Analysis of PSO Clustering Algorithm for Underwater Acoustic Sensor Networks

Vani Krishnaswamy, Shyam Sunder, Shubham Sharma, Swapnil Siddharth, Sandeep P.
vanikrishnas@reva.edu.in; ssthakur26@gmail.com; shubhamsharma0296@gmail.com
School of Computing and Information Technology,
REVA University,
Bangalore-64

Abstract-**To discover the lexicon of ocean, acoustic communication is used as the prime technology in underwater environment. Due to deficient of constant and adequate power supply and unable to use radio frequency signals in underwater environment, acoustic signals are used as the only means for underwater communication. This paper focuses on learning the fundamental idea of biologically computed optimized clustering algorithm like PSO (Particle Swarm Optimization) used in cluster based networks in underwater environment. The optimization of the sensornodes can be determined through the objectives considered like 1) fitness function of the sensor node 2) Selection of cluster head considering its energy, load and range.The simulation results prove that the PSO algorithm can efficiently increase the load balance and enhance the lifespan of the network.**

Keywords: UANs, PSO, clustering, fitness function

I. INTRODUCTION

The key to open era of ocean exploring is underwater sensor networks. Underwater acoustic communication is gaining popularity because radio waves fail to propagate in underwater environment. Hence acoustic waves are used to self-regulate data, surveillance and regulate specific applications like military uses, safety, environment, security. The situation of underwater surroundings is somewhat different from terrestrial domain in terms of cost, power resources and propagation of waves in channel. There are some issues in evolving underwater communication system that includes 1) terrible power constraints due to battery 2) awful bandwidth constraints and 3) medium characteristics including long circulation delay, multipath, and declining of signals.

There are two variants of UAN, centralized UAN, Multi-hop UAN and distributed UAN. In centralized UAN, the control node establishes the communication to the other nodes, in case of failure of control node whole communication function may fail. But this problem is overcome in distributed UAN; all nodes are similar and communicate in peer-to-peer manner. But deficit of control node leads to the disputation of communication channel between nodes.

In multi-hop, the responsibility of the control node is given to cluster head which is selected near the gravity. In case of power breakdown of a cluster node, the nodes in a cluster will select a node between them to be a new cluster control node. First, the data is conveyed to the control node and managed, and then the data is sent to the next hop or the base station.

One of the earliest clustering protocols is using LEACH algorithm. The algorithm executes the dynamic control node selection, and data merging is implemented in the cluster. But this process does not scrutinize the energy of node in the cluster head selection and has irregular cluster head load. One of the hybrid clustering algorithms is there which is known as HEED algorithm. The cluster head dispensation is more proportionate, and the unused energy of the nodes is looked in the cluster head selection. But in the clustering stage, it is essential to continue much iteration, so the control cost is very high

GA-WCA algorithm is one of the genetic algorithm which efficiently reduces the network delay, and the cluster headload is more proportionate. This algorithm does not looks for the unused energy of nodes and the consequences of node failure on network operation. To effectively improve the communication quality of the channel and lifetime of multi-hop UAN, PSO technique is used. Particle Swarm Optimization (PSO) is an algorithm which maximizes the given objective after investigating the parameters of the search space of given problem. The flexibility of PSO can be very constructive to solve the problem of varying solution space.

The paper is structured in the following ways. Section II will be explaining about the works done in suitability of the PSO in underwater communication networks. Section III will be illuminating about working of the PSO algorithm.

Section IV presents the simulation of the algorithm with results. Section V will have our conclusions.

II. RELATED WORKS

We summarize some of the research already done in this field.

Mong-Fong Horng et. al[14] proposes a system for underwater sensor network for underwater acoustic communication. To make the system energy efficient, cluster based sensor network is assumed. Particle swarm optimization algorithm is used to optimize the energy dissipation of the nodes.

Jayshree Ghorpade-Aheret. al [15] presents a brief overview of PSO and it's variant to solve different types of clustering problems. This paper also proposes algorithm for clustering of multidimensional data named as Subtractive Clustering based Boundary Restricted Adaptive Particle Swarm Optimization (SC-BR-APSO).

Mahamed G.H. Omranet. al [16] describes a dynamic clustering approach based on PSO. This automatically calculates optimum number of clusters using binary PSO.

Raghavendra V. Kulkarni et.al [5] describes about the problem faced in wireless sensor network like link failures, memory constraints etc. This paper then tells how PSO is optimizing the system because it is simple, effective and efficient algorithm and how it has been used to solve the WSN's problems.

Li-Lung Hung et. al [20] proposes a paper dealing with the problems faced by underwater networks.The transmission speed, under water is much slower as compared to the speed in outer environment.He presents a multichannel MAC protocol for UWSN for solving the propagation delay and also hidden terminal problems.Using this protocol utilization of bandwidth has been improved and waiting time of the network.

WeihongZhai et. al [17] presents a MAC protocol for UWSN which includes asynchronous reservation scheme. A sleep/wait-up process has been added to this paper to reduce the energy consumption.

DW van der Merwe et.al[18] presents a paper giving details of how PSO can be used to identify the centroids of the clusters.It also tells PSO can be used to refine clusters and then compare PSO with K-means algorithm.

Chandra PrakashPatidaret. al [19] proposes a paper which focuses on how to develop and test PSO algorithm on the software using test cases. To implement efficiently, test cases are necessary to test the system .This paper proposed a sequence diagram using which we can find out test cases.These test cases can be optimized using D-PSO.

III. WORKING OF PSO ALGORITHM

PSO is a population based optimization scheme. The random solutions of the system are initialized with a population and search optimal solutions in each generation. The potential solution in each generation is known as particles. Fitness function of every particle is executed and the fitness value (best solution) is calculated and stored. The fitness value of the current optimum particle is called "pb." PSO optimizes the best population value that is obtained so far by any particle in the neighbors and its location is called lbest.The positions of the particle keep on changing after each iteration so keep on comparing the pbest value from the previous one.

Step 1: Set parameter w_{min},w_{max},r1,r2 of PSO where w is inertia factor and r1,r2 are random number between [0,1].

Step 2: Initialize the particles with positions X and velocities V.

Step 3: Set iteration k=1.

Step 4: Calculate fitness of particles

$F_i^k=f(X_i^k)$ (1) for all i.Find the index of best particle b

Step 5: Select $Pb^k_i= X^k_i$; for alli and $Gb^k = X^k_b$. (2)

Step 6:$w = w_{max}- k * (w_{max}- w_{min})$/Max_iteration (3)

Step 7:Update velocity and position of particles

new velocity=w*old velocity+w_1(lb-current best position)+w_2(gb-current best position) (4) new position=old position+new velocity. (5)

Step 8: Calculate fitness of particles

$F_i^k=f(X_i^k)$ (6) for all i.Find the index of best particle b1

Step 9: Update pbest of population for all i

If $f_i^{k+1}<f^k_i$

$pbest_i^{k+1} =X_i^{k+1}$ (7)

else

$pb_i^{k+1}=pb_i^k$. (8)

Step 10:Update gb

If $f_{b1}^{k+1} <f_b^k$

$gb^{k+1}=pb_{b1}^{k+1}$ and set b=b1 (9)

else

$gb^{k+1}=gb^k$ (10)

Step 11: If k<max_iteration then k=k+1 and goto step 6 else goto step 12.

Step 12:Print optimum solution as gb^k.

IV. SIMULATIONS AND RESULTS

NS-3 is the Network simulator which is principally used in research and development. It is available publicly under the license GNU GPLv2. The aim of the tool is to develop an open simulation environment for conducting research on computer networks. The goal of the NS-3 is to create an open simulation environment for computer networking research that is favored for the community of the research.

The performances of the algorithms are observed considering a 300m*300m area for node deployment, density of the node is taken as 50 and 140 nodes. The energy-effectiveness of algorithm is met by the energy constraint which is converted to a distance constraint. Therefore, the distance constraint is taken less than 50m. In the first test case, there are 50 nodes in space. The remaining simulation parameters considered are depicted in Table1.

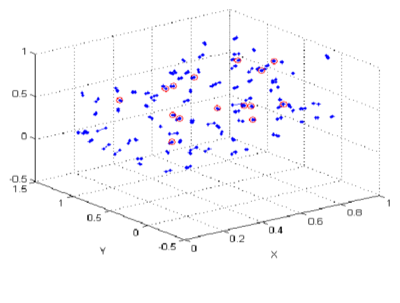

Figure1. Deployment of nodes

Remarks:Figure.1 shows the deployment of nodes and cluster head in 3D environment which is connected to the base station to send and receive data. The nodes here are deployed at certain ranges so as to cover a region of our requirement for analysis. This algorithm also implies more uniform distribution of cluster head load and distribution of the positions.

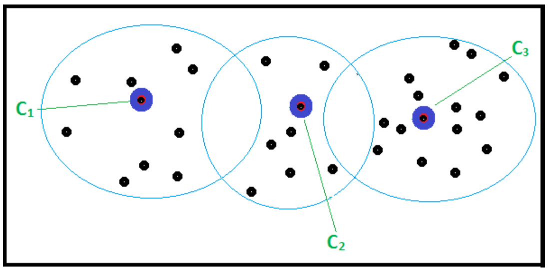

Figure2.Selection of cluster head

Remarks: Figure2. shows the final optimal result after successful simulation of the nodes.C1, C2,C3 depicts cluster head of the clusters which directly transfers the data to the base station.

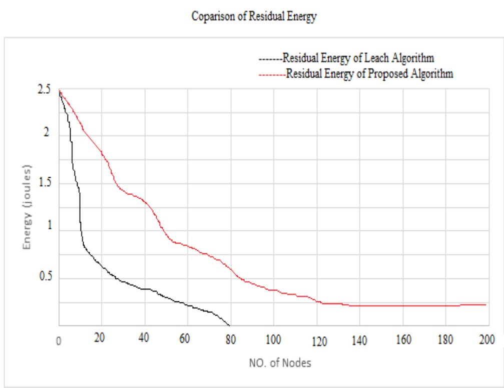

Figure3. Comparison of residual energy

Remarks: Figure 3. depicts the comparison of the total energy of the LEACH algorithm and the PSO algorithm. It is observed that after 10 rounds of time that LEACH algorithm consumes 50% of the total energy compared to PSO algorithm which consumes 50% of the energy after 25 rounds of time. The remaining energy of LEACH algorithm after 28 rounds is only 18% of the energy compared to PSO algorithm is 28% after 48 rounds.

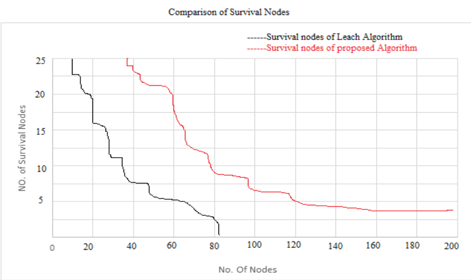

Figure4.Comparison of survival nodes

Remarks:Figure4. depicts the comparison of LEACH algorithm with PSO algorithm considering the number of survival nodes.Through the graph it is observed that in LEACH algorithm the first dead node is after 9 rounds whereas in PSO algorithm the first dead node appeared after 30 round.The number of alive nodes after 40 rounds in LEACH algorithm were 12 nodes compared to 24 nodes in PSO algorithm.The lifespan of the network after 50 rounds in LEACH algorithm is invalid compared to PSO algorithm is inavlid after 100 rounds. Hence PSO algorithm is proved to be better in robustness,efficiency and lifetime of the network in underwater communication environment.

Serial No.	Parameter	Description
1.	Area (deployment)	300m*300m
2.	Transmission power	0.02 watts
3.	Receiving power	0.01 watts
4.	Transmission duration	155 seconds
5.	Simulation time	200 sec
6.	Energy indulgence to run the radio device()	50 n joule/bit
7.	Coverage area	91 metre2
8.	Initial energy	3 joules

Table1.Simulation parameters

V. CONCLUSIONS

In this paper we draw a conclusion that PSO is the simple and easy to implement clusteringalgorithm which aims at increase the life span of the network. This algorithm widely considers the energy of the cluster head, number of survival nodes, location and number of the clusters. The simulation results also prove and satisfy the same parameters. Our future work will be on implementing advanced forms of PSO algorithms in underwater environment considering effectiveness of the energy.

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