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Analysis of Energy Efficiency Routing Protocols for Wireless Sensor Network

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Abstract: A Wireless Sensor Network (WSN) is a collection of tiny power, multifunctional, and communications nodes that observe and records one or more parameters at distinct places. Then, it converts recorded data to signals that can be processed. Such nodes are randomly implemented on a large or small scale, this becomes a significant field for study because these networks are used today in numerous consumer and industrial applications, for instance in healthcare, industry, transport system, government security, military systems, agriculture, and underwater sensor systems [1, 2]. The deployment of a huge amount of sensor nodes may enable greater monitoring with high accuracy, but it can be very costly or even impossible to charge or replace batteries because of the challenging deployed environment. These scattered sensor nodes are capable of collecting and transferring data back to an internal base station (BS) or other sensors, sending and receiving information drain node's energy. Therefore, the best way to improve the life of WSN is by selecting information transfer paths to minimize the complete drainage of energy along the route and to balance the load between the nodes [3]. The BS can be either a mobile or a fixed node that connects the sensor network to a current infrastructure for communication or the internet. Since the WSNs have become an important element of the modern infrastructure of communication. To transmit information to their destination effectively, the power consumption and maximize network lifetime have become the critical parameter in routing protocols [4].

Keywords: Sensor nodes, base station, Signals, Consumption, protocols, WSN.

I. INTRODUCTION

The advent of the computer and invention of communication network is raised and it made the transformation in information processing. The functionalities of network have been implemented by many of the professionals, government organization and industries. The connection of network is accomplished in two ways that is wired connection and wireless connection. The wired connection is established through cables and the wireless communication is established by transmission data through waves. To handle the rapid increasing of mobile and laptop usage, wireless technology has introduced for communication and transmission of data. In addition to that efficiency and capacity is increased by advancement of the wireless technology.

II. LITERATURE REVIEW

Muhammad Akram et al. (2016) [61] developed a new fuzzy rule-based inference model for network security in which the system selects some intermediate and verification node which is adaptive in nature with respect to data delivery. They considered the three network parameters namely the residual energy, the proximity of the intermediate node to the original cluster and the attack frequency in the network as evaluation parameters and proved that their model is more efficient with respect to energy conservation and also guarantees sufficient protection against network attacks. Zhao Han et al. (2014) [62] proposed a new routing protocol called General Self-Organized Tree-Based Energy-Balance routing protocol which was developed using a hierarchical modeling. Moreover, the tree based model developed by them uses a base station as the root node and sensor nodes as children nodes. Degan Zhang et al. (2014) [63] proposed a new energy balanced routing algorithm in which the author has used forward aware factor for making routing decisions. Moreover, the next hop node is selected in their model based on the awareness of link weight and forward energy density. In addition, a spontaneous reconstruction mechanism is proposed by the authors by using a new method for designing the network topology dynamically. Behrouz Maham et al. (2011) [79] proposed a cooperative protocol for outage restricted multi-hop wireless ad hoc networks. The proposed protocol allocates power, based on channel statistics and utilizes distributed space-time codes for efficient cooperative transmission. The proposed protocol achieved up to 72% of energy saving at an outage probability of 10^{-3} when compared to non-cooperative multipath routing. An optimal power control algorithm to maximize power efficiency for a given QoS in wireless sensor networks was proposed by Di Wang et al. (2011) [80]. Hongli Xu et al. (2013) [81] studied the problem of constructing an energy efficient topology in wireless sensor networks using V-MIMO communication. They proposed V-MIMO topology control algorithm which involves joint optimization of V-MIMO, partner selection and topology control.

They achieved 32% reduction in the power consumption when compared to the existing algorithms. Muhammad Kamran Naeem et al. (2014) [82] proposed a cooperative transmission and resource selection scheme for collaborative wireless sensor networks. Energy conservation is obtained by selecting optimal number of cooperating nodes. Yuyang Peng et al. (2016) [83] proposed an energy efficient scheme which combines the concept of combining cooperative communication with spatial modulation of randomly distributed nodes for an ad hoc network. They developed an adaptive algorithm which finds the optimal number of hops while considering the circuit and transmission energy consumption.

III. METHODOLOGY

1) Energetic Routing Technique using Latency wise Node Selection

Wireless sensor networks are widely utilized in the process of sensing diverse applications namely healthcare observation and monitoring of the atmospheric condition. Sensor nodes are always stable, whereas these nodes are constantly deployed in a specific location. The energy level of each sensor node is vital in performing the assigned work and it assures the working condition of the node. In the communication procedure across the network, it depends on two modes, namely inactive and energetic state. Some critical condition in the data transmission environment causes nodes with minimum energy can act as an active and proceed packet sharing, and this node suddenly drops the level of energy, which makes the packet transmission failure.

The transmission failure and the maximum energy utilization is caused in the transmission environment. This increases energy consumption, network overhead, and the end to end delay. Hence, the Energetic Routing Technique (ERT) is used to obtain energy-efficient communication in the wireless environment. The proposed ERT efficiently monitors the low energy nodes and provides the high energy neighbor node list for further packet forwarding in a sensor network and constructing the latency wise promote node selection algorithm, which is applied to remove maximum delay node, also choose lesser delay node for packet forwarding.

The Energetic routing Technique (ERT) is applied to provide energy efficient packet transmission in the wireless environment. Unexpectedly a waken by low energy nodes are observed efficiently by using ERT, and achieve the maximum energy level of neighbor node list for more packet sharing along with the sensor network. Designing the latency wise promote node selection algorithm is used to reject the higher delay node, also select lower delay node for the communication process. This reduces the energy consumption, network overhead, and end to end delay.

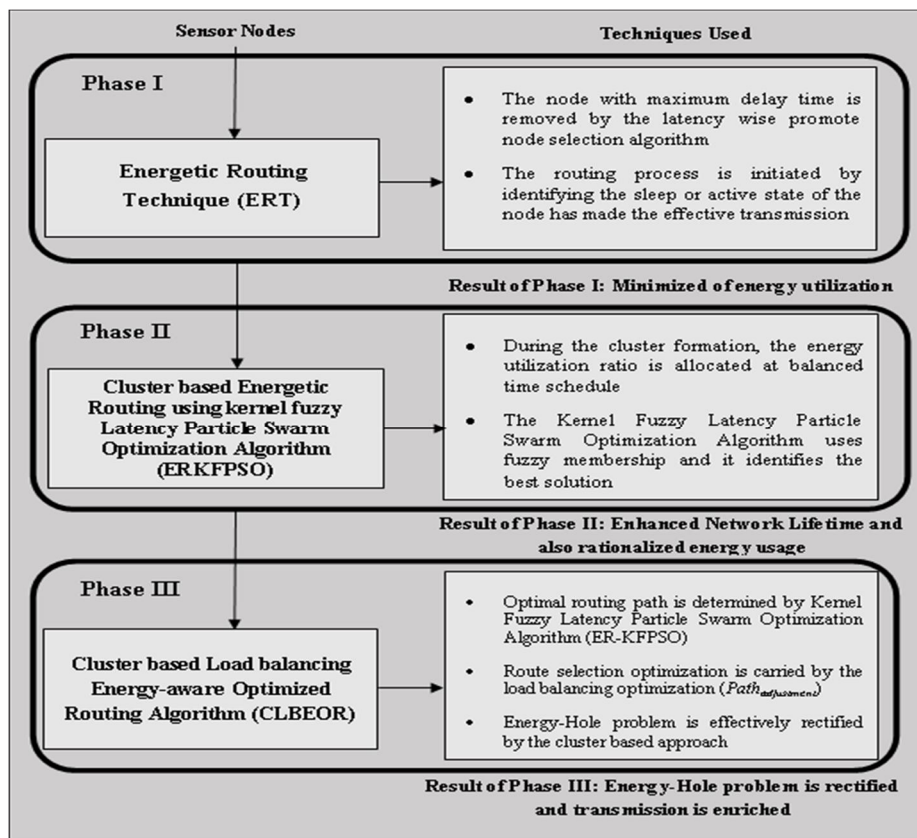
2) Cluster-based Energetic Routing using kernel fuzzy Latency Particle Swarm Optimization Algorithm (ER-KFPSO)

To attain the energetic routing diverse techniques were proposed and the developed techniques make significant progress in stabilizing the energy level as it is a vital parameter of a WSN. In the existing method particle swarm optimization based nodes and lifetime prediction method through linkage (PNLP) [7], the energy usage and lifetime of the network is not effective. In this phase, an Energetic Routing which is based on the Kernel Fuzzy Latency PSO (ER-KFPSO) is proposed, which considers the network lifetime and the energy rationalization. Load balancing methods along with energetic routing is utilized at the time of clustering. An Energetic Routing which is based on the Kernel Fuzzy Latency PSO (ER-KFPSO) supports the minimum energy consumption in WSN that plays a vital role in the improvisation of the lifetime of the network. The proposed method assists in shaping the clusters by making use of the energy fitness value along with the assignment of CHs.

The proposed method ERKFPSO is performed through a clustering framework that plans to allocate energy utilization among clusters at a balanced time and thus expands networks' lifetime. The objectives of the proposed algorithm are to reduce energy utilization of sensor devices, diminish latency and message overhead of real-time data access and exploit the lifetime of WSN. In a cluster, there exists a particular node that is the center of the sub-graph called head and is linked to all other nodes called cluster members to form a network topology.

In wireless sensor networks, the achievement of the selection of CHs algorithm based on the fitness weight function considered to select the nodes as CHs. A novel fitness function is planned for CHs selection. This function includes the two-considerable feature of WSN s.i.e. initially, the energy utilization among CH and sensor nodes; next, the sum of energy utilization for combining the data at CH's stage plus broadcasting the message to BS. The energetic routing technique process is used to discover the uses connected to the smart node, where real-time data packet observation is essential in the transmission process.

The Kernel Fuzzy Latency Particle Swarm Optimization Algorithm uses fuzzy membership particles that update their location qualified to the location and speed of the cluster. To find the best solution is attained from the group of randomly created primary explanations by moving particles approximately in the found space, which discovers the best solution by swarm's subsequent the finest particle. Every particle has a particular velocity and location in every iteration a novel velocity rate is considered and it is used to update the particle's location. By following this procedure data transmission is achieved effectively.



The integration of KFPSO in Energetic routing increases the performance of the energy-efficient LEACH method considerably

3) Cluster-based Load balancing Energy-aware Optimized Routing Algorithm (CLBEOR)

In WSN, sensor nodes are considered to have a short life duration appropriate to continuous sensing, and consequently, the battery drains quickly. Under the heavy load, energy utilization condition sensors in closer proximity to Cluster Head expire quickly and initiate the energy-hole problem. Thus, optimal usage of available energy is a key challenge in WSN assisted applications. To overcome the issues, a Cluster-based Load balancing Energy-aware Optimized Routing Algorithm (CLBEOR) with Energetic Routing aware Kernel Fuzzy Latency Particle Swarm Optimization Algorithm (ER-KFPSO) proposed, and it is performed with four major steps; Clustering, CH selection, Energy Utilization, and optimization-based route identification for data transmission. It focuses on the problem of traffic overloading near the sink. It has been elaborated in four steps: network setup, energy model, node clustering, and route identification.

The network setup phase explains the sensor network creation and deployment. The energy model analyses the energy consumption while transmitting data over the nodes. The node clustering and CH selection explains grouping the nodes and creating clusters in the network. In the route identification phase, the optimal path for transmitting the data will be identified by using the KFPSO algorithm. The proposed load balancing optimization (*Path adjustment*) is used for optimal route selection from the cluster head to the sink node. The proposed approach shows an improvement in terms of packet delivery ratio and packet delay ratio as compared to other existing PNL and KFPSO algorithms.

IV. RESULTS AND DISCUSSION

The proposed approaches were simulated using Network Simulator Tool (NS 2.34). The WSN is represented by 100 mobile nodes that are deployed in $820 \times 620 \text{ m}^2$ square regions. The base station is located at (50,175). The initial energy is 5 J for each sensor node. The simulation of the proposed approaches is running at an average of 20 times. The proposed mechanisms have been evaluated against three different performance metrics packet delivery ratio, end to end delay, and network lifetime.

Packet Delivery Ratio is a ratio of the total number of packets received at the destination to the number of packets sent from the source. The packet delivery ratio of the CLBEOR mechanism is high when compared to the other two proposed mechanisms as shown in Figure 2.

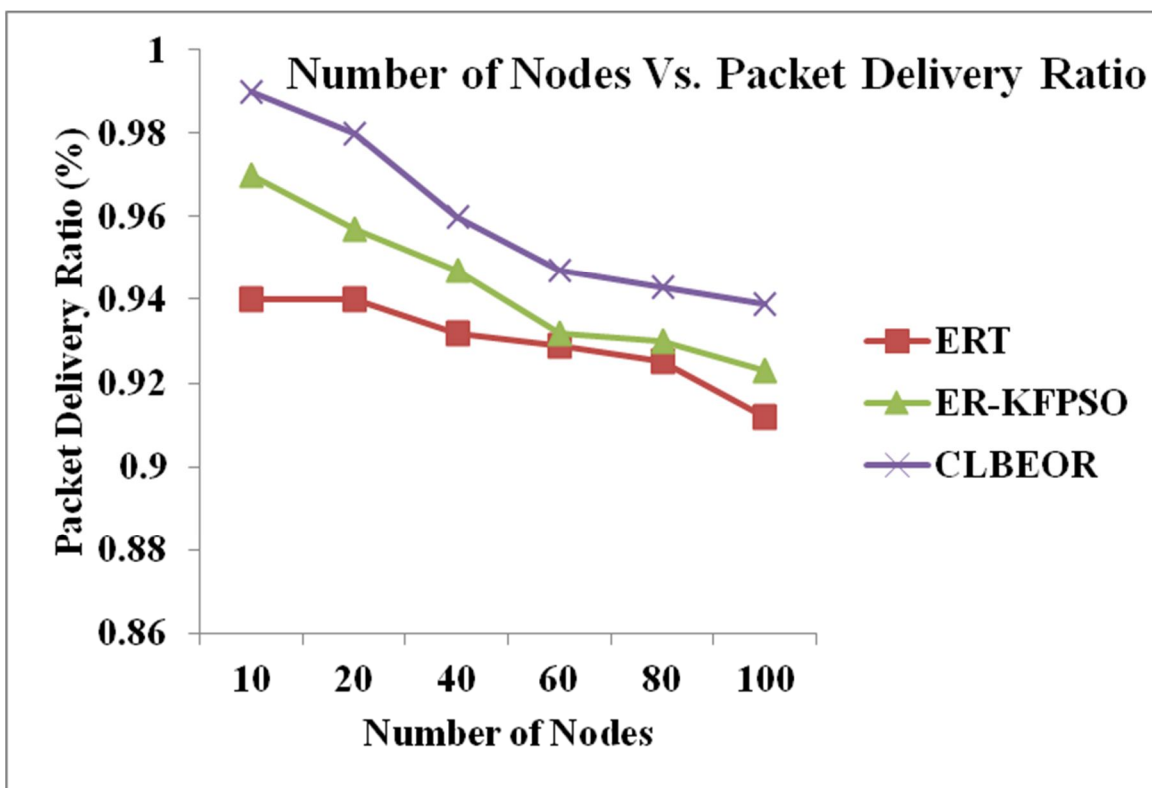


Figure2.NumberofNodesVsPacketDelivery Ratio

End to End Delay is estimated by the amount of time used for packet transmission from the source node to the destination node. The end-to-end delay of the CLBEOR mechanism is less when compared to the other two proposed mechanisms as shown in Figure 3.

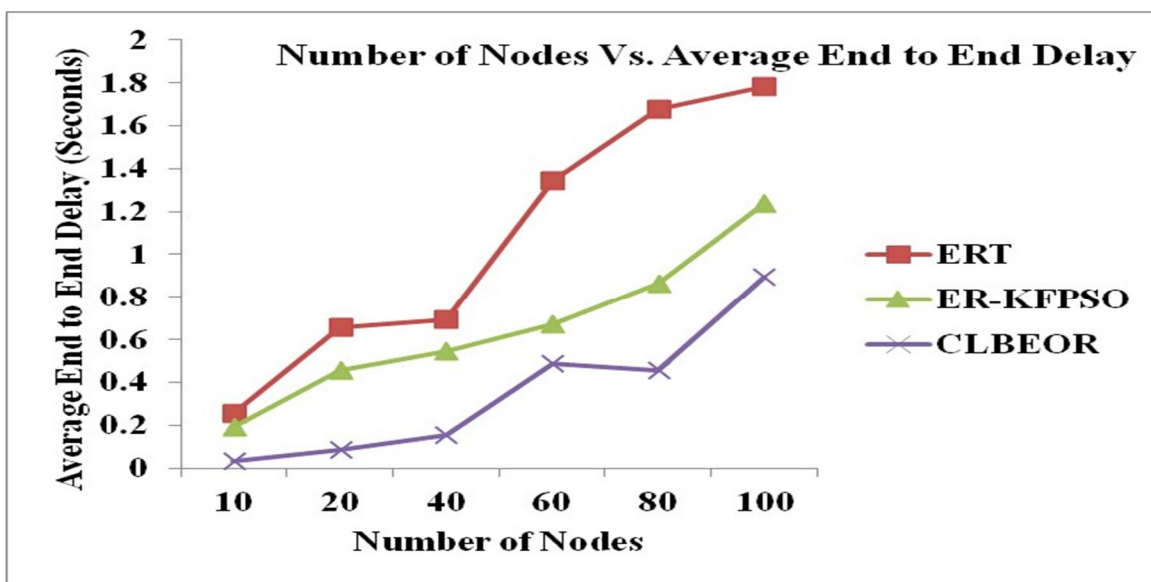


Figure3.Numberof NodesVsEndto EndDelay

Network Lifetime is measured by nodes process time taken to utilize network from overall network ability. The network lifetime of the CLBEOR mechanism is comparatively high when compared to the other two proposed mechanisms as shown in Figure 4.

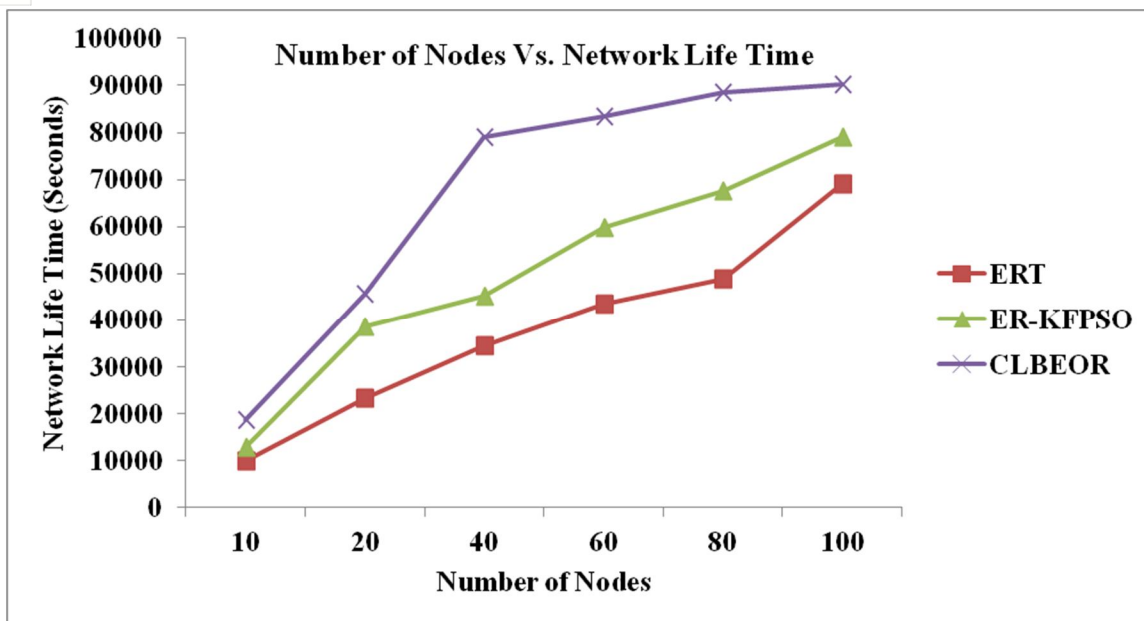


Figure4.NumberofNodesVsNetworkLifetime

V. CONCLUSION

The network of WSN is comprised of several sensor nodes with constrained resource and they are installed with non-rechargeable batteries. The sensors in the WSN consume more energy during transmission rather than computation. It increases energy consumption and drops the data packet, whereas the communication process is interrupted. Retransmission makes the maximum network overhead and an end to end delay is increased. Under the heavy load, energy utilization condition sensor in close proximity to CH expire quickly and initiate the energy-hole problem. By considering all these drawbacks, this research work is formulated. The Energetic Routing Technique (ERT) is used to provide energy-efficient packet transmission in the wireless environment. This process minimizes the utilization of energy, delay, and network overhead.

The Energetic Routing which is based on the Kernel Fuzzy Latency PSO (ERKFPSO) is performed through a clustering framework that plans to allocate energy utilization among clusters at a balanced time and thus expands network lifetime. The Cluster-based Load balancing Energy-aware Optimized Routing Algorithm (CLBEOR) with Energetic Routing aware Kernel Fuzzy Latency Particle Swarm Optimization Algorithm (ER-KFPSO) is proposed to support the energy consumption in WSN. The CLBEOR algorithm uses an energy-efficient cluster head selection method based on multiple objectives like proximity, cost, residual energy, and coverage. The proposed load balancing optimization (*Path adjustment*) is used for optimal route selection from the cluster head to the sink node. The performance of the proposed ERT, ERKFPSO, and CLBEOR are compared and the effectiveness of the result is investigated.

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