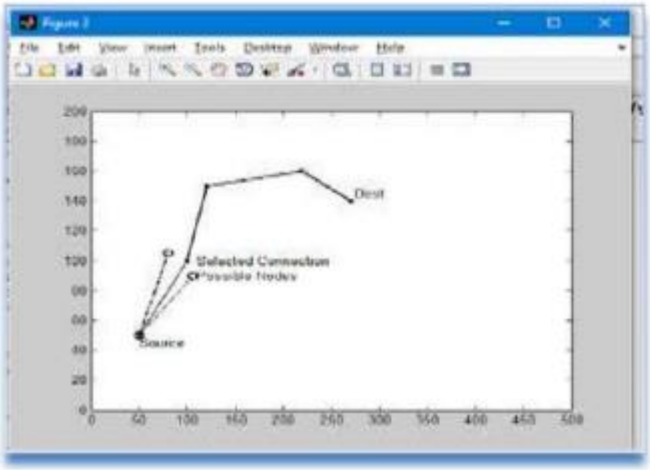

Figure 2 Path Finding

((X axis=Number of rounds and Y axis=Number of Nodes)

Proposed routing protocol "PDORP"

In order to maximize efficiency, PEGASIS-DSR Optimized Routing Protocol (PDORP) takes advantage of the best features of reactive and proactive routing models. A node's increased aggression during transfer, even if it wasn't in cache memory before, can force the other node to receive a packet from it, potentially damaging existing routes. While it might be possible to solve this issue by verifying each node as it receives a data packet, doing so would introduce unnecessary latency. So, every round, using the parameters given to the nodes, the suggested approach establishes a trustiest for the first time. To save unnecessary delays, the trust list is updated after each round and is no longer reviewed after a specific number of rounds. Our suggested scheme's flowchart is depicted in figure3. The process begins with a source node determining the distance from all of its neighbors. If the distance is less than or equal to a threshold distance, the data is sent to the neighbor node that is closest to the destination node. Additionally, the minimum distance between neighbor nodes should be in the direction of the destination node. Following this procedure, only in the initial simulation round are all nodes pointing towards the destination added to the trust list. Every time fresh data transmission is needed, the initial round of simulation will include updating the trust list. Only nodes that are in the trust vector will be allowed to transmit the data. Since the vector list is only generated during the simulation's initialization, it must be prepared using algorithm 3 and saved in the cache in order for transmission to proceed.

Algorithm 3. Routing Cache DSR Integration (PDORP)

1. PC=1;
2. For i=1 to N

$$\Delta H = \frac{\sum_{i=1}^{N} EA + ET + ER}{N}$$

3. If((EAi + ETi + ERi)> ΔH)

4. Routing distortion possible Nodes(PC) = i;
5. PC = PC + 1
6. endif;
7. endfor;
8. Initialize transfer;Packet.count=1000;
9. d=find(Packet.sender.Id)==Routingdistortionpossible Nodes)
10. if(isempty(d))
11. Accept Packet;
12. Else
13. Reject Packet;
14. End ;

Algorithm 4. Hybrid Algorithm (Action of GA and BFO)

It has been taken into consideration that every node appears in the trust list at least once. On the basis of algorithm4, a hybrid algorithm that is comprised of both GA and BFO has been presented for the purpose of generating the fitness value of trust. In this scenario, GA would be optimizing the consistency of the nodes based on the ER and ET. A fitness function that is presented in the first step of algorithm 4 will need to be passed by every node.

1. $f = (1 - \frac{ET_i + ER_i}{N} * rand)$

2. For i=1:N

3. If round (f)==1

4. Node is accepted for BFO fitness check;

5. GAlist(Gaa)=I; Gaa=Gaa+1;

6. Trust_value=0;

7. Endif

8. End for;

9. tr=0;

10. For each K in GA list

11. $g = 1 - (ETk - (\sum Nl{=}1ET)/N)$

12. If g>0, New_trust=Rand

13. $tr = t\,r + 1$;

14. Node_trust(tr) = $Node\_trust(tr) + New\_trust$.

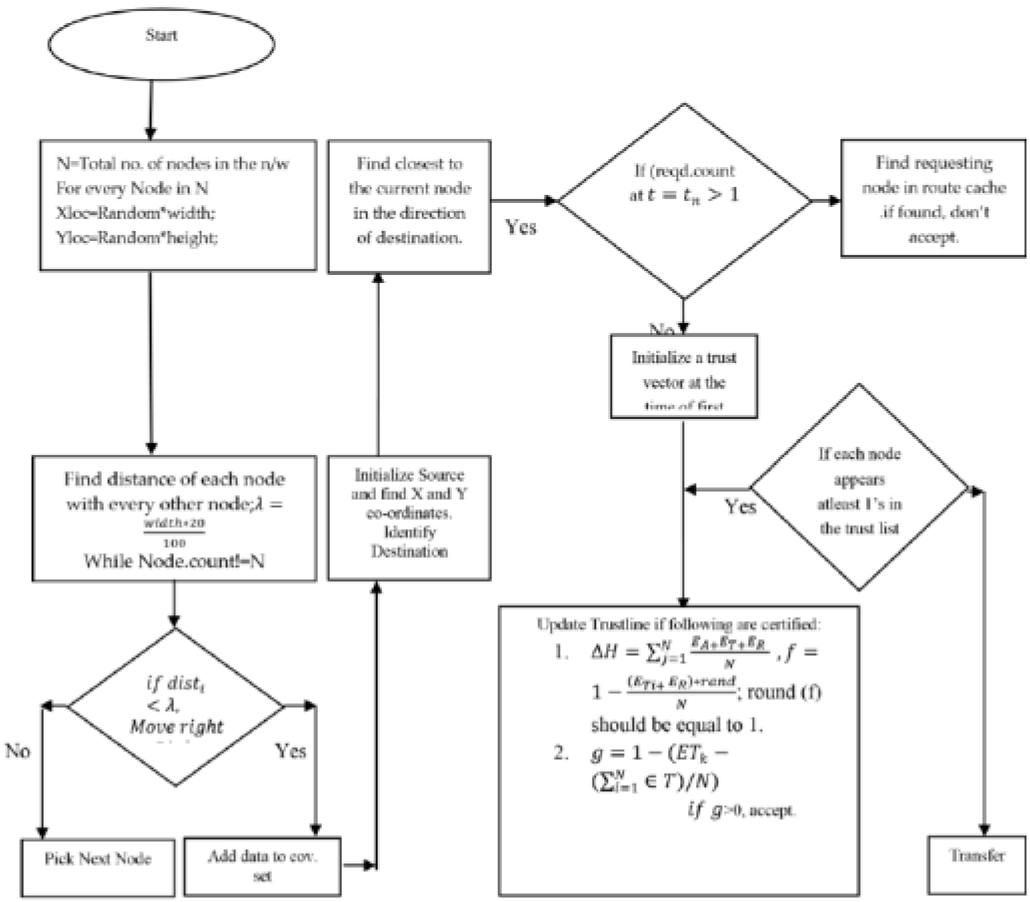

Figure 3 Flow chart of PDORP

PERFORMANCE EALUATION

In this section, the outcomes of the simulation are shown. The latency, bit error rate, and throughput metrics are utilized in order to evaluate and contrast the performance of a number of different routing protocols, including PRP, DSR, LEACH, and OD-PRRP, as well as the proposed routing protocol PDORP. One 512-byte per second is the pace at which the bits are processed. One hundred is the size of each of the packages. Two hundred seconds is the amount of time that the packets take to get at their destination, which is the amount of time that is required for each simulation scenario. There are a total of 500 nodes that are utilized. Below, Figure 4 depicts the simulation model that has been used to hybridize PEGASIS with DSR. This hybridization was accomplished by taking into account the direction notion of PEGASIS and the cache concept of DSR, in addition to utilizing two optimization approaches, namely GA and BFO.

The various simulation parameters used in the research are shown below.

1. Width of the network:1000 m
2. Height of the network: 1000 m
3. EA = Aggregation Energy of the nodes
4. ET = Energy consumption at transfer of packet;
5. ER = Energy consumption at receiving packets.
6. Network Type: GPS
7. Nodes: 100 to 500

8. Network. Allocation: Random
9. Network. Coverage: $\sqrt{(x2 - x1)2 + (y2 - y1)2}$
10. Network. Caching: DSR cache
11. Network. Routing: PEGASIS Inspired

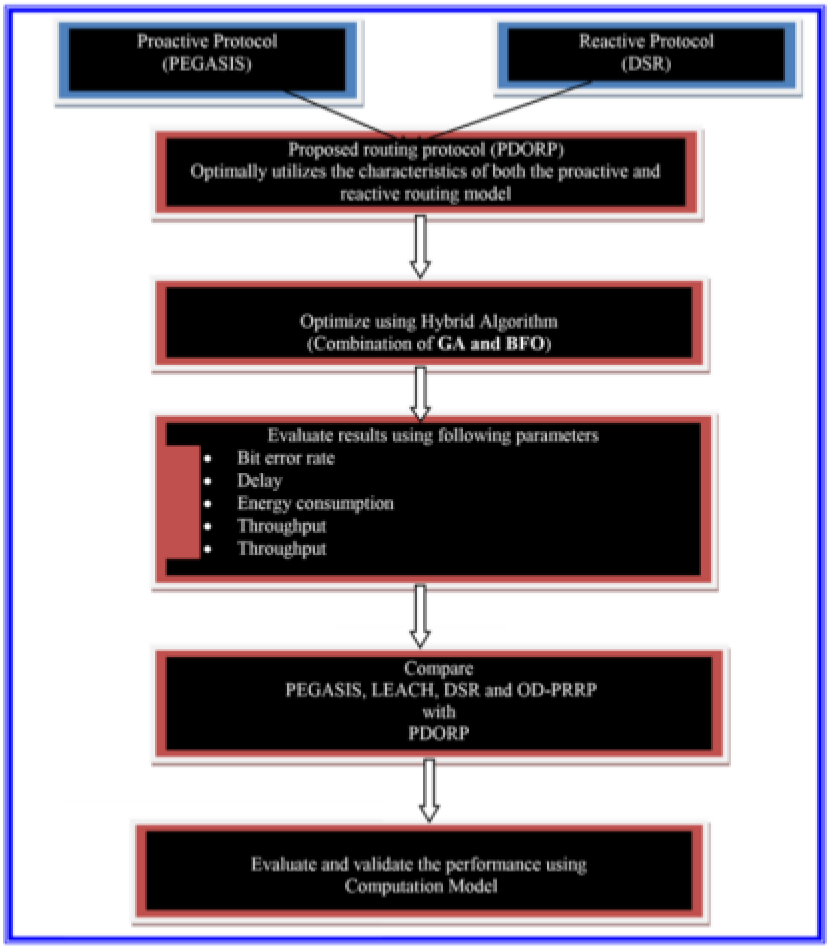

Figure 4 Simulation Model

Comparison based on various parameters with varying number of sensor nodes

This metric indicates the overall amount of time that a packet takes to travel from its origin to its destination. This measure takes into account the processing delay, the line up delay, the transmission delay, and the transmission delay. An increase in the number of nodes, on the other hand, means that the difference in latency will also rise. The length of time that passes between the sending of a data packet by the source node and the receiving of the same data packet at the destination node is referred to as the delay in the transmission of a data packet. Figure 5 illustrates the outcomes for the end-to-end latency when a different number of sensor nodes are used during the experiment. In the case of OD-PRRP, it has been noticed that the latency from beginning to finish grows as the number of nodes in the network increases. In addition, the findings indicate that the suggested routing protocol PDORP performs marginally better than LEACH, DSR, PEGASIS, and even OD-PRRP when taking into consideration the minimal packet delivery latency.

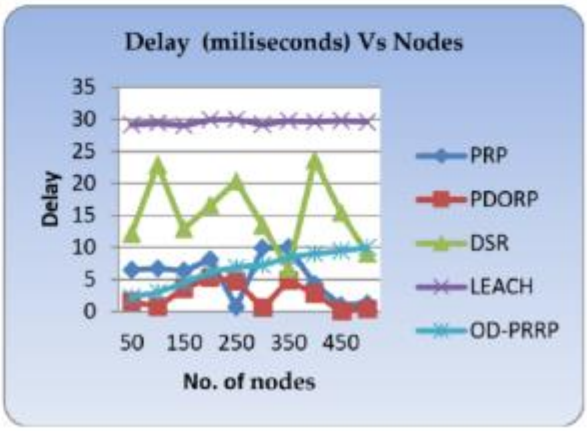

Figure 5 Comparison of end to end delay with varying number of sensor nodes

Bit Error Rate

The metric is a measurement that is used to determine the amount of mistakes that are discovered in the network when packets are being sent. Over the course of the attack, it has been seen that the value of mistake rates has been strengthened. It is evident from the data presented in Figure 6 that the DSR protocol has a lower error rate when compared to all of the potential routing protocols. Moreover, the performance of the suggested algorithm, PDORP, is superior to that of PRP, OD-PRRP, and even LEACH in some cases. In the event that a node gets more aggressive during the transfer process and it was not previously present in the cache memory, the other node is obligated to receive a packet from it. This results in the possibility of the node causing harm to routes that are already in place. Therefore, the suggested approach generates trusties for the very first time in each round based on the parameters that are assigned to the nodes. This results in a lower bit error rate and a lower possibility of an attack occurring.

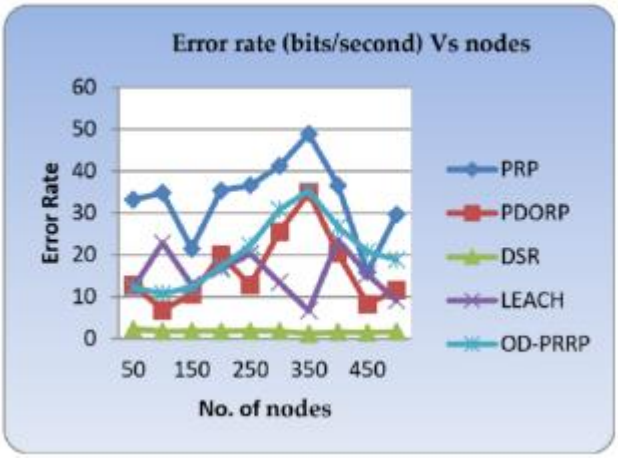

Figure 6 Comparison of bit error rate with varying number of sensor nodes

Energy Consumption

The number of transmissions for the messages that are relayed to all of the members of the group is reduced as a result of this happening. The total number of units that are necessary for the key transmission across the entirety of the simulation is what is meant by this notion. For the purpose of transferring the data, the formula for energy usage is as follows:

$(k, d) = Eelec * k + Camp * k * d\ 2\ , d > 1$ Energy consumption formula of receiving data:

$ERx(k) = Eelec * k$

Where k is the data volume to be transmitted, d is the distance among the two sensors. $Eelec$ is the energy consumption to take out the data transmission in terms of nJ/bit.

Therefore, the total energy consumed $=\sum ERx + \sum ETx$, i.e. both the total energy used by receiving data and the total energy consumed by transmitting data are included in this total. As can be seen in Figure 8, it has been determined that the performance of PRP and the newly developed routing protocol PDORP is superior to that of DSR, LEECH, and OD-PRRP. Even when the number of nodes in the network is increased, the suggested method maintains a nearly constant level of energy usage. In terms of the parameter that represents energy consumption, PDORP will function as the best routing protocol.

Throughput

In a particular period of time, this measure provides a description of the typical rate at which messages are successfully sent over the network. As may be seen in Figure 9. In comparison to all of the other possible algorithms, the LEACH protocol is superior. PRP, PDORP, and OD-PRRP treatments are all inferior than DSR, which is also superior. When it comes to throughput learning applications, the data make it very evident that LEACH performs better than its competitors. When it comes to throughput, the characteristics of PRP, PORP, and OD-PRRP are essentially identical to one another.

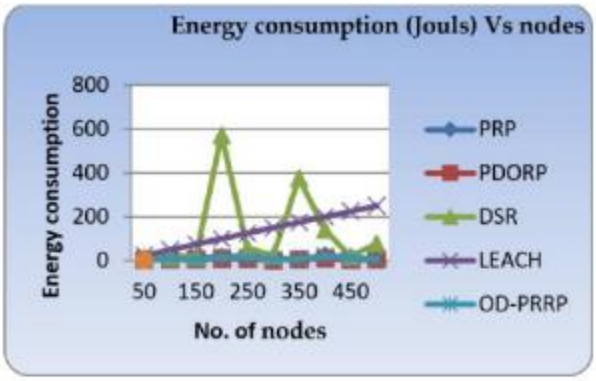

Figure 7 Comparison of energy consumption with varying number of sensor nodes

Comparison based on various parameters with varying number of rounds

It has been noticed from Fig. 10 that the suggested technique performs better than OD-PRRP, LEACH, DSR, and PEGASIS when taking into consideration bit error rate, end-to-end transmission latency, and energy consumption metrics with changing numbers of nodes. The LEACH routing protocol is superior to all other potential routing protocols when it comes to throughput metrics. On the other hand, LEACH is not suitable for situations in where energy consumption is a primary constraint. An increase in the number of rounds does not significantly affect the suggested algorithm's energy usage, which remains nearly unchanged. In terms of the parameter that represents energy consumption, PDORP will function as the best routing protocol. Based on observations, it has been noticed that the delay from beginning to finish for OD-PRRP grows as the number of rounds increases. In addition, the findings indicate that the suggested routing protocol PDORP performs marginally better than LEACH, DSR, PEGASIS, and even OD-PRRP when taking into consideration the minimal packet delivery latency.

CONCLUSION

The purpose of this study was to offer a hybrid optimization based PEGASIS-DSR optimized routing protocol (PDORP). This protocol makes advantage of the cache and directional communication idea of both proactive and reactive routing techniques. The results of the simulation showed that our suggested protocol was able to reduce the amount of time it took for transmission from beginning to end as well as the bit error rate without sacrificing energy efficiency. In the PDORP, both the proactive routing and reactive routing methodologies have been utilized in order to achieve a path that is both quick and free of harm, while also reducing the amount of time it takes for transmission to take place. The performance of PDORP has been examined by comparing it to other approaches that are currently accessible, such as etc.

REFERENCES

[1] M. Merck."The icecube detector: A large sensor network at the south pole". IEEE Pervasive Computing, 2010, vol. (4), pp 43-47.

[2] Y.-C. Wang; W.-C.Peng ; Y.-C.Tseng. "Energy-balanced dispatch of mobile sensors in a hybrid wireless sensor network". IEEE Transactions on Parallel Distributed Systems. 2010, vol-21, pp 1836-1850.

[3] B.K. Panigrahi, V. Ravikumar Pandi, "Bacterial foraging optimisation: Nelder–Mead hybrid algorithm for economic load dispatch", IET Generation Transmission Distribution, 2008, vol. 2, no. 4, pp. 556-565,

[4] T. H. Feiroz Khan and D. Sivakumar, "Performance of AODV, DSDV and DSR protocols in mobile wireless mesh networks," Second International Conference on Current Trends In Engineering and Technology - ICCTET 2014, Coimbatore, 2014, pp. 397-399.

[5] Mesh Networks", IEEE 2nd International Conference on Current Trends in Engineering and Technology,2014, Coiambtore, pp 397-399.

[6] Chen Han-ning, Zhu Yun-long, Hu Kun-yuan, "Cooperative bacterial foraging algorithm for global optimization", IEEE Chinese control and decision conference, Guilin, China, 2009, vol. 6, pp 3896-3901.

[7] D. Johnson, Y. Hu, and D. Maltz, "The Dynamic Source Routing Protocol for Nodes Ad Hoc Networks (DSR) for IPv4", IETF RFC 4728, 2007, vol. 15, pp. 153-181.

[8] Dong Hwa Kim, Ajith Abraham, and Jae Hoon Cho, "A hybrid genetic algorithm and bacterial foraging approach for global optimization", Informmation Sciences, 2007, vol.- 177, issue-18, pp. 3918-3937.

[9] Chang Wook Ahn, R. S. Ramakrishna, "A Genetic Algorithm for Shortest Path Routing Problem and the Sizing of Populations", IEEE transactions on evolutionary computation, Dec. 2002, vol. 6, no. 6, pp 566-579.

[10] J. Carretero, F.Xhafa, & A.Abraham. "Genetic algorithm-based schedulers for grid computing systems". International Journal of Innovative Computing, Information and Control, 2007, vol 3(7), pp. 247-272.

[11] L.G. Quesada. "A Routing Protocol for MANETs", In Master of Science in Communication Technology thesis, 2007,(http://brage.bibsys.no/xmlui/handle/11250/261916)

[12] H. AlAamri, M. Abolhasan, and T. Wysocki, On Optimising "Route Discovery in Absence of Previous Route Information in MANETs", Proc. IEEE Vehicular Technology Conference (VTC), Barcelona, 2009,pp. 1-5.

[13] H. Shen, Y. L. Zhu, X. M. Zhou, H. F. Guo, C. G. Chang, "Bacterial foraging optimization algorithm with particle swarm optimization strategy for global numerical optimization", World Summit on Genetic and Evolutionary Computation, 2009, Shanghai, China, pp. 497- 504.

[14] Kou Pan-gao, Zhou Jian-zhong, "Optimal PID Governor Tuning of Hydraulic Turbine Generators with Bacterial Foraging Particle Swarm Optimization Algorithm". In Proceedings of the CSEE, 2009, Vol. 29(26), pp 101-106.