Enhanced artificial bee colony algorithm with mobile sink management to improve network lifetime in WSN

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Abstract

Traditionally wireless sensor network uses multi-hop routing to transmit the data from source node to the sink. Many problems arise due to multi hop routing, the common problem is hotspot problem and transmission overhead. The paper has propose mobile sink based algorithm for Collection of data in wireless sensor network. Data Collection will be encouraged with efficient cluster head selection and enhanced artificial Bee Colony algorithm (EABC). Analysis of the proposed method with existing research methods has been done. Simulation results shows that proposed algorithm can effectively reduce transmission overload, and improve network lifetime, when compared with similar ant Colony algorithm and traditional LEACH methodology. Effective management of mobile sink and exploring shortest path through it proves efficient in energy Optimization of wireless sensor network.

Keywords: Artificial bee colony algorithm, dynamic deployment, mobile sink node.

Introduction

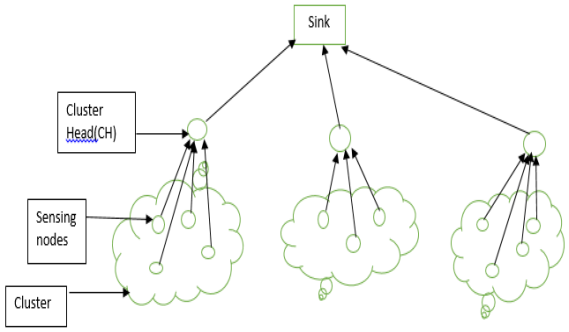


Fig 1: Clustering in WSN

Wireless sensor network has advances very rapidly from last few years. Applications of wireless sensor network has large coverage such as military applications, industrial applications, artificial intelligence, Home Automation. Large number of scholars are investigating in data transmission techniques of wireless sensor network. In typical wireless sensor network, position of all nodes and sink node is stationary. The sink is the node in wireless sensor network which is also called as base station. Every node in wireless sensor network can sense the data and transmit the data to the sink bi multi hopping. In the process of data transmission, the nodes which are near to the sink gets overloaded with the data and they die prematurely due to low energy remaining with them. This problem is known as hotspot problem or energy hole problem.[1] As the energy to the sensor node is limited and it cannot be replaced, this hotspot problem creates chaos in the network. This issue has to be addressed by introduction of mobile sink in the network, where King can move in the network and collect the data by shortest path. LEACH is the protocol used for transmission

of data in wireless sensor network traditionally. Here new approach of artificial Bee Colony algorithm is proposed to enhance lifetime of wireless sensor network along with mobile sink management. Later, multiple mobile sinks can be introduced to minimize the delay and effectively transmits the data in wireless sensor network. The networks area is (A). the nodes are fixed at one position and sink node is mobile in the network.(B) sink node is fixed at position and node is mobile and transfer the data to the sink.(C) both sink node and sensory node are moving. In these three networks, the most practical solution to achieve mobility in the network is keeping sensing nodes fixed and make the sink node moving. Most fundamental issue in wireless sensor network effectively managing energy consumption of tiny nodes which are deployed in the network to detect environmental area. As a nodes are packed with small battery power which are irreplaceable. The network lifetime can be increased only by appropriate routing algorithms. Protocols based on clustering should be effectively improved. Traditional clustering approaches search as LEACH in which clusters are made, each cluster has its cluster head (CH). All the nodes sense the information and send it to the respective cluster head. Cluster head further will send the data to the sink. Here, algorithm inspired from nature is used to deal with the complexity of wireless sensor network. Artificial Bee Colony Optimization is among search techniques. Performance evaluation is done based on various parameters, rounds.

Main contributions of this paper are listed below

1. Path optimization of mobile sink is formulated.
2. Selection of cluster head and data transmission in mobile wireless sensor network is done by enhanced artificial Bee Colony algorithm.
3. Efficiency of the data transmission is achieved in experimental analysis.

Literature Survey

Low-Energy Adaptive Clustering Hierarchy (LEACH) Protocol[2] forms clusters of the sensor nodes and then randomly selects some sensors as the cluster-heads for routing to the sink. Aggregation is performed by cluster head. It sends the aggregated data to the sink. Apart from reduction in energy dissipation compared to direct communication, it does not require any global knowledge of network.

Threshold-sensitive Energy Efficient sensor Network (TEEN) Protocols proposed [3] forms multi-level clusters where closer nodes and this process goes on to the second level until the base-station is reached. Two types of adjustable thresholds are used based on which transmission takes place leading to a trade-off between energy efficiency and data accuracy. An alternate to TEEN is where cluster-head also performs data aggregation for the sake of saving energy. The overhead and complexity associated with formation of multi-level clusters hinders in its wide scale adaptability. Also the threshold mechanism and dealing with attribute based naming of queries limit their use to some specific applications.

PSO author defines PSO[4] as bio-inspired technique which is effective yet simple to execute on the field. Particle Swarm Optimization is one of the popular Optimization algorithm which is easy to implement and provides efficiency in computation. It provides high quality of solution. Though, there are strengths, PSO also has some challenges which can be researched to get better results. Cross layer Optimization and development of PSO in hardware is the biggest challenge. It is very difficult to do transformation of simulation study to the practical solution of PSO

ACO [5]ant Colony Optimization algorithm- it works on heuristic approach. Forward moving ants are used to find the path from source node to the destination node whereas backward moving ants are used to update pheromone on the path. Fitness function, Residual energy of the nodes and length of the path are parameters used in optimization of the network using ant Colony Optimization algorithm. ACO does not deal with node failures. The biggest challenge of ant Colony algorithm is practical node failure in the sensor field.

Network Model

Wireless sensor network is composed of n number of stationary or fixed nodes. 20 nodes having same power backup are deployed in the network.MS is the mobile station or sink which keeps moving in the network is the transmission link between sensor node and the sink. It is assumed that every sensor node has same battery power where sink node has highest storage capacity and battery power. It is assume that sink node can freely move in the network without any obstacle. We have assume that there are b number of mobile sink fromms1,ms2...to msb. Let(x,y) be the link between node and its neighbor node.

n = (VU MS, L)

Proposed Methodology

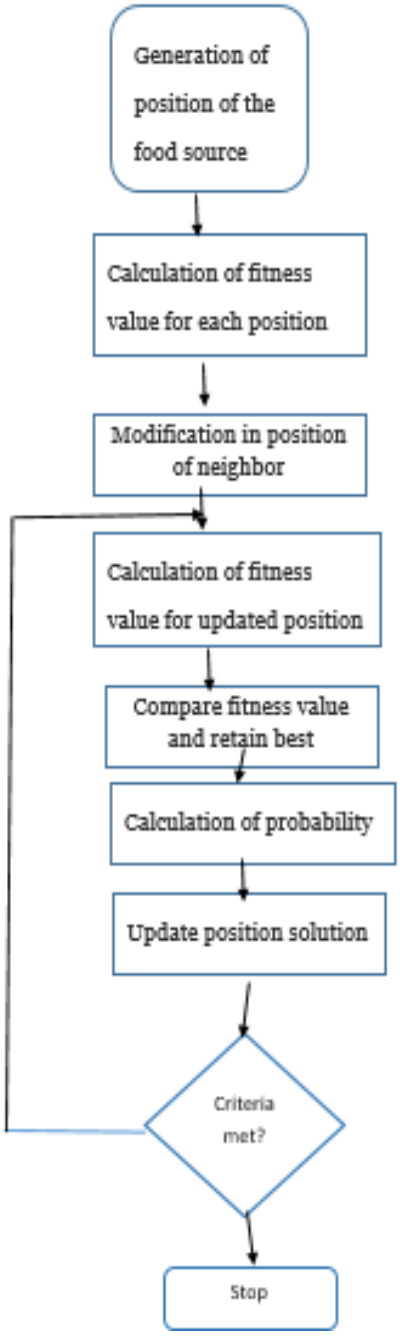
In the proposed system, fundamentally clustering will be done in wireless sensor network. Cluster head will be choosen in each cluster. The sensing node will sense the data and transmit the data to the cluster head. Cluster head will Store the data coming from all sensor nodes. As the sink is moving in the network, cluster head will transmit the data to the sink via shortest path. Here, optimized artificial Bee Colony algorithm is implemented to route the data effectively within the cluster and to the mobile sink. This technique will effectively reduce energy consumption and enhance lifetime of the network. Energy of nodes around the sink gets depleted too fast creating bottleneck problem. hotspot issue can be addressed with the concept of mobile sink is introduced. As the name indicates, the Sink keeps moving in the network and collect the data from the node by shortest path. In this paper, two aspects are studied. To avoid bottleneck issue multiple mobile sink is introduced and hybrid artificial Bee Colony algorithm is introduced to optimize the transmission of data through shortest path to the mobile sink. The loopholes in the communication can be eliminated with proper deployment of sensor node. Artificial Bee Colony algorithm guarantees to minimize network lifetime. Deployment of the sensor node plays a major role in wireless sensor network. As nodes are sometimes deployed in the tough environmental conditions, it is very essential to route the data two shortest path. Clustering is very effective in routing data over traditional multi hop routing. Particle Swarm Optimization (PSO) is well-known technique used to deploy nodes in the network. The popularity gained by wireless sensor network in last few decades motivates to research in this emerging networks. Traditional problems of wireless sensor networks are energy consumption and security. Fundamentals of sensor networking is based on clustering. Effective clustering approaches apart from traditional protocols has to be emerged. Right placement of sensor node in the network and effective clustering solves many problem in wireless sensor network. As very well said, good beginning is half done. If the clustering goes well, data transmission will go smoothly. Artificial Bee Colony algorithm effectively works in clustering of wireless sensor network.

Enhanced Artificial Bee Colony algorithm

For one food resource, there is only one employee bee. Number of employee bees and number of food sources are equal. The employee bee who is remaining with no food source will be termed as scout bee. Then scout bee will randomly search for food resource.

1. Initialization
2. Employee bee phase
3. Onlooker bee phase
4. Scout bee phase
5. Memorize best solution
6. Repeat until maximum cycle

Flowchart



Pseudo code for ABC algorithm

Step 1: initialize population Step 2: evaluate Step 3: cycle 0to 1 Repeat

Step 4: initialize Phase 1: employee bees.
Step 5: calculate probability for onlooker bees
Step 6: initialize Phase 2: Onlooker bees
Step 7: initialize scout bee phase
Step 8: index best solution
Cycle= cycle+1
Until cycle=max

Foraging behavior of bees helps to write artificial Bee Colony algorithm. It contains Three Types of bees. They are grouped as employee bees, onlooker bees and scout bees. Group of employee bees will search for food sources in their neighborhood and Store the locations in the memory. Employee bees inform their searching two onlooker bees. Onlooker bees will search for the food resource in the neighborhood of the previous search informed by employee bees. And gets best possible solution from it. Scout bees search for the food sources randomly. Huge conduction of research is going on to improve lifetime of the sensor network. To plan the route of transmission in wireless sensor network, artificial Bee Colony algorithm is used. Artificial Bee Colony algorithm is Optimization algorithm. It examines the behavior of honey bees. There are three groups of bees in the initial phase. Employee bees, onlooker bees, and scout bees. In the starting, 50% of the bees are employee bees. They search for the food resource in the neighborhood. Remaining 50% are onlooker bees, they works on the information shared by employee bees and track the fresh food resources available from them. Scout bees are the bees which search randomly for the food source. For employee be if in the search, the next food resource is having higher value then back one then employee be switches to the new food resource. All process of searching, onlooker bee choose the food resource with the highest value.

Algorithm for selection of cluster head

H_{opt}=Calculate()
If(random< P(n))
For(i=1,j=1;i<=S_m,j<=B_m-S_m;i++,j++)
Calculate X_i,X_j,E_{res}
Calculate P(n)

$$ch_{id} = \{ch|P(n) = max(P(i)), i \in ch$$

Broadcast (ch)
Else repeat
End

Algorithm for mobile sink management

Step 1: Calculate temporary Location of the sink.
$MS_t = (x'_{ms}, y'_{ms})$
Calculate Values for x'_{ms} and y'_{ms})
Step 2: Calculate Path. Compute
The path from sensor node s to sink node.(x'_{ms}, y'_{ms})
Step 3: For edge set $E_{ij} = 1$ if the edge is on path from sensor node S to the sink node.
Step 4: Calculate Final Position of the sink

$$MS_f = (x_{ms}, y_{ms})$$

Step 5: Repeat till max cycle

Simulation Results:

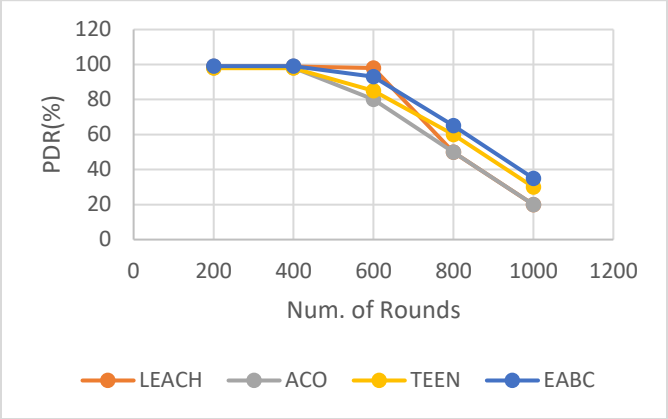
The comparison of Enhanced artificial bee colony algorithm is done with approaches like LEACH-Low-Energy Adaptive Clustering Hierarchy, ACO-Ant colony algorithm and TEEN- Threshold-sensitive Energy Efficient sensor Network.The analysis is done for EABC algorithm with respect to various parameters such as Packet delivery ratio (PDR), energy, delay. EABC algorithm shows 98.70% for packet delivery ratio whereas existing methods like LEACH, ACO and TEEN clustering approaches shows 97.70%, 97.10%, and 97.726 respectively. Energy value for EABC is 0.358 while energy value for LEACH, ACO and TEEN is 0.349, 0.3518 and 0.326 respectively. Delay in EABC is 0.0914 whereas delay in LEACH, ACO and TEEN is 0.112, 0.116 and 0.115. The Analysis is done for 50 and 100 rounds.

Comparative analysis

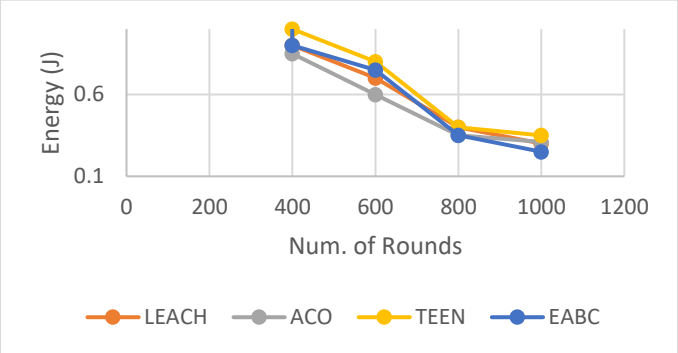
Table1. Comparative analysis

Metrics	**LEACH**	**ACO**	**TEEN**	**EABC**
PDR (%)	97.70	97.10	97.7	**98.70**
Energy (J)	0.349	0.3518	0.32	**0.358**
Delay (sec)	0.112	0.116	0.115	**0.0914**
PDR (%)	95.078	96.560	96.721	**97.551**
Energy (J)	0.312	0.311	0.261	**0.325**

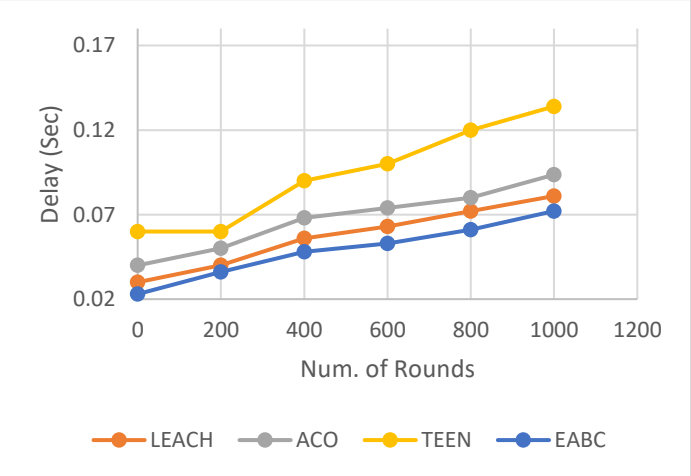
Delay (sec)	0.156	0.184	0.136	**0.092**



Graph 1: Packet delivery ratio



Graph 2: Energy Conservation



Graph 3: Delay in the network

Conclusion and Future Work

Enhanced artificial Bee Colony algorithm (E-ABC) with mobile sink management effectively optimize the performance of the wireless sensor network. The comparative analysis is done with similar optimization techniques like LEACH, ant Colony algorithm and TEEN protocol. Studies shows that E-ABC with mobile sink reduce energy consumption of the network thus network lifetime is enhanced. In future effective algorithm should be built to maintain security in E-ABC algorithm to make network most secure.

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