ER-KFPSO: Energetic Routing Technique Based Kernel Fuzzy Latency Particle Swarm Optimization Algorithm in Wireless Sensor Network

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Abstract: The applications of Wireless Sensor Networks in the recent times are wide in various places in sensor forms. Subsequently, the routing has to be done in a more energetic manner in line with the mobility and not compromising the QoS. Various techniques were proposed for the energetic routing in order to make a significant progress in the stability of the energy as it is a vital parameter of a WSN in times of data transmission for communication. These techniques are used for the life time enhancement of the sensor networks. Load balancing methods along with energetic routing are made used at the time of clustering. This article proposes an Energetic Routing which is based on the Kernel Fuzzy Latency PSO (ER-KFPSO) for supporting the energy consumption in Wireless Sensor Networks for improvisation in the life time of the network. The proposed method gives assistance in shaping the clusters by making use of the Energy Fitness value along with assignment of CHs. The proposed technique achieves better results on experiments when compared with the other existing methods that uses Particle Swarm optimization based nodes and life time prediction method through linkage (PNLP).

Keywords: Quality of Service, Wireless Sensor Networks, Energetic Routing, Particle Swarm optimization, Cluster Heads.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are dense ad hoc networks of (SNs), resource-confined sensing basics prepared with transmission channels, where methods for network self-association and routing of messages are frequently employed [1]. In various WSNs, a distinct sink node is dependable for gathering data from all sensors. Frequently the sink node also proceeds as a Base Station (BS) for system and sensor managing. There are several fundamental differences among conventional wireless ad hoc networks and WSN that create conventional ad hoc network protocols inappropriate for WSN applications. The tests for a WSN's are energy competence or efficiency [2]. Energy-efficient routing protocols try to decrease the energy utilization by corresponding above routes with least cost, so escalating the duration of battery-driven SNs.

Still, it is essential to obtain into account that WSNs typically transmit heterogeneous traffic [3] in which two special communication models can be distinguished. The models match to communications among the BS and the sensor nodes, and also to interactions among the neighboring nodes. The different characteristics of the two types of traffic require to be measured in designing a routing protocol for

sensor networks.To aiming an efficient-energy routing procedures is one of the solution concerns in WSNs. One time allocated in the network, sensor nodes cannot be restored. Hence, network procedure is extremely connected to the sufficient exploit and executive of nodes' control. One of the hierarchical routing protocols in WSN's are measured as the majority energy-efficient schemes that have been extensively applied in the precedent few years [4]. To separate the network into sequence of clusters, all of which has a cluster head (CH) portion as middle among the cluster nodes (CN), also called member nodes (MN), and the base station [5]. The CH has the highest energy stage in the cluster; it collects packet, aggregates them and distributes them to the BS in a method that reduces the generally energy consumption in the network. Figure 1 depicts the graphical model for cluster network.
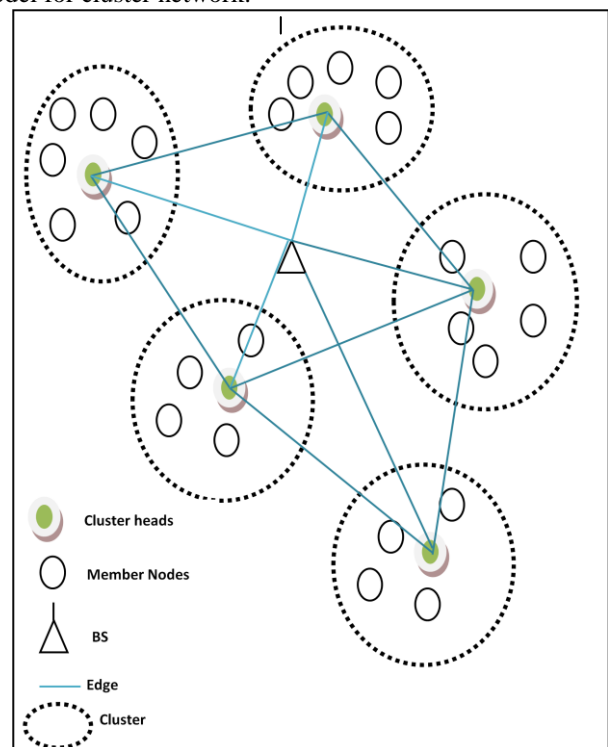

Fig. 1: Graphical representation of a cluster heads network

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The use of cluster based wireless sensor networks is increasing day by day and at the similar point it appearances the difficulty of power restrictions in terms of imperfect battery period. As every node depends on energy for its behavior, this has happen to a key problem in WSN. The collapse or malfunction of single node can suspend the whole structure.

Each sensing node can be static (getting and broadcast behavior), inactive and sleep manners. In active method nodes guzzle energy when getting or broadcasting packet. In inactive mode, the nodes guzzle roughly the similar quantity of energy as in active mode, as in snooze mode, the nodes blackout the radio to keep the energy.

The aim of the proposed work is mainly to give an extension of the Energetic Routing which is based on clustering by making use of the KFPSO for effectively improving the life time of the WSN.

The remaining content of the paper are organized as follows: Section 2 deals with the existing methods given as literature surveys, Section 3 describes the proposed method and section 4 discusses the experimental results followed by conclusion.

II. LITERATURE REVIEW

(*Tang et.al.,* **2012 [6]**) introduced a technique called CCM (Chain Cluster based Mixed Routing) that exploits of the benefits of LEACH and PEGASIS, and present an enhanced presentation. It separates a WSN into a little chain and executes in to some points. In the initial point, the nodes of the sensor in each chain broadcasts the data to the respective chains' head node in equal partition by use of chain routing in an efficient way. Subsequently, all the chain head nodes forms a group as a self-contained approach from where the broadcasting of complex data takes place to the CHs by the use of cluster dependent routing.

(Zhu Yong and Qing Peia**, 2012 [7]**) discussed the trouble of incomplete energy of sensors in WSN, based on the traditional clustering routing technique LEACH, a distance-energy cluster structure method believing equally the distance and remaining energy of nodes is vacant in the exposition, which progresses the procedure of CH determination and the procedure of data communication. It decreases the undesirable consequence on the energy utilization of the CH, resulting from the non-uniform distribution of nodes in network and circumvents the express communication among the base station (BS) and CH, which might has small energy and distant away from BS.

(Duc ching, Rajesh, Sanjib and panda*,* **2013 [8]**) Investigated on the real time execution of the energy aware cluster centric protocol for the WSNs. The proposed configuration of the apt clusters are of major impact for the energy sustainability and makes use of the sensor nodes inside each cluster of the WSNs. This invokes the energy conservation in the sensor nodes which consequently increases the life time of the network. Fuzzy C-Means clustering procedure was used for this purpose.

(*Dilip Kumar*, **2014 [9]**) discussed the hierarchical routing with the design of clustering similar to HEED, LEACH, DEEC and SEP and are previously well known as the most

excellent protocols to present energy efficiency. They presented examination the efficiency of these routing protocols, and conversation about their qualities and limitations in different circumstances. Moreover, evaluations of these protocols expressions of packet transmission, energy consumption, and network duration with an entire performance examination and simulation are examined.

(R.K. Yadav, Varun Kumar, and Rahul Kumar, **2015 [10]**) illustrated that clustering is an extensively utilized mechanism in WSNs to decrease the energy utilization by sensor nodes in data communication. Partitioning the network into finest amount of clusters and choosing a best group of nodes as CHs is an NP-Hard problem. The NP-Hard environment of clustering issue builds a suitable candidate for developing an evolutionary technique and PSO. The authors have suggested that PSO centric solutions offer the fine clustering which enhances the residual energy and the distance through the communications are done between any sensor nodes.

(D. Rajendra Prasad, P. V. Naganjaneyulu and K. Satya Prasad, **2016 [11]**) discussed a node duration differs depending on the basics predictable of its battery. Therefore, key aspect in building sensor networks is flexibility to compact with reducing lifetime of every sensor nodes. Different network infrastructures as well as their routing protocols for decrease of power consumption as well as to extend network lifetime are considered. Following examination, it is practical that network structures that depend on grouping the most efficient techniques in provisions of power consumption. Clustering splits networks into consistent clusters such that all clusters have numerous sensor nodes with a CH at its head. Sensor collected the information was broadcasted to data processing centers through CH hierarchy in clustered surroundings.

(*Santar Pal Singh and SubhashChander Sharma*, **2017 [12]**) discussed a Wireless Sensor Networks (WSNs) have fascinated group of kindness from the controlled and technical society. The distributed characteristics and active topology of sensor networks begins very unusual requirements in routing systems that believed to be met. The explanation feature of efficient routing protocol is energy overheads and addition in lifetime of network. In precedent years, different routing algorithms have been obtainable for WSNs. The authors focused on cluster based routing algorithms and suggested a novel algorithm for routing in WSNs.

(Jayprakash, Radha and Balasubramaniam*,* **2018 [13]**) discussed on the collection of networks that is privacy preserved and the CHs are reliable for the communication purpose that connects with the cluster that induces further energy in the assignment of CMs within a cluster. The consistency of the network is a tedious job as the message communication within a cluster is extremely testing. A cluster centric and privacy aware routing protocol which uses a mixed algorithm was proposed inside and outside the clusters, a protocol was proposed that is cluster aware.

The protocol was based on the CH selection and is completely based on the source of routing and on-demand procedures. The choice of the routing was implemented and tested across different applications that are varied from the on-demand source nodes discussion in-between the nodes in a potable sensor network.

(N. Deepa and D.Devi, **2019 [14]**) proved that the WSN consists of many independent devices that are spatially scattered and uses sensors together in monitoring the environmental variables such as the noise, pressure and temperature and also its motion and pollutants. The WSN includes an enormous amount of sensor nodes. These nodes are battery powered, power competence of the sensors is furthermore crucial. Appropriate to this the network routing procedure is executed based on two conditions namely sleep and active state. In various critical situation low energy nodes go to active state and execute communication procedures. Various sensor nodes rapidly lose energy causing message collapse. This amplifies energy utilization, network overhead, and end to end delay. Therefore they proposed Energetic routing Technique (ERT) is used to attain the energy efficient communication in wireless surroundings. This ERT efficiently monitors the low energy nodes and presented the elevated energy neighbor node list for additional packet promoting in sensor network and Constructing the Latency wise promote node selection algorithm is applied to eliminate maximum delay node, also choose lesser delay node for packet forwarding. Consequently it reduces the energy consumption, network overhead, and end to end delay.

III. PROPOSED METHODOLOGY

The proposed method of Cluster based Energetic Routing using kernel fuzzy Latency Particle Swarm Optimization algorithm (ERKFPSO) is performed through a clustering framework which plans to allocate energy utilization among clusters at a balanced time and thus expand networks' lifetime. The objectives of the proposed algorithm is to reduce energy utilization of sensor device, diminish latency and message overhead of real-time data access and exploit lifetime of WSN. The figure 2 describes the proposed method flow process.
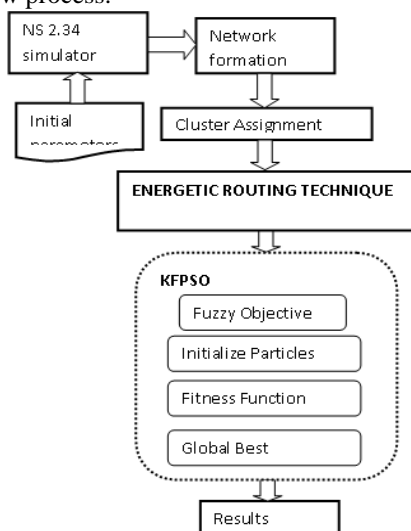

Fig. 2: Proposed Flow Diagram

A. Network Formation

A dynamic WSN is characterized during the formation of the network through an undirected graph that is represented using G = (SN, L), where SN denotes the group of senors and L represents the collection of the links in-between the SNs. The link that exists among the other sensor nodes x and y in a G, if the nodes x and v are in the range of communication to all other. The underlying theory of a WSN G can be described as

- Nodes have the unique IDs. Before the fusion happens, the nodes do not have any awareness on the network other than its unique ID. When the nodes leave away from the network, the complete information except the ID is removed.
- Inside the network, the base station shall exist in prior to the link that takes place and BS is already set.
- A particular node can duplicate the broadcast or the response and shall execute a local calculation which is co-ordinated and fixed interval of time. Each period, a single node can be either active as a transmitter or a receiver or not as both in a given time. The overall gaps for gathering the packets or data into a sink are termed as round.
- Collision detection is not present in the network
- The data among the nodes are symmetric and all the nodes that are adjacent can communicate with each other. It shows that if a particular node y would allow packets from a given node x, then x also permitted to accept messages from y.

Nodes in graph *G* are divided into groups, called as clusters. i.e., a cluster is an initiate sub-graph of *G*. In a cluster, there exists a particular node which is the center of the sub-graph called head and is linked to all other nodes called cluster members to form a network topology.

B. CLUSTER ASSIGNMENT

In Wireless sensor networks, achievement of the selection of CHs algorithm based on the fitness weight function considered to select the nodes as CHs. In this section, a novel fitness function is planned for CHs selection. This function includes the two-considerable feature of WSNs i.e. initially, the energy utilization among CH and sensor nodes; next, the sum of energy utilization for combining the data at CHs stage plus broadcasting the message to BS. The energy utilization among sensor nodes and CHs is calculated using equations 1 to 4.

$$Eg(i) = \sum_{j=1}^{J} \sum_{\forall n_{j_i} \in j} \left\{ \frac{Eg_{j_i - w_{fitness(j_i)}}}{Eg_{max} - Eg_{min}} \right\} \times j_i \quad eqn.(1)$$

$$W_{fitness}(j_i) = Ol(i) + WT + D_C + R_M \quad eqn.(2)$$

$$WT = WT_{max} \left[1 - \frac{Eg_{residual}}{Eg_{initial}} \right] \times Avg(v_j^i) \quad eqn.(3)$$

$$D_C = \left(\frac{n_i}{dist(i,j)} < tr_{range} \right) \quad eqn.(4)$$

Where, *Ol* is Operation level; *WT* is the time of weight of the node.

If at all the node itself to be supposed to form a cluster head, D_C *represents the connectivity degree.* (i.e. to identify the neighbor of each nodes in a given range of communication such that , $i \neq j$ is the range of transmission of the node and depicts the distance between the nodes) R_M denotes the relative mobility among the nodes and CH but not the summation of vectors of various velocities. At last, the node with has maximum weight are chosen as the cluster head for a given round. The benefit of such a technique is to give position which has the constraint of weights and can be then adjusted as per the constraints of the network.

ALGORITHM 1: CLUSTER ASSIGNMENT

Input: Unique ID of node , Weight

Output: Selection of CHs

Process

Step 1 : N nodes deployment

Step 2 : for k =1 ; N DO

    if Eg >0 and $| r |(1/p) \neq 0$

    Compute Ol = $1/Trust_{i,j}(t)$

      if $Ol > 0.75$ **then**

      cruel node declaration and do not allow to participate in the selection of CHs.

      Else

      Computer Time for waiting using (3);

      Compute connection degree using (4);

      Compute Relative Mobility

      End

    End

Step 3: Calculate $Weight_{fitness}$ (j_i) for present round

Step 4: for m =1:N **do**

    If $Eg(Weight_{fitness}$ (i)) $\geq Eg(Weight_{fitness}$(i+1)) **then**

    CH_i = true;

    Broadcast an announcement message

    Else

    CH_i = false;

    End

C. ENERGETIC ROUTING TECHNIQUE

The energetic routing technique process is used to discover the uses connected to smart node, where real time data packet observation is essential was already presented by (*N. Deepa and D. Devi Aruna*, 2019). In this model, the system will described a network with the following assumptions:

- The route or direction for communication using node energy Level Based Routing scheme follows ranking based nearest neighbouring node.
- The direction begins from origin node to the target node. The adjacent node to the target node in the related energy level is particular as the active node from which message is observed.
- Respectively, the procedure is frequent from the nearest neighbour node choose turn over the origin node to make a decision the entire route.

D. KERNEL FUZZY LATENCY PARTICLE SWARM OPTIMIZATION ALGORITHM (KFPSO)

In shortest path routing algorithm, Base Station discovers the closer CH with respect to its current point, during which it movements and gathers the message from high energy nodes merely. In this work, Latency is define by how much occasion a node obtains to sense, or observes and correspond the movement. Sensor nodes gather information, development it and send it to the target node. Latency in a system is considered based on these behaviors as well as how much duration a sensor takes to promote the data in heavy load traffic or in a small density network. So, the fuzzy latency Particle swarm optimization (FLPSO) is influenced by behavior of sensor nodes in a group. In this method, fuzzy membership particles update their location qualified to the location and speed of the cluster.

The proposed Fuzzy latency PSO which varies from normal PSO in only single respect: in each neighborhood, instead of only the finest particle in the neighborhood being permitted to weight its neighbors, a number of particles in every neighborhood can be permitted to weight others to a degree that depends on their degree of connectivity, where charisma is a fuzzy variable. The Latency wise promote node selection algorithm was already presented by (*N. Deepa and D. Devi Aruna*, 2019). So according to our previous work, we integrate a fuzzy with PSO in latency algorithm. To discover a delay node of a communication path to find *k* best particles in every neighborhood are chosen to be charismatic, where *k* is a user-set parameter.

In the proposed method, FLPSO based particles are subjected to revise the location that are then qualified for the position and the velocity of the cluster, The data that represent the particle *i* in the given population D can be written as

$$P_i = [N_{i,1}, N_{i,2}, N_{i,3}, \ldots, N_{i,D}] \quad eqn. (5)$$

The position of all the particles are then calculated by making use of the Weighted fitness that decide upon the future solutions The individual best fit position is then used to obtain a best position globally and denoted as (I_{best})

And the best position obtained globally (G_{best}). The position and the velocity of each particle Ve_{id} and N_{id} is then updated as

$$Ve_{new,i} = W \times Ve_i + constant_1 \times kern_1 \times (NI_{best} - N_i) + constant_2 \times kern_2 \times (NG_{best} - N_i) \quad eqn. (6)$$

$$W = W_{initial} - \frac{Max.iteration - Present\ Iteration}{Total\ Number\ of\ Iterations} \quad eqn. (7)$$

Where W = idleness weight, $constant_1$ and $constant_2$ represents the constraints that are non-negative and kern1 and $kern_2$ depicts the value of kernel between [0, 1].

To find the best solution is attained from the group of randomly created primary explanations by moving particles approximately in the find space, which discovers the best solution by swarms subsequent the finest particle. Every particle has particular velocity and location in every iterations a novel velocity rate is considered and it is used to update the particle's location. This procedure iterates until realization a stopping condition.

ALGORITHM 2: KFPSO

Input: initialize fuzzy weight W, fuzzy kernel *kern*, CH, Particles P_i.

Output: *Node Selection*

Process

Step 1: Calculate the fitness latency (P_i) of every particle using below equation and discover the I_{best} of particle and set it to I_{besti}.

$$FL(P_i) = Eg_1(i) + mean(Eg_2(i)) \quad \text{eqn. (8)}$$

Step2: Compute the best position globally in the PSO

$$Gbest = \{Ibest_j | FL(Ibest_j) = min(Fitness(Ibest_i)|)\} \quad \text{eqn. (9)}$$

Step 3: Update velocity and position using eqn. (6)

Step 4: if FL(P_i) < FL(Ibesti) then

　　　Ibesti = Pi

　　Else

　　Gbest = Pi

　　End

Step 8: Repeat the steps 1-4 until the stopping criteria are not met.

IV. PERFORMANCE EVALUATION

This performance evaluation illustrates the various parameters and the experimental conditions for the proposed method. The experimental environment taken is of a 500* 500 dimensioned field. The entire sensor are constantly isolated in the field and it is assumed that the Base station is located much inside the sensor area. Minimum system configuration is used and the settings on the parameter are describes as in table1. Ns2 simulator is used as the tool for performing the experiments.

TABLE 1: SIMULATION PARAMETERS

PARAMETERS	SYMBOL	VALUE
Number of Nodes	N	50~100
Network Region	Row $\times$ Column	500×500
Energy	E_{node}	100Joules
Initial Weight	W_i	0.42
Kernel Value	*kern*	2

Average packet delivery ratio: It is the fraction, amount of packets conventional successfully and the total quantity of packets broadcasted. The proposed ER-KFPSO algorithm executes improved PDR ratio evaluated with existing PSO-based node and link lifetime prediction algorithm (PNLP) method [15].
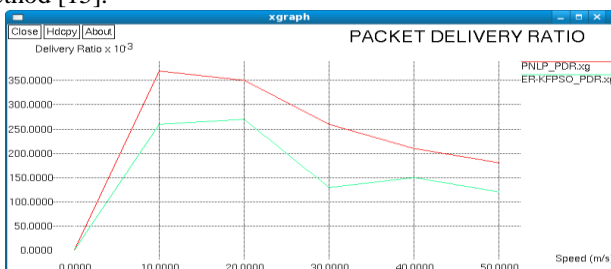

Fig. 3: Speed vs packet delivery ratio

The evaluation of packet drop ratio is provided in the figure 4. In this figure, the performance of the ER-KFPSO is represented given in red line and the line in green denotes the performance of the existing PNLP method [15]. It is evident that the count of packet transmission has decreased. In the graph, Y axis denotes the size of the packet and the X axis denoted the time in (m/s) for the experiment.
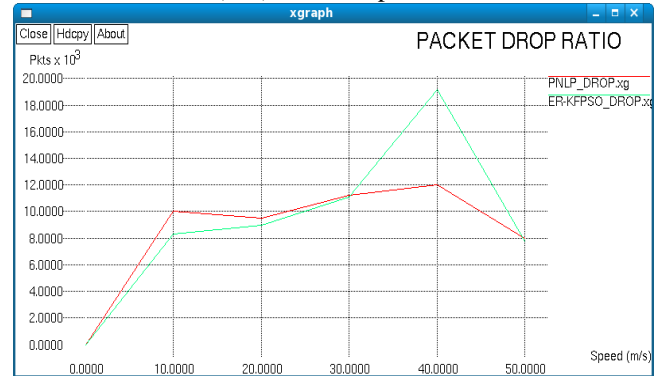

Fig. 4: Speed vs packet drop.

V. CONCLUSION

In the proposed paper, an eminent and valuable CH algorithm with an Energetic Routing aware Kernel Fuzzy Latency Particle Swarm Optimization Algorithm (ER-KFPSO) is proposed to support the energy consumption in WSN. The KFPSO algorithm is then integrated inside the proposed method in-order to enhance the performance and also to find an optimum latency for promoting the selection of nodes. The cluster assignment is supported on the energy weighted fitness with operation levels, which includes the energy version at CH. The KFPSO algorithm is used for discover the node delay process during routing function and new inertia. The results from the experiments prove that the proposed ER-KFPSO is much efficient and effective. The integration of KFPSO in Energetic routing increases the performances of the energy efficient LEACH method considerably.

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