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Selection of Cluster Head in Wireless Sensor Network using Convolution Neural Network Algorithm

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Abstract

Network lifetime enhancement is one of the primary goals for all the Wireless Sensor Network (WSN) applications. Clustering process helps the WSNs to improve its lifetime by forming a group with nearby sensor nodes. A primary node called cluster head is elected from the group for managing the data transmission from the other clustering groups to the basic sensor nodes. Also, the cluster heads are placed to transfer the signal collected from its sensor nodes to the base stations. Identifying an optimum node for making it as a cluster head is a challengeable process for many WSN applications. The proposed work is employed with a neural network algorithm for electing a cluster head by analyzing the residual energy, base station distance and neighbor sensor counts. The experimental work carried out in the paper indicates a betterment on survival node time and energy consumption.

Keywords: Energy consumption, clustering, cluster head selection, network routing, sensor node

1. Introduction

Wireless sensor networks are designed to transfer the observed signals from one place to another place without any connecting medium. The data transmission of WSNs are conducted through wireless channel medium. In certain cases the data transmission is carried out through multiple sensor nodes connected in between the source and destination. Hence the sensor nodes are placed with a battery source as it is kept at most challenging locations. The lifetime of such remotely placed networks are improved by having several optimization techniques. In very rare applications the sensor nodes are kept along with a solar energy

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management module for providing power supply. However, due to the constraint on space occupancy and installation cost such methods are employed in many applications.

Several energy optimization algorithms are employed so far for managing the energy utilization from the stored energy. The optimization algorithm makes the sensor nodes to go for sleep mode when it is not under operation. Selection of right cluster head will always improve the network lifetime to certain extent and the cluster heads are not fixed for all the time and those are changeable with respect to their energy availability. The following section explores the list of cluster head selection algorithms employed for WSN applications.

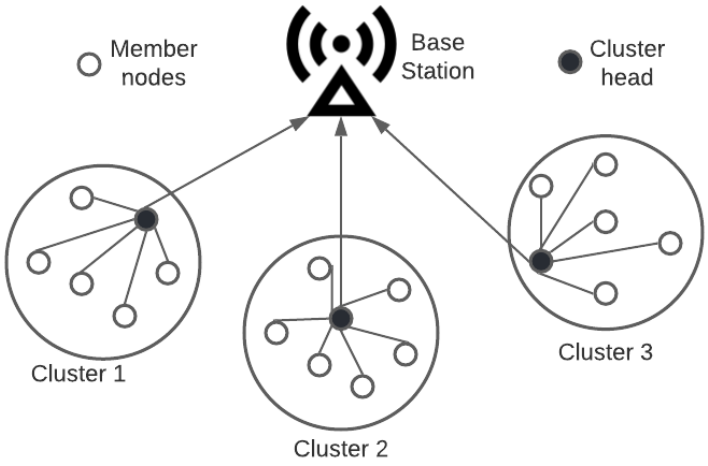

Figure 1. Architecture of cluster based WSN

2. Literature Survey

A residual energy based clustering head selection algorithm was proposed to manage the power requirement in a WSN model and the experimental work explores a betterment of 66% in lifetime enhancement and 64% in residual energy saving over the traditional LEACH approach [1]. A high quality clustering algorithm was designed to improve the cluster head selection process using fuzzy logic principle. The experimental analysis projects an energy utilization of 45J in total, where as in LEACH it goes around 500J [2]. A hybrid model based on dragonfly and firefly algorithm was structured to enhance the energy utilization on WSNs. The experimental analysis indicates a performance improvement of 45.95% over the traditional firefly algorithm and 24.32% than the dragon fly algorithm [3]. A fruitfly and glowworm swarm optimization based hybrid algorithm was developed to optimize the energy efficiency and network operating time of WSN. The analytic work indicates an improvement of 38.97% over the artificial bee colony optimization algorithm [4].

A fuzzy based balanced cost cluster head selection algorithm was framed to identify a better cluster head available from the clustering node group. The experimental performance was compared over the LEACH and balanced cost cluster head selection algorithm and provides 27.4% betterment over LEACH and 22.83% over the balance cost cluster head selection approach [5]. A shortest path relay node algorithm was developed to increase the energy efficiency of the cluster heads. The simulation study provides a betterment of 42% in its efficiency over the traditional mutual exclusive distributive clustering method [6]. Genetic Algorithm-based Optimized Clustering approach was structured by analyzing the node density, sink distance and residual energy availability. The simulation work indicates an improvement over the LEACH and GA methodologies [7]. The particle swarm optimization algorithm is merged with the tabu search algorithm for detecting an efficient cluster head in the WSNs. The alive node performance betterment on the proposed approach is reached up to 14.79% over the multi hop LEACH algorithm [8].

The monarchy butterfly optimization algorithm was merged with artificial bee colony algorithm for making a hybrid model on detecting an optimum cluster heads. The algorithm avoids a cluster node to be over loaded by the maximum number of sensor nodes to avoid rapid failure of cluster heads. The analytic work indicates an outcome of 18.92% improvement over the firefly cyclic grey wolf optimization approach [9]. Taylor series and crow search algorithms are utilized for making a multi-objective taylor crow optimization model for selecting an optimum cluster head. The remaining energy of the cluster node reaches up to 0.1007 with 100 node operation and that is 0.0596 on LEACH technique [10]. Energy efficient mobility based cluster head selection model was designed to perform better over the traditional LEACH and MODLEACH algorithms. The experimental work represents an improved outcome of 20% betterment over the LEACH and 30% over the MODLEACH models [11].

Diversity-driven multi-parent evolutionary algorithm was incorporated with adaptive non-uniform mutation for selecting a cluster head in heterogeneous WSNs. The experiment work provides a betterment of 22.71% over the network lifetime of GADA-LEACH and 6.88% over GAOC model [12]. A double cluster head selection method was designed to overcome the issues of the traditional cluster head selection approaches. The experimental result indicates a better throughput, energy consumption and network lifetime over the conventional LEACH model [13]. A multi-criteria decision-making technique was combined with fuzzy logic model for providing a reliability-based cluster head selection process. The

experimental work indicates a betterment of 20 to 25 percentages over the traditional LEACH approach on network lifespan, energy conservation and frequency reduction [14]. The traditional particle swarm optimization algorithm was combined with sea lion optimization to make a hybrid algorithm for cluster head selection in WSNs and it shows a betterment over the traditional non-hybrid techniques [15]. Table 1 presented in the paper explores the recent techniques that are developed based on neural network algorithms on Cluster Head (CH) selection process.

Table 1. Survey on neural network algorithms on WSN cluster head selection

Citation	Technique	Attributes	Attainments
Sharma et al. [16]	Artificial Neural Network	Maximum energy value	Node fails at 894 rounds in ANN 812 rounds in LEACH 788 rounds in LEACH-C
Sanhaji et al. [17]	Artificial Neural Network with single hidden layer	Survival nodes and energy consumption	Energy consumption at 2700 seconds ANN = 33 LEACH = 36.7
Guo et al. [18]	Back propagation neural network	Location information and residual energy	Reduced network traffic and improved lifetime
Nehra et al. [19]	3 layer neural network	Power consumption and remaining lifetime	Mean residual energy for 150 nodes = 0.06 for 3 layer neural network and 0.06 for PEACH
Shafiabadi et al. [20]	Neural network clustering with self-organizing map	Energy consumption	Last node death time of the proposed model = 2523 For LEACH = 2311

3. Proposed Method

The literature section clearly explores that the traditional methods are assigning the cluster head based on some optimization techniques. In some cases, certain techniques found with hybrid architecture. Only very few techniques are found based on neural network algorithms. Therefore the proposed work is structured with a familiar neural network based algorithm called Convolutional Neural Network (CNN). The CNN approach receives the

input and gives weights and bias to the input attributes based on the output requirement. The network connection over the input and output of the CNN are connected as like of neuron connections inside the human brain. Figure 2 explores the architectural overview of the proposed model.

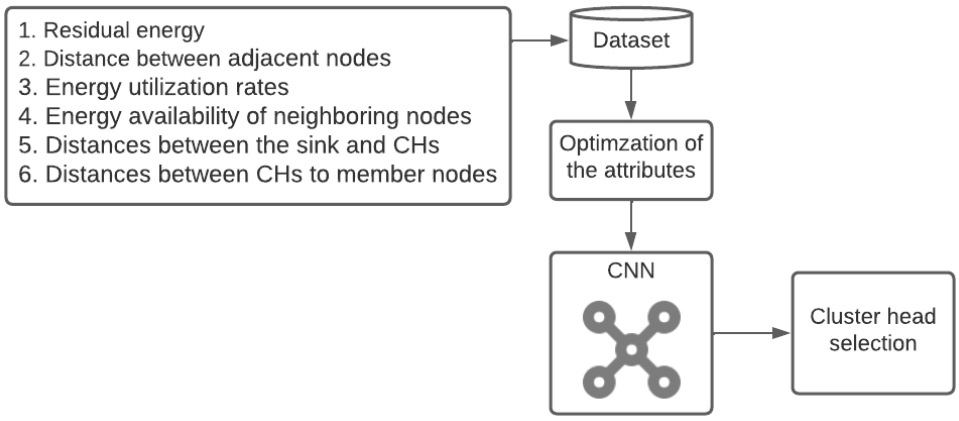

Figure 2. Workflow of the proposed CH selection approach

3.1 Dataset Preparation and Description

A self-made dataset is employed in the work with 10 cluster models along with 10 member modes to each cluster. The information regarding the residual energy, distance among the neighboring nodes and cluster heads along with their energy information are formulated through a simulation process and those are structured to change their values in a regular interval. The training process of the CNN algorithm is optimizing the values of available 6 features based on the inbuilt tuning parameters to give an optimum weightages to the given attributes to reach a better accuracy. Table 2 indicates the attributes and the values obtained in a .csv format.

Table 2. Sample dataset description

Cluster	Residual energy (J)	Neighbour count (Max 10)	Base station distance	Energy dissipation	Distance between neighbours
1	0.9982	9	11.359	0.4631	0.9852
2	0.9942	8	22.982	0.5123	1.2546
3	0.9849	7	15.664	0.4956	1.8645
:	:	:	:	:	:
10	0.9913	8	21.786	0.5017	0.9473

4. Experimental Analysis

To create the proposed model a simulation network is created in the NS2 application based on the parameters noted in the table 3. The raw data on network performance is observed in the simulation tool and fine-tuned with the CNN algorithm for improving its performances. The improved performances of the CNN are compared with the traditional LEACH, and Fuzzy Particle Swarm Optimization (FPSO) in the NS2 application.

Table 3. Simulation parameter settings

Simulation parameters	Values
Network size	200m x 200m
Sensor node count	100
Base station location	50m
Initial energy	1J
Packet size	500 bytes
Aggregation energy	75 pJ/bit
Transmission energy	150 pJ/bit
Reception energy	50 pJ/bit

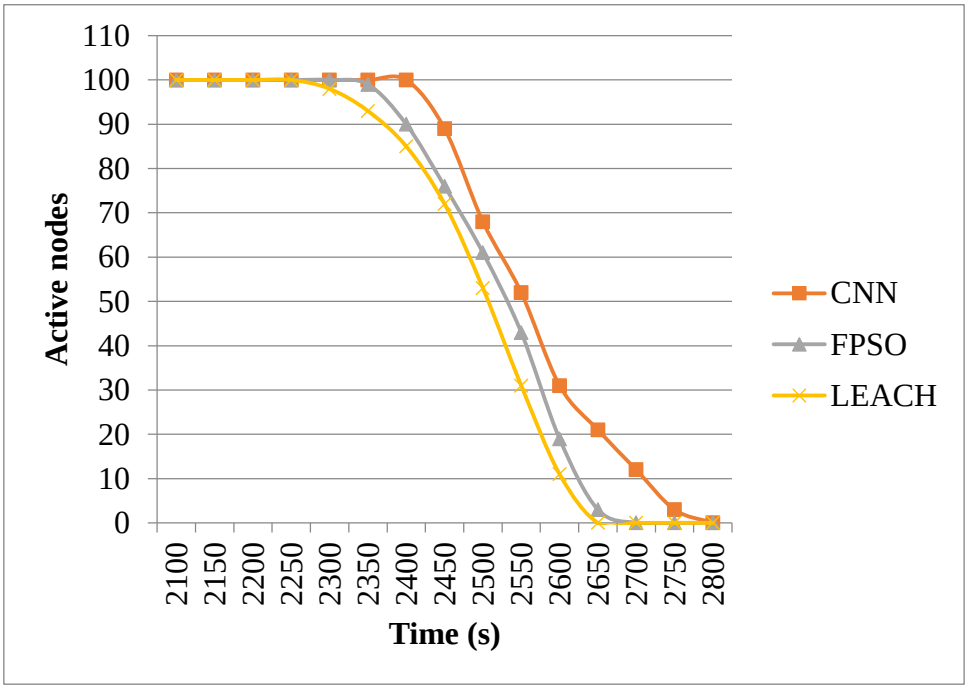

Figure 3. Performance comparison of the verified model with active nodes count

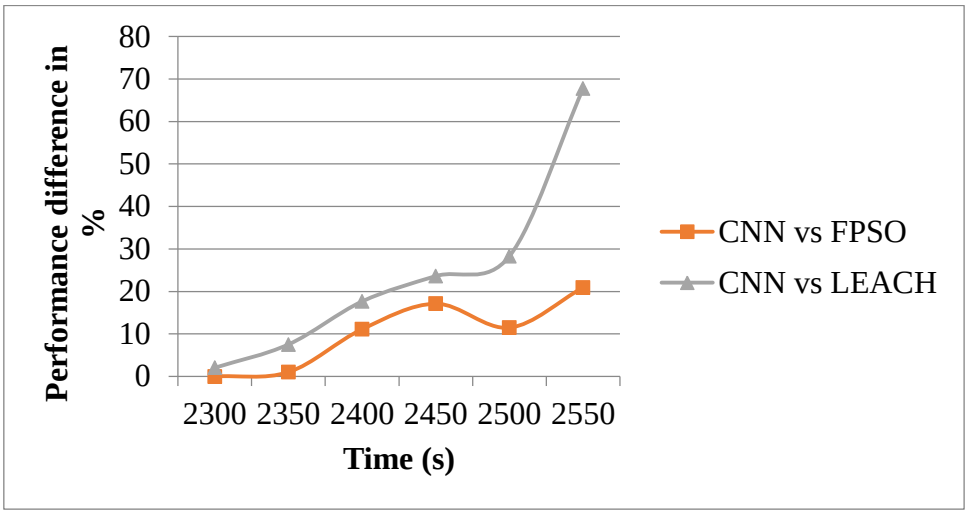

Figure 4. Percentage difference among the alive nodes with verified models

The performances of the simulated network are verified in terms of the aliveness count with respect to time and it is projected in Figure 3. Similarly the activeness difference among the CNN with FPSO and LEACH is projected in Figure 4. The experimental projection clearly indicates that the performance of CNN is good over the traditional approach and it is observed that the final node death time is at 2800 seconds for CNN where as in FPSO it is 2700 seconds and for LEACH it is 2650 seconds. The activeness difference percentage is also found better in CNN and a drastic change is found in the LEACH over the CNN than the FPSO.

5. Conclusion

Lifetime improvement is one of the primary requirements for any wireless sensor network applications. The sensor nodes are placed in different locations that are not easily accessible by a power source causing the diminution of lifetime. Therefore, the proposed work is designed with a goal to form clusters, and utilizes the neural network algorithm for achieving increased lifespan of WSNs. A simulated network model is deployed in the work for creating a dataset to train the CNN for choosing a best node to act as a cluster head. The performance of the proposed model is verified with the traditional LEACH and FPSO algorithm and is found satisfied with the outcome of the CNN model in terms of final node death time.

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