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IMPROVING THE LIFETIME OF THE NODES OF WIRELESS SENSOR NETWORKS USING THE ANT COLONY OPTIMIZATION

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Abstract: **- This paper proposes an ant colony optimization (ACO) based routing algorithm for wireless sensor networks. The algorithm incorporates link quality into pheromone formation and supports multiple routes, which are characteristics of an ant colony algorithm. When routing is chosen, the probability of the node being chosen as the next hop is calculated based on the pheromone concentration on the route. Because ant colony optimization is self-organizing, dynamic, and multi-path, it is ideal for wireless sensor network routing. This algorithm has a low routing cost, good self-adaptation, and can handle multiple paths. It has the ability to balance the network's energy consumption and extend the network's survival time. The thesis performs a comparative analysis of the simulation experiment and experimental results, demonstrating that the ant colony algorithm can find the optimal routing in a wireless sensor network and achieves the design goal of a wireless sensor network routing algorithm.**

Index Terms **– Wireless Sensor Networks, Ant Colony Optimization etc.**

1. INTRODUCTION

Now a day‟s advance in technology wireless sensor network required failure node detection, low power, and low cost sensor nodes. The main purpose of wireless sensor network is to sense the data process them and then transmit to the sink. However, the major constraint of wireless sensor network is power consumption, battery harvesting and communication failure and connect with failure node [1][2]. Localization and routing is the supporting key techniques in WSN. Localization approach is to collect the whole network information into one place and processed them accordingly. In WSN, many techniques are available to detect failure nodes like MANNA, tree structure and using clustering head etc. In these techniques, have same disadvantages like high communication cost, accuracy, and high power consumption etc. These issues solved by using support vector machine [3]. The support vector machine is a type of supervised learning algorithm, which is, used for classification, outliers‟ detection, and regression challenges. In SVM, we have given a set of training dataset points, where each dataset point is marked for belonging to either one or two categories. SVM has two main category i.e. kernel function and set of support vector. The data point located near to the separating hyperplane is called support vector. Based on the category SVM training algorithm prepares a new model, assign new dataset in both categories, and make a linear classifier [4]. SVM model plot each data as a point in features space. SVM can be linear classifier and nonlinear classifier. In linear classifier, samples are map into space separated by hyperplane, whereas nonlinear classification has done by using different kernel trick. The advantages of SVM are it gives accurate localization of sensor nodes in rough and sparse environment [5]. The main constraint in WSN is limited battery power and memory of sensor nodes. When designing routing protocol two main challenging issues are generated that is network should be energy efficient and maximum network lifetime. The maximum network lifetime can achieve by minimizing the energy consumption of the nodes. The proposed technique is increase the network lifetime and makes energy efficient. ACO based on the foraging behavior of ants that used to discover shortest path from source node to destination node. ACO also used to improve network efficiency and reduce power consumption of sensor nodes [6].

The organizational framework of this study divides the research work in the different sections. The Literature review is presented in section 2. Further, in section 3 shown Concept of Existing System,, in section 4 shown the Methodology and section 5 shown the Performance metrics used in this work. Simulation Results work is shown in 6. Conclusion and future work are presented by last sections 7.

2. LITERATURE REVIEW

[1] Husna Jamal Abdul Nasir, kuRuhana Ku-Mahamud, EijiKamioka: Wireless Sensor Network (WSN) has been widely implemented in large sectors such as military, habitat, business, industrial, health and environment. WSN is part of a distributed system where elements such as routing, load balancing, energy efficiency, node localization, time synchronization, data aggregation and security need to be addressed to improve its efficiency, robustness, extendibility, applicability and reliability. Despite multiple approaches proposed to improve all these aspects, there is still room for improvement in order to enhance the capability of WSN in terms of routing and energy efficiency. Ant Colony Optimization (ACO) is one of the approaches used to extend WSN capabilities because its heuristic nature is very suitable with distributed and dynamic environments. This study covers the common WSN aspects and performance evaluation criteria in addition to the list of previous studies that have used ACO approaches in WSN.

[2] Nwamae, Believe B., Kabari, Ledisi G.: Vehicle traffic congestion leads to air pollution, driver frustration, and costs billions of dollars annually in fuel consumption. Finding a proper solution to vehicle congestion is a considerable challenge due to the dynamic and unpredictable nature of the network topology of vehicular environments, especially in urban areas. Ant colony optimization (ACO) has been widely used for different combinatorial optimization problems. Ant Colony Optimization (ACO) as a heuristic algorithm has been proven a successful technique and applied to a number of combinatorial optimization (CO) problems. The traveling salesman problem (TSP) is one of the most important combinatorial problems. We present a bio-inspired algorithm, food search behavior of ants, which is a promising way of solving the Travel Salesman Problem. in this paper, we investigate ACO algorithms with respect to their runtime behavior for the traveling salesperson (TSP) problem. Simulation results conducted using MATLAB suggests that the proposed system would perform consistently despite increase of vehicles with in the given area.

[3]Neeraj, VarshaSahni,: Wireless Sensor Networks (WSNs) have been widely considered as one of the most important technologies for the twenty first century. Due to the advancements in microelectronic mechanical systems (MEMS) and wireless communication technologies, it has become possible to deploy tiny, cheap, and smart sensors in any physical area. The routing is one of the dominant factors which decide the fate of limited battery resources in WSNs. In this paper, a review on the state-of-the-art on PEGASIS (Power efficient Gathering in Sensor Information System) protocol has been presented. PEGASIS is highly significant in small areas applications, some of the variants of PEGASIS protocol has been studied in this paper. After studying various protocols, it has been found that Chain Based Cluster Cooperative Protocol (CBCCP) has tremendously improved network lifetime by incorporating cluster based concept in routing. Although it has outperformed various routing protocols but it still leave a great margin of improvement in the inter cluster communication. This paper basically focuses on reflecting the significance of chain based protocols in WSNs.

[4] S. Roy, M. Conti, S. Setia and S. Jajodia: Wireless sensor networks (WSNs) are increasingly used in many applications, such as volcano and fire monitoring, urban sensing, and perimeter surveillance. In a large WSN, in-network data aggregation (i.e., combining partial results at intermediate nodes during message routing) significantly reduces the amount of communication overhead and energy consumption. The research community proposed a loss-resilient aggregation framework called synopsis diffusion, which uses duplicate insensitive algorithms on top of multipath routing schemes to accurately compute aggregates (e.g., predicate count or sum). However, this aggregation framework does not address the problem of false sub aggregate values contributed by compromised nodes. This attack may cause large errors in the aggregate computed at the base station, which is the root node in the aggregation hierarchy. In this paper, we make the synopsis diffusion approach secure against the above attack launched by compromised nodes. In particular, we present an algorithm to enable the base station to securely compute predicate count or sum even in the presence of such an attack. Our attack-resilient computation algorithm computes the true aggregate by filtering out the contributions of compromised nodes in the aggregation hierarchy. Extensive analysis and simulation study show that our algorithm outperforms other existing approaches.

[5] P. Corke, T. Wark, R. Jurdak, W. Hu, P. Valencia, and D. Moore: This paper is concerned with the application of wireless sensor network (WSN) technology to long-duration and large-scale environmental monitoring. The Holy Grail is a system that can be deployed and operated by domain specialists not engineers, but this remains some distance into the future. We present our views as to why this field has progressed less quickly than many envisaged it would over a decade ago. We use real examples taken from our own work in this field to illustrate the technological difficulties and challenges that are entailed in meeting end-user requirements for information gathering systems. Reliability and productivity are key concerns and influence the design choices for system hardware and software. We conclude with a discussion of long-term challenges for WSN technology in environmental monitoring and outline our vision of the future.

3. EXISTING METHOD

Wireless sensor technology is growing rapidly, especially with many new Internet of Things (IoT) applications. In another side, researches are coming out with diversities of approaches to enhance and improve this technology trying to cover the needs in this era. The drawback of sensor Technologies is the low battery and short lifetime. So, most of the following researches considering sophisticating these weaknesses and suggesting different algorithms and approaches overcome these issues. Sharma proposed novel LEACH protocol in the heterogeneous network and compared the simulation results with LEACH Homogeneous system; They chose 100 * 100 meters area to simulate the protocol. Sharma found that 10 nodes have more energy than the rest of 90 nodes which improves the system lifetime and enhanced wireless sensor network performance.

Naveen explored fifteen different types of clustering wireless sensor protocols which considered more in energy efficient and lifetime of the network system.. Prasad simulated LEACH using TDMA routing protocol. Also, they surveyed the previous approaches for selecting CH and improving the WSN performance such as Euclidian Distance from a node to BS, remaining energy and number of nodes in the same cluster. Increasing the number of dead nodes in the cluster would be the reason for shortening the WSN lifetime. Nandi [10] implemented a new protocol for choosing an optimal place for the BS, which overcomes the issues of delivering data and they compared the simulation result with the basic LEACH protocol with TDMA technique. Commonly when the BS located far away from the node, then transmitting data from a node to BS will cost more energy in the node, which leads to reduce the node lifetime and therefore reduce the network lifetime [10]. Moreover, packet delivery time would be reduced when the sink positioned in the center near the nodes [10].The authors proposed an algorithm called Distance Based Cluster Head (DBCH) which the threshold value measured by the following equation :

$$T(n) = \frac{p}{1-p\left(r mod \frac{i}{p}\right)} + (1-p)\frac{D_{max}-D_{i\ to\ BS}}{D_{max}-D_{min}}\left(\frac{E_R}{E_0}\right)$$

where ER is the residual energy of the node for the current round and E0 is the initial energy. This algorithm proposes to select the closest node to the BS as a cluster head. This enhancement considered on two-parameter energy and distance. In addition, it considers the distance from the node to cluster head base station and compared the distance from node cluster head and BS. This study simulated the suggestions on a homogenous network, where all nodes have the same amount of energy.LEACH (Low-Energy Adaptive Clustering Hierarchy) protocol is a basic clustering-based routing protocol for WSNs.

LEACH routing protocol is a WSN routing algorithm designed by Heinzehnan et al. from MIT in the United States, which is the earliest typical hierarchical routing protocol [9]. LEACH protocol adopts the method of distributed CH election, in which some nodes are randomly selected from the network as CHs, and other nodes become cluster member nodes [10]. The CH broadcasts the message that it becomes a CH, and other nodes select the CH with the strongest received signal to join to form a cluster [9]. The cluster member node collects data and transmits it to the CH, which receives data and transmits it to the BS through single-hop communication. The CHs undertake the heavy tasks, including managing the member nodes of the cluster, collecting the data transmitted by the member nodes, data fusion, and intercluster forwarding. Therefore, to balance the energy consumption of nodes, CHs rotate, and the cluster structure is updated periodically.LEACH is a self-adaptive cluster formation protocol. The basic idea of the LEACH protocol is to divide the network into clusters of equal size. The CH rotates periodically, and each cycle is called a "round." Each round is divided into two stages: the establishment stage of the cluster and the stable transmission stage [10].

In the establishment stage of the cluster, each node generates a random number from 0 to 1, and the threshold T(n) is calculated according to equation (1). Then, the random number generated by each node is compared with T(n). If the value is less than T(n), the node is selected as the CH:

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left(r \bmod \left((1/p)\right)\right)}, & n \in G, \\ 0, & n \notin G, \end{cases}$$

where p is the percentage of CH in all nodes, r is the number of current election rounds,

(r mod(1/p)) is the number of nodes that have been selected in this round, and G is the set of nodes without CHs selected in this round. After the end of each CH selection round, each selected CH broadcasts its message of becoming a CH to other nodes. After receiving the broadcast message, other nodes choose to join a cluster according to the received signal strength and send their joining message to the selected CH [11]. Each CH creates and assigns a TDMA schedule between each member node after its member nodes are joined. Then, end the cluster establishment stage and start the data transmission stage. Node becomes cluster head for the current round if the number is less than threshold T (n). Once node is elected as a cluster head then it cannot become cluster head again until all the nodes of the cluster have become cluster head once. This is useful for balancing the energy consumption. In the second step, non-cluster head nodes receive the cluster head advertisement and then send join request to the cluster head informing that they are members of the cluster under that cluster head. All non-cluster head nodes save a lot of energy by turning off their transmitter all the time and turn it on only when they have something to transmit to the cluster head [2]. In third step, each of the chosen cluster head creates a transmission schedule for the member nodes of their cluster. TDMA schedule is created according to the number of nodes in the cluster. Each node then transmits its data in the allocated time schedule [3].

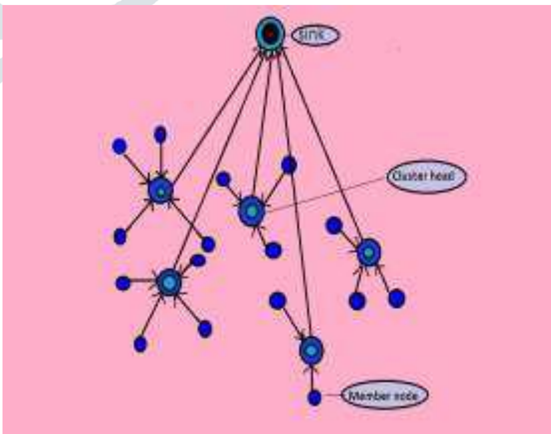


Fig.3: Hierarchical or cluster based routing

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is a TDMA based MAC protocol. The principal aim of this protocol is to improve the lifespan of wireless sensor networks by lowering the energy consumption required to create and maintain Cluster Heads.

LEACH is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy.

Nodes that have been cluster heads cannot become cluster heads again for P rounds, where P is the desired percentage of cluster heads. Thereafter, each node has a 1/P probability of becoming a cluster head again. At the end of each round, each node that is not a cluster head selects the closest cluster head and joins that cluster. The cluster head then creates a schedule for each node in its cluster to transmit its data.

All nodes that are not cluster heads only communicate with the cluster head in a TDMA fashion, according to the schedule created by the cluster head. They do so using the minimum energy needed to reach the cluster head, and only need to keep their radios on during their time slot.

LEACH also uses CDMA so that each cluster uses a different set of CDMA codes, to minimize interference between cluster. The operation of LEACH protocol consists of several rounds with two phases in each [3] [4]: Set-up Phase and Steady Phase.

Steady Phase which is comparatively longer in duration than the set-up deals mainly with the aggregation of data at the cluster heads and transmission of aggregated data to the Base station. In steady phase, cluster nodes send their data to the cluster head. The member sensors in each cluster can communicate only with the cluster head via a single hop transmission. Cluster head aggregates all the collected data and forwards data to the base station either directly or via other cluster head along with the static route defined in the source code. After predefined time, the network again goes back to the set-up phase. The LEACH protocol adopts the concept of clustering and periodic data collection, which can reduce the data transmission between the nodes and the BS.

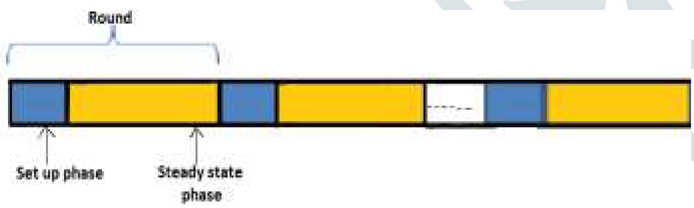


Fig.3: Leach phases

A cluster head in the LEACH protocol is not stabilized; LEACH is established over the round concept and each round includes two stages: a setup stage and a steady-state stage. The setup stage is separated into advertisement aspect and cluster setup aspect, while the steady stage includes the creation of schedule and transferring of data .The LEACH protocol suits WSNs under the following suppositions: &Every sensor node is static, exactly alike, and charged with the identical quantity of initial energy. &Every node consumes energy at the same degree and is capable to identify its remaining energy and controls power transferring and distance. &All nodes can directly connect to every other node, as well as the sink node. &The sink node is determined and in a distance from the wireless network. Thus, the energy consumed by the sink node is ignored. &All nodes have transferred data in each period. The data transmitted by sobering nodes are connected and can be combined.

However, the density of nodes is not considered in the traditional LEACH protocol when selecting the CH. The placement of nodes and the expected number of CHs per round are considered when assigning CHs. Therefore, this protocol cannot ensure the uniform distribution of the CHs Additionally; the LEACH protocol does not consider the residual energy of nodes and the average energy of all nodes when selecting the CH. This will lead to a node with a lower energy being chosen as the CH. Thus, this protocol leads to the quick exhaustion of the node energy. Finally, the CH communicates directly with the BS by adopting a single hop communication mode.

LEACH protocol is threatened by the following types of attacks which degrade the performance of LEACH by dropping, altering, spoofing or replying the packets. A. Sybil Attack Most of the peer to peer networks face security threats due to Sybil attack [8], [9]. This attack is the most difficult attack to detect. In this attack, malicious node uses the identity of many other legitimate nodes to gain the data exchanged between the legitimate nodes. It affects the network by dropping vital packets, increasing traffic, lowering network lifetime etc. Encryption and authentication techniques can be used to prevent wireless sensor network from the Sybil attack. B. Selective Forwarding LEACH protocol is also susceptible to selective forwarding attack. In this kind of attack a malicious node places itself in the path where data is exchanged between the two legitimate nodes. It collects the data and instead of forwarding this node drops all the data. It is the case where the malicious node can easily be detected. The worst scenario of this attack is that when malicious node does not discard the entire data, but selectively forwards some of the non vital information. In this case it is very difficult detect the malicious node. To develop the LEACH protocol we consider the scenario consisting of the following network model and energymodel as proposed by the author:

Network Architecture

The network model for development of the algorithm for clustering and routing consist of the following:

1) In our model we have 100 nodes with equal initial energy The base station is under human observation therefore has unlimited power and the transmit power can be adjusted in an available range.

2) The nodes are considered to be immobile and their locations have been known with the help of either GPS or node self-localization algorithms.

3) We have single sink node which can be moved. The distance between node in the network and the sink node is known by exchanging information. We can change the positions of sink node for analyzing the best position so that minimum distance and low energy communication will take place.

4) CHs can use a single hop to the sink node and need more energy in transmitting the data to the base station and Cluster Member (CM) nodes use single-hop communication with CH as they are closer to the CHs.

5) Sensors periodically sense the environment and send the data to the Base Station

Radio Signal Propagation Model: The first order radio frequency energy consumption model to describe energy feather of the communication channel. The first order radio model can be divided into free-space model and multi-path fading model according to the distance between the sending node and receiving node. The protocol assumes that the communication channel is symmetrical, the energy consumption of l bits message between two nodes with a distance of d can be shown as below equations :

$$E_{Tx}(l,d)=\begin{cases} E_{elec}*l+\varepsilon_{fs}*l*d^2 & d\leq d_0 \\ E_{elec}*l+\varepsilon_{mp}*l*d^4 & d>d_0 \end{cases}$$

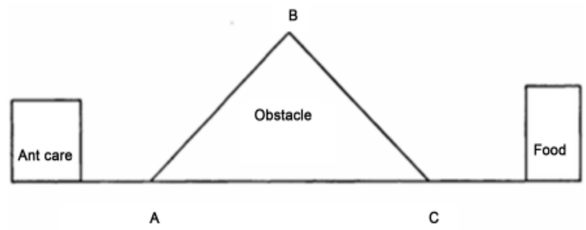
$$E_{Rx}(l)=E_{elec}*l \quad .$$

Where E (l,d) Tx is the energy consumption in transmitting l bits data to a node with a distance of d , E (l) Rx is the energy consumption in receiving l bits data. E elec equals the per bit energyconsumption for transmitter and receiver circuit . E mp and E fsare the amplifier parameters of transmission corresponding to the multi-path fading model and the free-space model respectively. d0 is the threshold distance between multi-path fading model and the free-space model, If d0 < d , the channel approximates free-space model, the energy dissipation in transmitter amplifier is in direct ratio to d^2 . If d0> d , the multi-path fading model will be employed and the energy dissipation is in direct ratio to d^4 .

4. PROPOSED METHOD

Swarm intelligence is a class of Swarm Intelligence algorithms where the algorithms mimic the behaviour of behaviour in the biological organism like fishes, ants and bee's colonies etc. ACO is the one class of swarm intelligence and is a relatively novel meta-heuristic technique (Forster 2007) and has been successfully used in many applications especially problems in combinatorial optimization.

The ant is a social insect. The behaviour of a single ant is very simple, but the ant colony formed by the single simple individual shows extremely complicated behaviour and can finish complex tasks. Besides, ants can adapt to the changes of environment. For example, when obstacles burst in on the path that the ant colony moves on, the ants can find the optimal path again very fast [8]. A large number of studies have found that the reason why the ant colony shows complex and orderly behaviour is that the exchange of information and mutual cooperation among individuals play an important role. In the process of movement, ants can leave a substance called Pheromone on the route that they pass. They can perceive the existence and its strength of this substance when moving and use it to guide the moving direction of them. Ants are inclined to move towards the direction with high strength of this substance. They search for food through ex- changing of this information. Next, we give a very simple biological prototype to understand the principle of ant colony algorithm, as shown in Figure. We suppose the ant colony find food in all directions randomly. When an ant finds the food, it will go back home along the road it comes and leaves pheromone on the way home. The pheromone will volatilize as time goes on and the concentration will decrease constantly. If two ants find the food and go back home, they can walk along the route of ABC or AC from the ant cave to the food. The route of ABC is longer than that of AC. Three ants move food, and the first and the second start first. The probability of choosing the route of ABC or AC is the same. We suppose the first ant takes the route of AC and the second ant takes the route of ABC. Each ant will release pheromone of certain concentration on the route it passes. The biological nature of ants will make it advance towards the route with higher concentration of pheromone. In this way, when the first ant has begun to return, the second ant is still on the way . At this time, because the route of AC has pheromone while the route of ABC does not have pheromone at the end of food source, the first ant still return on the route of AC. When the first ant arrives at home, the third ant starts. It will move forward along the route of AC, which has remnants of pheromone for twice (the ant goes there for one time and returns for one time). The route of ABC has remnants of pheromone only for one time. So the concentration of pheromone on the route of AC is higher than that of the route of ABC. Therefore, the ants will proceed along the route with higher concentration of pheromone. In this way, the ant colony will finally move forward along the route of AC, and then the ants at the back will gradually reach the food source along the short line from A to C.



. Figure.4: of path for ants to find food.

Marco Dorigo introduced the first ACO algorithms. These algorithms were developed by studying the foraging behavior of ants. The inspiring factor was observing how ants build and discover shortest paths among the colony's nest and the source of food. Initially, as the ants start looking for food, they randomly survey the area surrounding their nest. Each ant places a trail of pheromone on the ground. Ants have senses which allow them to smell the pheromone. When subsequent ants leave the nest, they will be inclined to select, in probability, those paths which have stronger concentrations of the pheromone. Whenever an ant locates a origin of food, it assesses the quality and quantity of food. The ant then carries a small quantity of food back to the colony's nest. While coming back to the nest, the amount of chemical pheromone that an ant deposits along the pathway depends on the quality and of quantity the food discovered.

Ant colony optimization (ACO) is an algorithm based on the behavior of the real

$$p_{ij}^{k}=\begin{cases} \dfrac{[\tau_{ij}]^{\alpha}*[\eta_{ij}]^{\beta}}{\sum[\tau_{ij}]^{\alpha}*[\eta_{ij}]^{\beta}} & \forall j\in N_j \,\&\, j\notin M^k \\ 0 & otherwise \end{cases}$$

ants in finding the shortest path from a source to the food. It uses the performance of the real ants in the process of searching for the food. We have observed that the ants accumulates a definite amount of pheromone in its path while they travel from the nest to the food. As they return to the nests, ants tend to follow the same path as marked by the pheromone and again deposit the pheromone on its path. In this way the ants following the shorter path are expected to return earlier and hence increase the amount of pheromone deposit in its path at a faster rate than the ants following a longer path. However, the pheromone is subjected to evaporation by a certain amount at a constant rate after a certain interval and therefore the paths visited by the ants frequently, are only kept as marked by the pheromone deposit, whereas the paths rarely visited by the ants are lost because of the lack of pheromone deposit on that path and as a result the new ants are intended to follow the frequently used paths only. Now, all the ants starting their journey can learn from the information left by the previously visitor ants and are guided to follow the shorter path directed by the pheromone deposit. In ACO, a number of artificial ants (which mimic the data packets) build solutions to the considered optimization problem and exchange information on the quality of these solutions via a communication scheme that is pheromone deposit on the path of the journey performed.

The main objective of the Ants Colony Optimization algorithm is to find the ideal solution through the mutual cooperation and through the exchange of information between the individual variables called ants in the algorithm .The main advantage of ACO is that there is no priority in the information, robustness, and sensors organization requirement. ACO is also used in internet problems, assignment problems etc. related to Wireless Sensor Networks.

In ACO based approach behaviour of real ant searching for food through pheromone deposition is used to find the optimal path.

Ant Colony Optimization (ACO) Algorithm Step by Step:

1.Initialize ACO parameters.

2.Ant solution Construction: Position each ant in the starting node. Each ant will select next node by applying state transition rule.

3.pheromone update. Repeat until ant build the best solution

4.best solution.

1.Intilatizing the Aco parameters: the parameters are as follows Total number of Ants or agents.Max no of iterations, Pheromone initial value, Pheromone exponential weight, Pheromone heuristic weight.

2. When ants trace out a path from their nest to a food source, ant drop pheromone on that path, the shorter a path is, the more pheromone gets accumulated on the path. This is because shorter paths accumulate pheromone deposits at a faster rate. Suppose each ant starts from the source "s" to destination "d", it tries to find the shortest path between these nodes. At each node "i" ant "k" decides to visit the next node "j" based upon the probability (transition probability: probability of moving from node i to node j) given by formulae in equation 1

. ------------(1)

Where $\tau_{i,j}$ is the pheromone concentration on edge between node "i" to node "j". $\eta_{i,j}$ Is the value of heuristic related to path length, α and β are two parameters that control the relative importance of pheromone trail and heuristic value. Related to path length N_j is set of SN. M^k Is the memory of ant "k" The heuristic value related to path length is

$$\eta_{ij} = \frac{1}{l(i,j)}$$

------------------------ (2)

Where l(i,j) is the edge length between nodes "i" and "j".

After each iteration "t", ants deposit quantity of pheromone which is given by

Where $j^k(t)$ is the length of the path from source to destination traversed by ant "k".

3. Total Amount of pheromone quantity on edge "i" to "j" is given by the equation

$$\Delta \tau^k(t) = (1 / j^k(t))$$

$$\tau_{ij}\, \tau_{ij}(t) \leftarrow \tau_{ij}(t) + \Delta \tau_{ij}(t)$$

--------- (4)

But as the time passes the pheromone deposited on the edge start evaporating. A control coefficient ρ ∈ [1,0] decides the amount of pheromone on each edge at any specific iteration which is given by the equation

$$\tau_{ij}(t) \leftarrow (1-\rho)\tau_{ij}(t)$$

4. As no of iteration increases pheromone concentration on shortest path becomes more as compared to relative longer paths present in the network. So more no of ants start taking the path with greater concentration of pheromone which keeps increasing pheromone level. Eventually paths with shorter length are more preferred by ants.

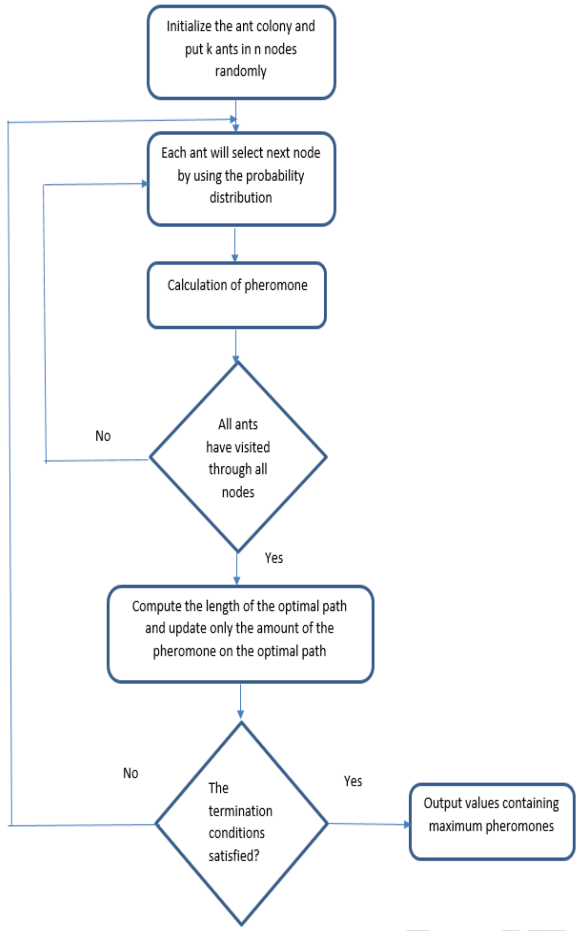


Fig:5: Flow of Proposed method

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5. SIMULATION RESULTS

The simulation performed in MATLAB 2020b. The proposed algorithm is the ant colony optimization (ACO). In proposed algorithm, we take various number of sensor nodes and deploy them randomly. After that, these sensor nodes are trained at different data points, which classify them into dead nodes and alive nodes. After that we apply ant colony optimization algorithm to these trained sensor nodes. In which ants discover the optimal path from source node to destination node. In proposed algorithm, we have taken 50 sensor nodes and placed randomly. We have taken the node 5 and 30 select as a source node and destination node. ACO algorithm trained all these sensor nodes and classified into dead node and alive nodes. Through alive nodes, ants discover the optimum path from source node to destination node as shown in figure 1.

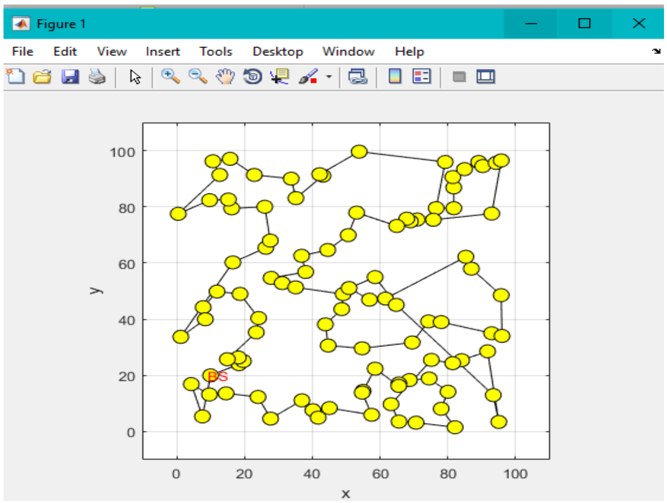

Fig.6:: The optimal path found.

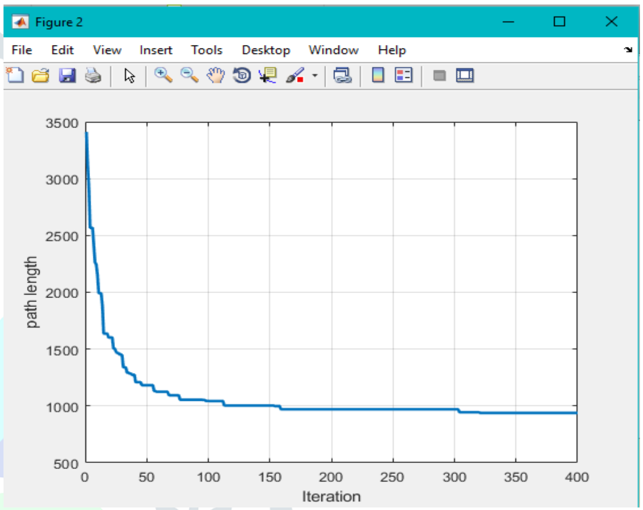

Figure 7:The length of the path in each cycle

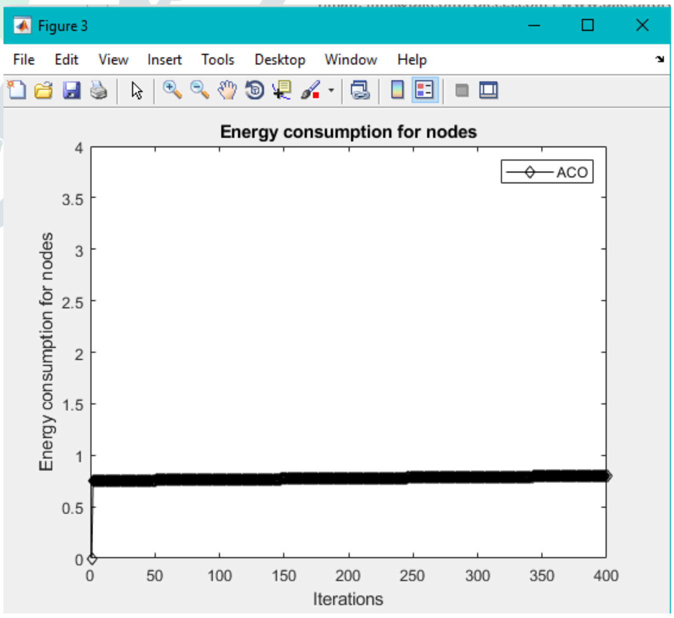

Figure 8 :The energy consumption for nodes

6. CONCLUSION AND FUTURESCOPE

The ant colony algorithm adopts the strategy of controlling the moving direction of ants, to make the ants move towards the direction closer to the target node, so that the ants can reach the target node faster, accelerating the convergence rate of the algorithm. It makes the path with the least energy consumption of nodes. The simulation data prove that the optimal path with the least energy consumption can be found.

Future Work

ACO can be an effective optimization algorithm to improve the lifetime of the nodes of WSNs. The proposed approaches can be combined or used individually to achieve the desired performance objectives. Future research can explore the application of other bio-inspired optimization algorithms for WSN optimization.

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