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Performance analysis of EPMS and EAPMS routing protocol in WSN

Kiran Gandhi
er.kirangandhi@gmail.com
C T Institute of Engineering Management and Technology, Lambri, Punjab

Varsha
barkhabright@gmail.com
C T Institute of Engineering Management and Technology, Lambri, Punjab

ABSTRACT

Routing in a wireless sensor network is a key challenge. The appropriate routing is done in WSN by using swarm intelligence approach. Various swarm intelligence techniques are available like ant colony optimization, particle swarm optimization, artificial bee colony optimization etc. But the hybrid approach of ACO and PSO is a promising one. The PSO is used to enhance the attributes in the ACO, which define that the selection of parameter doesn't depend on artificial experience, but relies on the robust search on the particles in the PSO. We also used an enhance utilization of ACO, by this technique we have found the shortest path or routes of ants. The output of the experiment shows that the optimize algorithm not only reduce the number of paths in the ACO but also finding the shortest path at the place of the largest path. The simulation result shows that the combination of ACO-PSO performs better than Energy Efficient PSO in terms of dead nodes, alive nodes and throughput of the network.

Keywords— *Wireless Sensor Networks, Routing, ACO/PSO dead nodes, Alive nodes, Throughput*

1. INTRODUCTION

A wireless device network with an outsized quantity of tiny device nodes may be utilized as an effective tool for gathering knowledge in numerous circumstances. One of the most problems in wireless device networks is producing an energy-efficient routing protocol that has a substantial effect on the overall lifespan of the sensor network. Sensor nodes evaluate the ambient circumstances from the natural world surrounding them. The applications of WSN are numerous from health monitoring to the battlefield. The pattern of remote sensing has become greatly modified by useful and low-priced sensors as well as demanded software bundles. To boot, the client can supervise and ensure the fundamental natural world from a remote location. Lots of routing, power management, and data dissemination protocols have been generally planned for WSNs where energy consciousness is important to design issue. Routing protocols in WSNs might dissent depending on the application and network architecture. Wireless sensor network (WSN) area unit extremely distributed networks of little, light-weight wireless nodes, deployed in massive numbers to watch the setting or system by the measure of physical parameters resembling temperature, pressure wetness, sound, vibration, pollutants and put together relay their detected information to the sink node. Each node in the network associated with one another. Each sensor node within the network consists of three subsystems:

· The device system that is employed to sense the environment,
· The processing system that performs native computations on the perceived knowledge.[1,2]
· The communication system that is answerable for sharing the perceived knowledge with the neighbouring device nodes.

Amongst the sources of energy usage in a sensor node, wireless data transmission is the most vital. Within a clustering organization, intra-cluster communication can be single hop or multihop, as well as inter-cluster communication. Multihop communication within a data source and a data sink are usually more energy efficient than direct transmission because of the features of the wireless channel. [3] However, the hot-spots problem arises when using the multihop forwarding model in inter-cluster communication. Because the cluster heads nearer to the data sink are loaded down with large relay traffic, they will expire much quicker than the other cluster heads, cutting down detection coverage and getting network segmentation.

2. ENERGY EFFICIENT PSO (EPMS)

The main aim of this protocol is to conserve the energy in communication to prolong the network lifespan. Energy efficient PSO based routing algorithm with Mobile Sink support for WSNs, which we name it EPMS for short. EPMS routing algorithm mainly combines the virtual clustering and mobile sink techniques during the routing process. [4]

Firstly, it uses the PSO algorithm to divide the network into several regions. In each region, the EPMS uses a similar clustering algorithm to select the cluster head nodes inside each cluster. It combines with the two conditions of the region of the gravity centre of the distance and the energy of the node.

Then, the EPMS defines three kinds of data packet formats: Hello, Message-s and Message-h packets. The Hello packet is used to determine which cluster area send data to the mobile sink.

The Message-s packet sends data to the sink node, and the Message-h sends information to the cluster head. EPMS can balance energy consumption, prolongs network lifetime and reduces the transmission delay based on the extensive simulation results.

2.1 The problem in energy efficient PSO

(1) The performance of the particle swarm optimization depends upon the initial particles; poorly selected particles lead poor results. But in ACO/PSO this problem is solved by the reference point.
(2) PSO has premature conversions but there is no such conversion in ACO/PSO.
(3) The use of the ACO is ignored for the shortest path or routes of ants in WSN.
(4) The use of hybrid ACO-PSO for efficient path selection has also been neglected by most of the researchers.

3. PROPOSED ENERGY EFFICIENT ACO PSO PROTOCOL

The Energy Efficient ACO PSO protocol used the hybrid routing algorithm based on ACO/PSO. In the given calculation, the PSO is utilized to upgrade the characteristics in the ACO, which characterize that the determination of parameter doesn't rely upon fake understanding, however, depends on the vigorous pursuit on the particles in the PSO. We additionally utilized an improve use of ACO, by this strategy we have discovered the most limited way or courses of ants. The yield of the investigation demonstrates that the upgrade calculation not just lessens the number of ways in the ACO. Yet in addition finding the briefest way at the place of biggest way. The recreation result demonstrates that mix of ACO-PSO performs superior to Energy Efficient PSO. The ACO and PSO are the two best methods of the perfect swarm intelligence. PSO copies the sharing of data procedure of a school of fish looking nourishment. While ACO emulates for aging behaviour of ants colonization. The hybrid algorithm has been implemented to exploit the advantages of both the algorithm finding the global optimum.

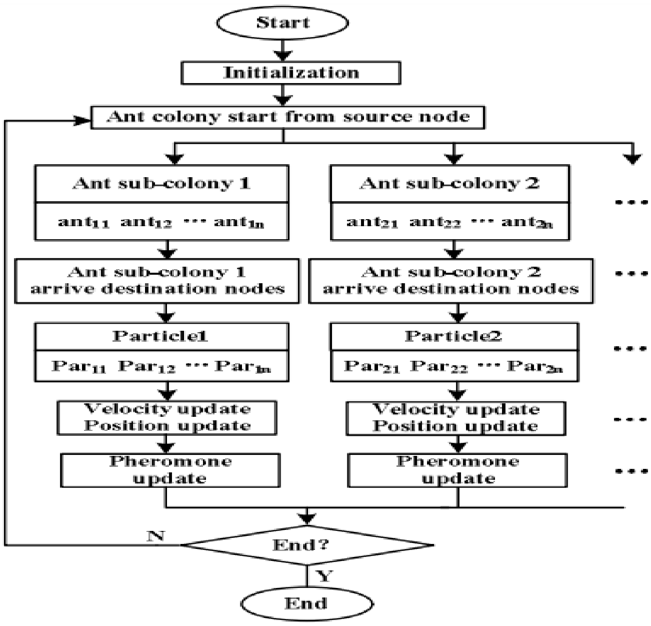

Fig. 1: Hybrid ACO/PSO Technique

3.1 Tool

MATLAB (Matrix laboratory) is a numerical computing environment. It is a fourth-generation programming language. MATLAB is developed by Math works; MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, the creation of user interfaces, and interfacing with programs written in other languages, including C, C++, and Java. The MATLAB application is built around the MATLAB language. The simplest way to execute MATLAB code is to type it in the command window, which is one of the elements of the MATLAB desktop. When the code is entered in the command window, MATLAB can be used as an interactive mathematical shell. Sequences of command scan are saved in a text file, typically using the MATLAB editor, as a script or encapsulated into a function, extending the commands available.

3.2 Proposed Ant Colony Optimization (ACO)

In 1999, 'Dorigo' proposed an Ant Colony Optimization system. Steering convention ACO is an individual from swarm enhancement strategy that emulates the conduct of normal ants for finding the briefest way from source to goal. Amid beginning of a calculation, ants move in an irregular design. When the sustenance is found, insect's moves back to their provinces leaving "markers" (a concoction substance called pheromones) which shows the way is having nourishment. At the point when different ants found these markers, they begin following the way and keeping in mind that returning to their settlements, they leave pheromones and populate the way. On the off chance that the ants pursue a similar way that way ends up more grounded. At whatever point ants bring their nourishment they leave a marker called pheromones. Utilizing this Ant, locate the briefest course to sustenance. Since pheromones is a concoction substance which begins dissipating with a section of time. When all the pheromone dissipates, the wellspring of sustenance additionally gets drained. [5]

3.3 ACO Working

Let 'num' denotes count of cities, 'tn' denotes a total number of ants. Assuming an ant to be initially at city x. An ant l movement from city x to city y depends on:

(a) Is city y has been visited earlier or not. For this check, all ants have a list of cities they already visited. Let JRl(x) is the set of cities that are not visited by ant l when the location of ant l is on city x.
(b) Distance dxy from city x to y.
(c) "Artificial pheromone" deposited on edge that connects x and y is given by (x,y).

Let τxy(t) denotes the pheromone on the edge (x,y) at time t. When all the ants complete their journey, time t is increased with value 1. Initially, the quantity of pheromone deposited on edge is assumed to be small positive constant: $\forall(x,y), \tau xy(t=0) = C$. In the beginning of round, the the the ants are assumed to be placed in on cities randomly. When an ant l is at city x and decides to move to city y, then it checks all the cities attached with source city i.e. x. In spite of visiting all the cities, unvisited cities are firstly examined and when all the cities are examined only then other cities are considered for visiting. The candidate list of city cothe ntains n_l closest cities. Cities are arranged in the order of increasing distance is placed in the candidate list. This list is sequentially scanned. Ant l selects the city from this list. Once all the cities have been visited as mentioned in candidatethe the list, then city y can be selected using:

$$JR = \begin{cases} \underset{u \in JR_l(x)}{Arg\ Max}\{[\tau xu]^{\alpha}.[dxu]^{-\beta}\} & if\ q \le q_o \\ JR & otherwise \end{cases} \quad (1)$$

Where q be the real random variable that is distributed uniformly in the interval [0,1], qo be the tuneable parameter (0 <= qo<=1) and $J \in J_k(x)$ is the node which is selected randomly using the following probability:

$$Pro(C_{x,y}|S^{pr}) = \frac{\tau_{x,y}^{\alpha} * \eta_{x,y}^{\beta}}{\sum_{C_{x,y} \in P(S^{pr})} \tau_{x,y}^{\alpha} * \eta_{x,y}^{\beta}} \quad (2)$$

Where, S^{pr} is para tial solution, P is set of all the paths from the city x to all adjacent cities still not visited by ant, $C_{x,y}$ denotes path from city x to y, Pro denotes probability, $\tau_{x,y}$ is the amount of pheromone in the path $C_{x,y}$, $\eta_{x,y}$ is the heuristic factor usually $\eta_{x,y} = \frac{Q}{d_{x,y}}$, where $d_{x,y}$ be the distance along the cities x and y, Q be the some constant and 'α' and 'β' are algorithm parameters.[6]

3.4 Particle Swarm Optimization (PSO)

In 1995, Dr Eberhart and Dr Kennedy proposed a Particle Swarm Optimization (PSO) system. This strategy emulates the social conduct of feathered creature rushing. Give us a chance to consider a case of feathered creatures that are set haphazardly in a territory and that zone has just a bit of sustenance being looked. The area of sustenance isn't known by the flying creatures. They just know the separation of nourishment from them. For this situation, the least complex system to get sustenance is to pursue that winged creature which is nearer to nourishment. Fowl is classified "molecule". The particles are having a few qualities which can be determined utilizing wellness work and a certain speed. In it, each molecule refreshes "best" two qualities i.e. best arrangement (wellness) called pbest and gbest. Utilizing these two qualities, particles refresh their speeds and positions as appeared in conditions. (3) and (4).

vel[] = vel[] + c1 * ran() * (pbest[] - present[]) + c2 * ran() * (gbest[] -present[])

pre[] = per[] + vel[]

vel[] represents velocity of particle, per[] represents current particle, ran() represents random number ranges from 0 to 1 and c1, c2 represents learning factors which is equal to c1= c2=2. [7]

3.5 Hybrid ACO/PSO optimization

Hybrid ACO/PSO optimization technique has been applied. Firstly, Ant Colony Optimization (ACO) has been applied for finding the smallest route from the node to the sink (which in turn generates the values of α-Best and β-Best). The results obtained through ACO technique are given to PSO algorithm for the refinement. It provides a population-based search technique that uses Pbest, Gbest and particles current position for finding a coming location in the area of search. The PSO algorithm is applied to find the best shortest routes. Transmission of data takes place after finding the shortest routes.[8]

4. SIMULATION RESULTS AND ANALYSIS

We have utilized MATLAB to tentatively check our results. The parameters utilized throughout the whole course of simulation have been recorded in Table 1. Additionally, we have assessed EPMS v/s ACO-PSO EPMS.

Table 1: Simulation parameter

Area of simulation	100 × 100 m^2
Number of nodes	100
ϵ_{fs} (energy used in short distant communication)	10 pJ/bit/m^2
ϵ_{mp} (energy used in long distant communication)	0.0013 pJ/bit/m^4
l (length of data)	2000 bit
Ee (Initial energy of the nodes)	0.5 J
ET (Transmitting energy)	50 nJ/bit
ER (Reception Energy)	50 nJ/bit
Ebf (Energy consumption in Beam Forming)	5 nJ/bit

4.1 Alive nodes

This is the graph of alive nodes in EPMS and ACO-PSO EPMS protocol. It has been found that the number of nodes alive much more in ACO-PSO EPMS protocol. Here, we can see from the graph that the nodes are alive at the round of 1550 in case of EPMS and 2450 in case of ACO-PSO EPMS.

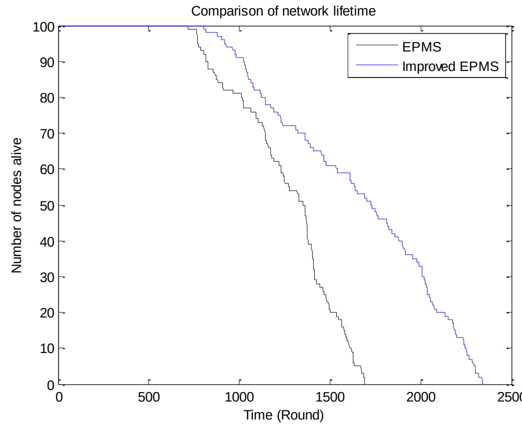

Fig. 2:Alive nodes versus rounds

4.2 Dead Nodes

This is the graph of dead nodes in EPMS and ACO-PSO EPMS protocol. The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes dies earlier in EPMS protocol. Here, we can see from the graph that all the nodes die at the round of 1550 in case of EPMS and 2450 in case of ACO-PSO EPMS.

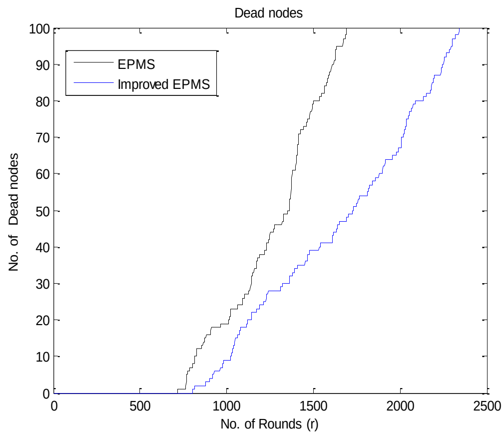

Fig. 3: Dead nodes versus rounds

4.3 Packets Send to the base station

This is the graph of Packet send to the base station after simulation. This graph shows the total number of packets send to the base station by the sensor nodes. At the round of 1500, the total number of packets sent to the base station is 12000 in the case of EPMS protocol and in case of ACO-PSO EPMS, the packets sent to the base station is 16000.

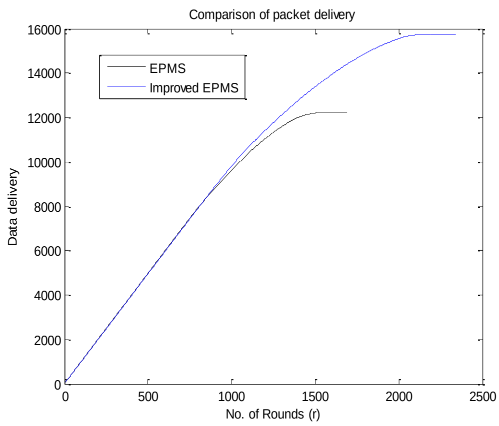

Fig. 4: Packet send to base station vs. rounds

4.4 Remaining Energy

This is the graph of remaining energy, how much energy is left with the rounds. From the graph, we can see the remaining energy with EPMS goes to 1500 rounds, whereas in the case of ACO-PSO EPMS the remaining energy goes to 2200 rounds means more work can be done with ACO-PSO EPMS protocol.

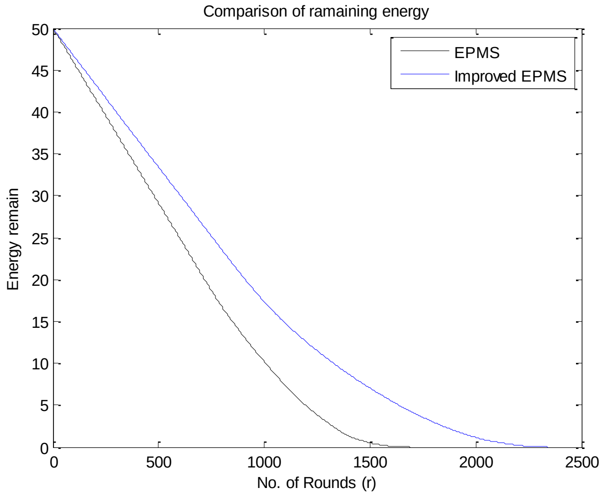

Fig. 5: Remaining energy vs. rounds

5. CONCLUSION

To minimize the energy consumption, we proposed a hybrid routing technique which is called hybrid ACO-PSO based on swarm intelligence. Hybrid ACO-PSO helps to find out the shortest distance for the routing process and thereby enhancement can be done in network lifetime. At the round of 1500, the total number of packets sent to the base station is 12000 in the case of EPMS protocol and in case of ACO-PSO EPMS, the packets sent to the base station is 16000. Similarly, the nodes are alive at the round of 1550 in case of EPMS and 2450 in case of ACO-PSO EPMS. Through the extensive simulation, it can be evaluated that the performance of ACO-PSO EPMS is more than that of EPMS. For the proposed work, we are using wireless communication and data analysis toolbox of Matlab2013a. The proposed protocol shows the better improvement over existing protocol.

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