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Analyzing the Efficiency of Algorithm for Routing and Data Transmission in Wireless Sensor Networks

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Abstract :

Wireless Sensor Networks (WSNs) comprises a massive set of sensor nodes undergo random deployment in the target region to observe the physical parameters. The sensor nodes in WSN are constrained in energy, transmission power, storage, and computation abilities. Several studies ensured that the energy spent for data transmission is significantly higher than sensing and processing. Design of effective routing mechanism in WSN finds helpful to reduce the energy consumption in throughout the network. Several approaches are available with the objective of enabling energy efficient routing to maximize the network lifetime. Energy efficiency remains a major issue in the design of wireless sensor networks (WSN). Earlier studies reported that the routing techniques can be employed to reduce energy consumption and lengthen the lifetime of WSN. Numerous routing techniques with dissimilar features are proposed in the literature to design an energy-efficient WSN. The Oppositional Lion Optimization *algorithm (OLOA) based routing technique called OLOA-R to select the optimal routes based on energy consumption, residual energy, and distance between nodes. The proposed algorithm has been simulated and the simulation outcome shows the improved performance over the compared methods in a significant way. The BSO algorithm is presented to enhance the effectiveness of the swarm optimization by the foraging principle of beetles. The presented model chooses the possible routes to destination based on the fitness function involving residual energy, distance to base station (BS), and node degree. Besides, the presented model follows hybrid data transmission process where the data is transmitted at periodic time duration and reactive way. Moreover, a thresholding mechanism is applied for reactive data transmission. This process helps to balance the load properly and thereby achieves energy efficiency.*

Keywords : Wireless Sensor Networks, Routing, Beetle Swarm Optimization, Thresholding Concept, Quantum Computing, etc.

I. Introduction :

The applications of WSN in diverse fields become practical due to the versatile behavior of sensors. WSN is constrained with massive number of autonomous sensor nodes endure arbitrary use in the sensing field. It is commonly used for data gathering or target tracking applications where human involvement is very difficult. Since the sensor nodes are smaller in size and are connected in a wireless medium, it is limited by energy, bandwidth, memory and processing capabilities. Practically, sensor nodes are deployed with limited power supply in terms of inbuilt battery, it should sustain for a longer time period based on the application at a stretch without any intervention. For example, a WSN is deployed by a team of engineers on a small island ten miles off the coast of Maine to explore the nesting behavior of petrels. The aim of routing protocols for WSN is quite challenging due to multiple features that separated them, from wireless infrastructure-less networks. Some varieties of routing challenges engaged in WSN. A few major challenges are revealed under : It is nearly complex to assign a universal recognizers system to huge amount of sensor nodes. Thus, wireless sensor motes are not proficient of utilizing usual IP-based protocols. It is progress of identified data is necessary from a number of sources to a particular base station (BS). However this is not take place in usual transmission networks. It is generated data traffic have important repetition in some of cases. As several sensing nodes is create similar data as sensing. Thus, it can be necessary to use such redundancy with routing protocols and use the accessible bandwidth and energy as efficiently as feasible. Additionally wireless motes are firmly controlled in connections of broadcast energy, bandwidth, ability and saved and on-board energy. Because of such differences, a number of novel routing protocols have been presented to manage through these routing challenges in WSN. Several approaches are available with the objective of enabling energy efficient routing to improvise the lifespan of a network. In this work, heuristic techniques are used to enhance the routing in WSN. The proposed algorithm has been simulated and the simulation outcome shows the improved performance when related with alternate models. One of the significant problems in WSN is to enhance the network lifespan if the initial node is unfit to send the data to BS. For data collection, every node is accountable for sending the data packets to BS node. The procedure of combining data intends to reduce the data traffic and power consumption by unifying various input data packets as single packets. Hence, massive applications are developed to expand the network lifespan [3]. The power efficiency is also a major issue in WSN because the sensor nodes are simulated with the help of battery. Therefore, power consumption is balanced to extend the network lifespan. The routing modules are essential in WSN due to their simplicity and their reduced power consumption, delay, Quality of Service (QoS), as well as data throughput. In this approach, green routing protocol has been developed for limiting the additional burden. It is applicable to extend the network lifespan and mitigates the load simultaneously with the help of energy effective protocol. Additionally, relay nodes are employed to transmit accumulated cluster data under the application of inter-cluster transmissions. Hence, the working function is estimated according to the protocol developed with active nodes count and neighboring protocols. As a result, the network lifetime is increased and limited the premature death of nodes. The processing time is greater in this approach. A novel quantum beetle swarm optimization based route selection and hybrid data transmission (QBSOR-HDT) protocol for WSN. The presented model chooses the possible routes to destination based on the fitness function (FF) involving residual energy (RE), distance to base station (BS), and node degree (ND). Also, the presented model follows hybrid data transmission process where the data is transmitted at periodic time duration and reactive way. Besides, a thresholding mechanism is applied for reactive data transmission. This process supports balancing the load properly and thereby achieves energy efficiency.

II. Proposed Work :

The multi hop routing in WSN is utilized for optimizing the network transmission. Usually, multi hop routing is applied for computing effectual data transmission. But power is one of the major constraints in multi hop routing. To overcome these problems, the newly developed QBSOR-HDT applies multi hop routing where the source node forwards the data to CH by using intermediate nodes within a cluster. In this approach, the solution is best route selected for data transmission. Also, optimization models apply the presented QBSOR-HDT framework according to the newly developed multi-objective FF to determine optimal hop from collection of hops in WSN. Therefore, FF value is measured to identify best solution by applying collective parameters. Thus, solution implying higher fitness value is referred to multihop routing. Finally, fitness of newly developed QBSOR- HDT is expressed as,

$$Fitness\ function = W_1 \times E + W_2 \times D + W_3 \times ND$$

Where W_1, W_2 and W_3 represents the weights, E, D, and ND show the power, inter-cluster distance, and ND correspondingly.

Energy : The summary of power in all hops is referred to be the system energy which points the RE in nodes. Hence, energy should have maximum.

Inter-cluster distance : The ratio of distance amongst 2 clusters are named as inter-cluster distance which has to be maximum to offer effectual routing.

Node degree : It describes the count of sensor nodes from CH. A CH with minimum sensors are decided as CHs with maximum Cluster Members (CM) drops the power within a short duration. And, ND is represented in the equation.

The domain of calculation method, OBL is usually executed to improve the convergence value of various optimize methods. It key objective of this technique is to consider the current population and contrast population at the same time and derive more optimize candidate solution. In recent times, various authors have made OBL method in population-relied optimize manner to enhance the convergence value. As a solution, the adverse candidate solution is placed at close to global result if related by a random candidate solution. A contrast solution of OBL is signified with small point of solution from middle of exploring space that is represented in a mathematical format. There is a point that, it OBL technique are created at early phase of LOA method and it is able of creating opposition-relied population. Subsequent with, optimal individuals have been chosen to take part in evolution of original population as well as opposition-based population. So, it enhances the variety of a population and develops the significance of LOA.

Hybrid Data Transmission :

When the data aggregation is computed by CH, hybrid data transmission is initialized. First, CHs broadcast the adjacent parameters :

Attribute (A) : It is defined as user-based attribute for accomplishing the data.

Threshold values : It is composed of Hard Threshold (HT) and Soft Threshold (ST). HT is defined as specific parameter value and value that exceeds HT is transmitted. Thus, ST refers a small difference in parameter value, which simulates the data transmission.

Schedule : In scheduling process, Time-division multiple access (TDMA) is applied in that a slot has been declared for all nodes.

Timer : It describes greater duration among 2 subsequent reports forward by a node. It has several TDMA schedule lengths and employed for proactive data conversion.

Under the application of hybrid data transmission, irregular and repeated data transmission is ignored. Finally, higher power efficiency and throughput enhancement have been accomplished.

III. Analyzing the Efficiency :

To highlight the effectiveness of the OLOA-R, a series of experiments are done under different testing scenarios. A number of performance measures is used, to validate the effectiveness of the proposed method are listed below : Average energy consumption- It measures the total amount of energy, on average, spent with every sensor nodes in every round. First Node Die (FND)- It indicates the round number in which the first node in WSN depletes its total energy. It is helpful to determine the amount of time period that the network is completely operative. Half Node

Die (FND)- It represents the round number in that the half of the total nodes in WSN depletes its total energy. First Node Die (FND)- It denotes the round number in that the 100% of the sensor nodes in WSN depletes its total energy. It is helpful to determine the actual round number that the network becomes completely inoperative. For validating the consistency of the proposed method, it is rested in 3 various scenarios based on the place of BS which are represented by S1, S2 and S3 correspondingly. S1- BS is placed at the centre of the target area, S2- BS is placed at the corner of the target area, S3- BS is placed distant from the target area. The QBSOR-HDT model is executed by applying MATLAB R2014a. In order to point the efficiency of QBSOR-HDT, series of processes has been performed under various testing scenarios. In order to validate the consistency of QBSOR-HDT approach, it is sampled in 3 diverse scenarios on the basis of BS as depicted by S1, S2, and S3 correspondingly. The proposed method is implemented using MATLAB R2014a. For simulation, 300 nodes are deployed arbitrarily in the target area of 100 ×100m. Moreover, the first order radio energy model is used with the following parameters: Eelec = 50nJ/bit, Efs = 10pJ/bit/m2, Emp = 0.001310pJ/bit/m4 and EDA = 5nJ/bit/signal. The simulation setup is tabulates in Table. A set of five clustering methods are utilized to comparative function. To ensure the effective performance these protocols, the average energy utilization of S1, S2 and S3 are computed and are depicted in the figure mentioned. The energy consumption is determined by computing the total amount of energy utilized by every sensor node, on average in every round. The presented technique seems to be highly energy efficient than the compared algorithms. This is because of the fact of effective forwarding set selection using OLOA-R. It assures that the node with higher energy and lower distance will be elected as relay nodes. It eventually reduces the amount of energy spent for data transmission. LEACH depicts worst action than other techniques as the subsequent features: random selection of routes makes it possible for any node to become CH more than once or a node with lowest RE can also become a CH. It also does not consider any parameters which are essential in the optimal path selection process. Furthermore, the absence of multi hop data transmission produces higher amount of energy utilization. The reactive nature of the TEEN protocol results in lower energy consumption than LEACH and at the same time the single hop data transmission makes it to fail when compared to DEEC, EAUCF and presented algorithm. Though EAUCF utilizes fuzzy logic for CH selection, probability based tentative CHs selection degrades the overall performances. Here, the power utilization is estimated by processing the overall power consumed by a sensor node, for all iterations. Hence, the newly developed framework is considered as energy effective when compared with traditional methodologies. It is due to the fact of productive forwarding set selection with the help of QBSOR-HDT. It makes sure that a node with maximum power and minimum distance would be selected as relay nodes. Eventually, the volume of energy expended for data transmission is reduced. LEACH demonstrates poor action when compared with alternate models by means of features like random routes selection makes feasible transmission for a node to become a CH when a node with minimum RE is considered as CH. Also, CH does consider parameters which are suitable for best path selection. Moreover, the inexistence of multi hop data transmission generates maximum power consumption. The reactive behavior of TEEN protocol intends in minimum power utilization when compared with LEACH and simultaneously the single hop data transmission tends to fail than DEEC, EAUCF, and QBSOR-HDT models. Even though EAUCF applies FL for CH election, probability based tentative CHs selection reduces the complete performance. Afterward, network lifespan is an important factor for calculating the movement of clustering in WSN. Network duration is called a number of rounds completed until the nodes in WSN drain the energy.

IV. Experimental Results and Discussion :

To highlight the effectiveness of the OLOA-R, a series of experiments are done under different testing scenarios. A number of performance measures is used, to validate the effectiveness of the proposed method are listed below : Average energy consumption- It measures the total amount of energy, on average, spent with every sensor nodes in every round. First Node Die (FND)- It indicates the round number in which the first node in WSN depletes its total energy. It is helpful to determine the amount of time period that the network is completely operative. Half Node Die (FND)- It represents the round number in that the half of the total nodes in WSN depletes its total energy. First Node Die (FND)- It denotes the round number in that the 100% of the sensor nodes in WSN depletes its total energy. It is helpful to determine the actual round number that the network becomes completely inoperative. For validating the consistency of the proposed method, it is rested in 3 various scenarios based on the place of BS which are represented by S1, S2 and S3 correspondingly. S1- BS is placed at the centre of the target area, S2- BS is placed at the corner of the target area, S3- BS is placed distant from the target area. The proposed method is implemented using MATLAB R2014a. For simulation, 300 nodes are deployed arbitrarily in the target area of 100 ×100m. Moreover, the first order radio energy model is used with the following parameters: Eelec = 50nJ/bit, Efs = 10pJ/bit/m2, Emp = 0.001310pJ/bit/m4 and EDA = 5nJ/bit/signal. The simulation setup is tabulates in Table

Table 1 : Comparison of various Algorithms in Terms of FND, HND and LND Algorithm

	Scenario 1			Scenario 2			Scenario 3		
Algorithm	FND	HND	LND	FND	HND	LND	FND	HND	LND
LEACH	802	1126	1278	542	849	1024	452	614	857
TTEN	1024	1089	1327	768	889	1124	389	602	945
DEEC	1088	1102	1386	948	1041	1206	894	948	986
EAUCF	1342	1496	1532	1196	1274	1304	941	988	1035
T2FLCA	1501	1689	1896	1278	1436	1611	1064	1195	1379

V. Conclusion :

Several approaches are available with the objective of enabling energy efficient routing to maximize the network lifetime. This paper has presented an effective OLOA-R technique for the optimal selection of routes on energy consumption, residual energy, and distance between nodes. To highlight the effectiveness of the OLOA-R, a series of experiments are done under different testing scenarios. A number of performance measures are used, to validate the effectiveness of the proposed method. The proposed algorithm has been simulated and the simulation outcome shows the improved performance over the compared methods in a significant way. In future, the performance of the OLOA-R can be increased by the use of unequal clustering techniques.

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