CO-EVOLUTIONARY PARTICLE SWARM OPTIMIZATION WITH FUZZY MULTIPLE PARAMETER DECISION-MAKING TOAVOID LOAD AND BANDWIDTH CONSUMPTION IN WSN

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Abstract- *The Wireless Sensor Network (WSNs) basically includes wireless communication capabilities, computation process and nodes with sensing capabilities. Data dissemination protocols, power management, and many routing process have been particularly designed for WSNs where load and bandwidth consumption is an important design issue. Thus, in this paper introduce a distributed energy-efficient clustering algorithm such as Fuzzy Multiple Parameter Decision-Making (FMPDM) for selecting an optimal cluster algorithm. For cluster head selection process considering different kinds of parameters such as Initial Energy, Average Energy of the Network,Energy Consumption Rate and Residual Energy. After this cluster head selection process other cluster nodes are selected by using Co-Evolutionary Particle Swarm Optimization (CEPSO) algorithm to avoid the load and bandwidth consumption. The simulation results shows that this proposed method is more effective in term of avoiding bandwidth and load consumption. In this process use NS2 simulation with differentkinds of metrics such aspacket delivery ratio, network lifetime and energy consumption.*

Keywords:*Wireless Sensor Network (WSNs), Fuzzy Multiple Parameter Decision-Making (FMPDM), Co-Evolutionary Particle Swarm Optimization (CEPSO) algorithm, Energy Consumption Rate, load and bandwidth.*

1. Introduction

One of the most important technologies in present networking work is known a Wireless Sensor Network (WSN). In the past decades, the WSN has received marvelous attention from bothindustry and academia side. Typically WSN comprise computation capabilities,wireless communicationswith sensing,multifunctional wireless sensor nodes,low-power and low-cost. The WSN sensor nodes are basically communicate through the short distance over a wireless medium and which is collaborate to complete a common task, like industrial process controls, military surveillance, environment monitoring and so on. The fundamental philosophy behind WSNs is collection of power node is sufficient for needed any kind of mission, while the individual sensor node's capability is limited.

Sensor nodes are basically battery powered nodes and these nodes are expected to work without attendance for a comparatively long period of time. The WSNs typically characterized by memory constraints, computation, sever power and higher unreliability of sensor nodes, denser levels of sensor node deployment. Thus, the unique constraints and characteristics present many new challenges for application and development of WSNs.

Unlike fundamental networks, a WSN has its own resource constraints and own design. Basically the resource constraints comprise storage in each and every node, limited processing,low bandwidth,short communication range and limited amount of energy. Design constraints are basically dependents on different kinds of application and which process depends on the monitored environment. The environment plays a main role in the network topology,the deployment scheme and determining the size of the network. The network size is differing from monitored environment. Indoor environments, some nodes are needed to form a network in a restricted space whereas outdoor environment may need more nodes to cover a longer region.

Additionally, the Data dissemination protocols, power management, and many routing processes have been particularly designed for WSNs where load and bandwidth consumption is an important design issue. Thus, in this paper introduce a distributed energy-efficient clustering algorithm such as Fuzzy Multiple Parameter

Decision-Making (FMPDM) for selecting an optimal cluster algorithm. For cluster head selection process considering different kinds of parameters such as Initial Energy, Average Energy of the Network,Energy Consumption Rate and Residual Energy. After this cluster head selection process other cluster nodes are selected by using Co-Evolutionary Particle Swarm Optimization (CPSO) algorithm to avoid the load and bandwidth consumption. The simulation results show that this proposed method is more effective in term of avoiding bandwidth and load consumption.

2. Related Work

In [6] author proposes two different kinds of soft computing localizationmethods for WSN such as Artificial Neural Network (ANN) and Neural Fuzzy Inference System (ANFIS) which focus on a range-based localization approach which done based on the measurement of the Received Signal Strength Indicator (RSSI) from the three ZigBee anchor nodes is typically distributed throughthe track cycling field. The main aim of soft computing approach is to approximate the distance between bicycles moving on the cycle track for indoor and outdoor velodromes. In the initial method the ANFIS was taken, at the same time second method is taken as the ANN these two methods areindividuallyhybridized with three optimization algorithms such as Particle Swarm Optimization (PSO), Backtracking Search Algorithm (BSA) and Gravitational Search Algorithm (GSA). The experimental results examine that the hybrid GSA-ANN method which is outperforms when compared with other methods adopted in this proposed methodwhen consider thedistance estimation accuracy and accuracy localization. The hybrid GSA-ANN attains a mean absolute distance estimation error of 0.02 m and 0.2 m for indoor and outdoor velodromes, correspondingly.

In [7] authors presentextensive survey different kinds of WSNs protocols. In this work typically discuss the swarm intelligence'sfundamental principles and their application in term of routing process. In this work additionally present a novel taxonomy for routing protocols in wireless sensor networks and utilize it to categorize the measured protocols. Finally, conclude this work with a status about critical analysis of WSNs, pointing outdifferent kinds of fundamental issues associated with the (mis) use of evaluation procedures and scientific methodology, and additionally identify various future research directions.

In [8] author describes a novel energy efficient routing method which integrates swarm intelligence, particularly the Ant colony based meta heuristic, with a novel difference of Reinforcement learning for Wireless Sensor Networks (ARNet). The main aim of this workis to maintain maximumnetwork lifetime, while finding the shortest paths from the source nodes to the sink node utilizingoptimization process with the help of improved swarm intelligence.The experimental results show that the proposed ARNet can perceptiblyenhance theadaptability andaverage energy consumption effectively reducedwhen itcompared with the traditional EEABR algorithm.

In [9] author proposed Ant Colony Optimization based routing method, this proposed method basically considers the WSNs dynamic nature with the Fault Detection process is basically done by using spatio-temporal correlation between measurements of the sensor. This proposed method can detach and detect the faulty sensor nodes and enhance the network lifetime with the optimal routing path depends on Meta heuristics.

In [10] author tried to review present techniques to create clusters utilizing nature inspired methods. Proper classification operations are discussing with their demerits and merits has been done. After the optimal positioning the subsequent phase required, the energy efficient multi-hop routing between the nodes ofthe base stationpacketcommunication. This multihoprouting required, the selectionof an optimal cluster head and achievablethe maximum time toget a complete circuit to get a clustered optimalnetwork.

3. Cluster Head Selection

In this work the cluster head selection process is considering different kinds of parameters such as Initial Energy, Average Energy of the Network,Energy Consumption Rate and Residual Energy. After this cluster head selection process other cluster nodes are selected by using Co-Evolutionary Particle Swarm Optimization (CPSO) algorithm to avoid the load and bandwidth consumption is shown in figure 1. Each cluster head is selected by threshold values is computed by using four factors of energy is as follows

Average Energy of the Network: The average energy is utilized as the position energy for each and every node. The average energy is known as the ideal energy which means each and every node should own in presentcluster head selection round to keep the network alive.

Initial Energy: This is a one of the signification parameter to select the cluster head. When any kind of procedureinitiates it normally considers the initial energy.

Energy Consumption Rate: This is another one of the signification parameter that considers the remaining energy

Residual Energy: After some of the cluster head rounds are done, the CH selection should be done depends on the energy remaining in the sensors.

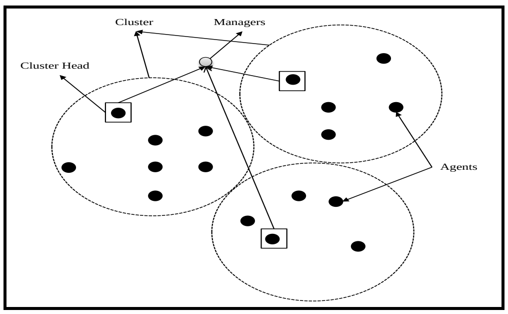

Figure 1.Co-Evolutionary Particle Swarm Optimization Cluster Head Selection

3. Co-Evolutionary Particle Swarm Optimization (CEPSO)

Clustering strategy based on CEPSO (CS) proposes an algorithm to avoid load and bandwidth consumptionby givingmutant strategy and mixed inertia weight [11]. Mixed inertia weight is computed as follows

$$w = w_{max} - (w_{max} - w_{min}) * \frac{iter}{maxiter} \quad (1)$$

When the cluster global best keeps unchanged for maximum 10% iterationsthe Mutant strategy is used half of the normal nodes are reinitiated. An optimal function is utilizedso as toretain the distance between normal nodes and cluster head and similarlyprobable and distance between each and everynormal node and cluster head should be roughly equal. When a nominatedcluster headfulfillsboth the conditions stated above an even cluster is designed is optimal function is defined as follows

$$F = \min\left[mean\left(\sum_{i=1}^{m} D_{ji} - j_{ch}\right) * mean\left(var\left(\sum_{i=1}^{m} D_{ji} - j_{ch}\right)\right)\right] \quad (2)$$

In Cluster selectionapproaches are accessible to avoid impulsiveimmobility whereas stagnation at a late stage is not protected.

The value of cluster constants $c_1 and c_2$ utilized by

$$c_1 = c_2 = c_{initial} + random(0,1) \quad (3)$$

Where$c_{initial}$is 2 and the value of c_1&$c_2$deceptions between $2 - 3$.The value of inertia can be computedby using following eq.

$$w = w_{initial} + \frac{random\,(0{,}50)}{100} \quad (4)$$

Where $w_{initial}$ is initiallydefined as 0.4. Hereafter, consider the inertiavalue ranges is between $0.4 - 0.9$.

4. Fuzzy Multiple Parameter Decision-Making

Concerning multiple parameter decision making from the fuzzy system and their decision making approach is shows the better cluster head selection process. The main aim of this proposed fuzzy multiple parameter decision making approach is to support the process of decision making and avoiding theload and bandwidth consumption problem. Typically, the process does not exit a unique optimal solution for above mentioned issues and it is needed to use preferences of the decision maker to discriminate between different kinds of solutions.The typical decision making process is shown in figure 2.

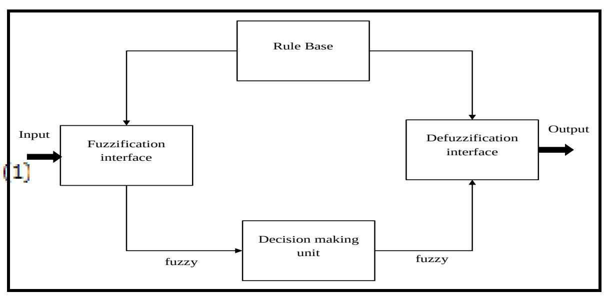

Figure 2.FuzzificationProcess

Typically, the different way of the cluster selection process is done which is corresponds to selecting the "best" cluster head is done by usingevolutionary particle swarm optimization cluster head selection is algorithm is as follows

Fuzzy Multiple Parameter Decision-Making
Step 1:$if\,broadcastingTime\,then$ ***Step2***:$send(ID, Er, RSn, RTn, X, Y)$// *RSncharacterizes restart number, While RTndesignates retransmission number* *//X,Y is defined as the node'coordinates.* ***Step3***:*else*

$Step4$: $receive(ID, Er, RSn, RTn, X, Y)$
$Step5$: $endif$
$Step6$.
$fuzzymatrixconstructiondependsonthequestionnaireinvestigation$

$Step7$: $theconsistencytest$
$Step8$: *compute the composite value* f *of the followingcriteria*
$Step9$:
$T_i \leftarrow (1 - (0.9\ xf\ + 0.1\ xrand\ (0,1)))\ xT_i$
$Step10$: *if no cluster headsignal was received* $\&\&T_i$ *time out then*
$Step11$: $broadcast\ (clusterhead)$
$Step12$: $headFlag \leftarrow 1$
$Step13$: $endif$
$Step14$. $if total\ signalTimetimeoutthen$

$Step15$: $CH \leftarrow selectBest\ (CH)$
$Step16$: $connect(\ CH)$
$Step17$: *end if*
$Step18$: $ifheadFlag\ == \ 1\ then$
$Step19$: $generateCEPSO\ ()$
$Step20$: $broadcast\ (CEPSO)$
$Step21$: $else$
$Step22$: $receive(CEPSO)$
$Step23$: $endif$

The FMPDM is basically concerned with planning and solving structuring and involving multiple measures. In the cluster creation process, the clusters are basically contained several ordinary and single CH nodes. A cluster heads typically process as local coordinator for processing clusters and it performs intra-cluster transmission process. In the network model is deal with initially assume Wireless Sensor Network (WSN), where gateway nodes links between each and every cluster in case there is not direct communication between the CH. The clustering objective is avoided theload and bandwidth consumption problem and increasing the network life time.

3. Results and Discussion

Scenario of the network has been simulated by utilizing the NS- 2 simulator with 500 sensor nodes with one sink node. A qualified analysis has been done with the proposed CEPSO with FMPDM and the existing techniques such as PSO-SD [12]. The simulation outcomes have been assessedby utilizing the metrics such as packet delivery ratio, network lifetime and energy consumption.Table 1 shows the proposed work simulation parameters with their values.

Table 1 Simulation Setup

Simulation Parameters	Values
Weighting parameters (α_1, α_2, α_3)	0.25, 0.45, 0.2
Number of particles and ants	20, 20
Simulation period	1000s
Number of nodes	200
Routing protocol	DSR
Number of iterations	260
Initial sensor energy	150 joules
Sleep power	0.002 watts
Transmission power	12 watts
Transmission range	125 meters
Sink node location	500×500
Simulation Area	1000×1000 sqmeters
Reception power	11 watts

Figure 3 shows that the implementation results about a cluster head selection using proposed CEPSO with FMPDM.

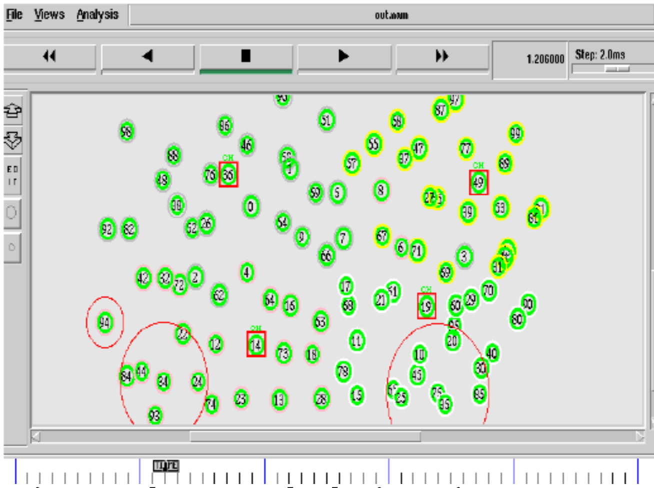

Figure 3.Cluster Head Selection Using CEPSO with FMPDM

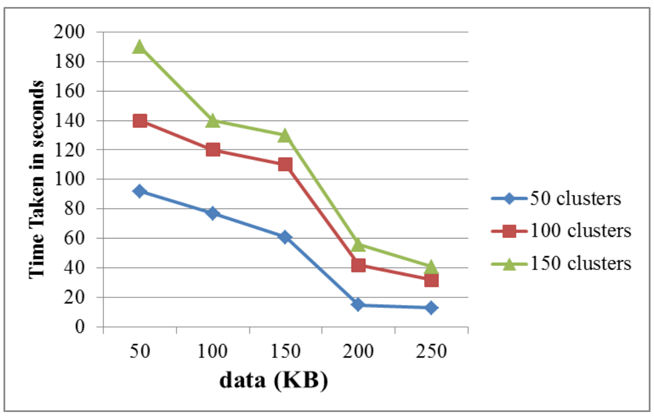

Figure 4. Processing Time

Figure 4 shows that the processing time of proposed work such asCEPSO with FMPDM in term of different cluster selection process.

Packet Delivery Ratio (PDR) is the ratio of No. of packets delivered to the Agent node to the number of packets created in the CH node

$$PDR = \frac{Noofpacketsdeliveredtothesinknode}{Noofpacketssentbytheclusterheadnode} \quad (5)$$

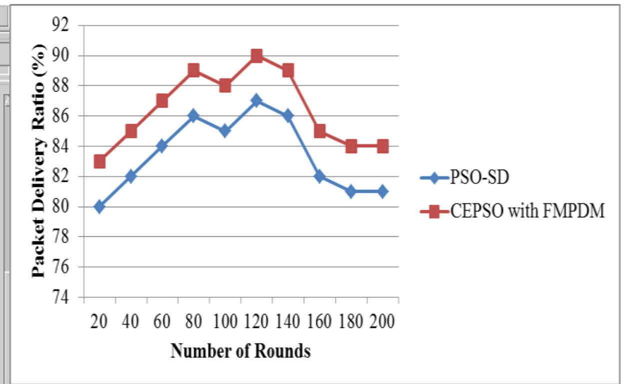

Figure 5 Packet Delivery Ratio

Figure 5 shows that the packet delivery ratio in term of different number of rounds Vs. packet delivery ratio. From the results the proposed CEPSO with FMPDM shows that the promising results with compared with existing PSO-SD which means the proposed work shows the high packet delivery ratio.

Figure 6 shows that the packet delivery ratio in term of different number of cluster head selection rounds Vs. total number of alive nodes.From the results the proposed CEPSO with FMPDM shows that the promising results

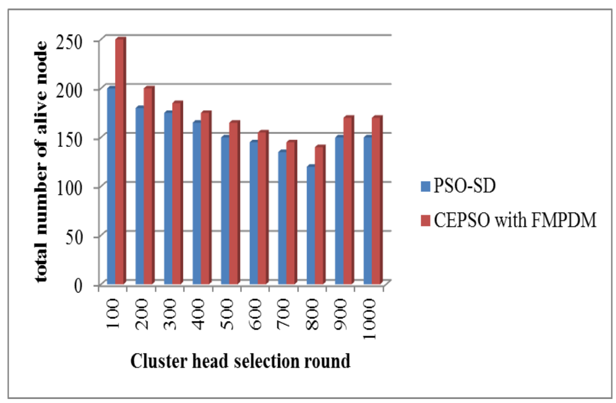

Figure 6 Network Life Time

with compared with existing PSO-SD which means the proposed work shows the high network lifetime.

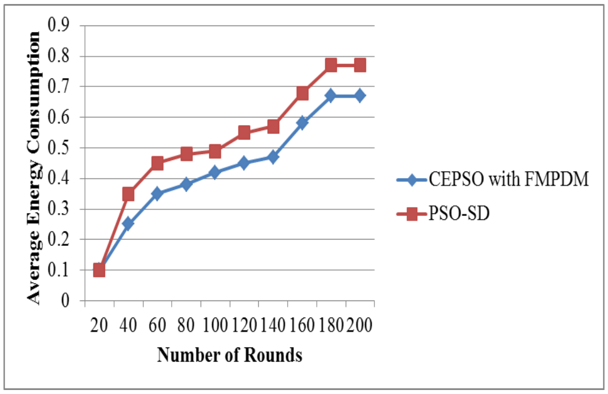

Figure 7.Energy Consumption

Figure 6 shows that the packet delivery ratio in term of different number rounds Vs. Average energy consumption. From the results the proposed CEPSO with FMPDM shows that the promising results with compared with existing PSO-SD which means the proposed work shows the lowenergy consumption.

5. Conclusion

In this paper introduce a distributed energy-efficient clustering algorithm such as FMPDM for selecting an optimal cluster algorithm. After this cluster head selection process other cluster nodes are selected by using a CEPSO algorithm to avoid the load and bandwidth consumption. Here consider the different kinds of metrics such as Initial Energy, Average Energy of the Network,Energy Consumption Rate and Residual Energy. In this process use NS2 simulation with different kinds of metrics such aspacket delivery ratio, network lifetime and energy consumption.The simulation results show that this proposed method is more effective in term of avoiding bandwidth and load consumption.

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