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DYNAMIC DEPLOYMENT OF WIRELESS SENSOR NETWORKS USING MACHINE LEARNING ALGORITHMS

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Abstract— **Wireless Sensor Networks (WSN) consisting of nodes with limited power are deployed to gather useful field. In WSNs it is critical to collect the information in an efficient manner. The routing problem is a very important part in this kind of networks that need to be considered in order to maximize the network life time. As the size of the network increases, routing becomes more complex due to the amount of sensor nodes in the network. Sensor nodes in Wireless Sensor Networks are very constrained in memory capabilities, processing power and batteries. Heuristic routing approach have been proposed to solve the routing problem trying to deal with these constrains. This paper mainly focuses on routing in WSN using Artificial Bee Colony(ABC) algorithm and Ant Colony Optimization(ACO) algorithm.**

Index Terms— **Wireless sensor networks, Artificial Bee Colony optimization, Ant Colony Optimization, FANT,BANT**

I. INTRODUCTION

A wireless sensor network consists of a large number of unattended, usually self-organized micro sensors, of size of the order of a cubic centimeter, scattered in an area for a specific application. Each micro sensor is capable of sensing data from the environment, performing simple computations and transmitting this data over wireless medium either directly to command centre or through some cluster head, commonly known as gateway. WSNs [6] are designed for information gathering, rather than distributed computing.

Sensors nodes are battery operated and once deployed are unattended and expected to operate for a long period of time, usually from a few months to years. Thus, energy is a scarce resource in a wireless sensor network and hence its efficient usage is crucial for extending the life of the whole sensor network. A sensor's energy is mainly consumed in the three main activities: sensing, computing and communicating [7]. The main task of a wireless sensor node is to sense and collect data from a certain domain, process them and transmit it to the sink where the application lies.

Routing of sensor data has been one of the challenging areas in wireless sensor network research. Current research on routing in wireless sensor networks mostly focused on protocols that are energy aware to maximize the lifetime of the network, scalable for large number of sensor nodes and tolerant to sensor damage and battery exhaustion. This paper focuses on these applications, for which it proposes a localized ABC routing protocol [1] to compute the number of nearest nodes along with their optimizations and the outcome of this is given to next level that uses ACO algorithm [3] for better optimization that leads to global optima decision by selecting a shortest path.

In WSNs, sensors can collect information about the area within their detection ranges[8]. They share their information with their neighbor sensors. Therefore, to have effective detection in a network that includes sensors communicating with each other, the covered area should be expanded. In order to increase the ratio of covered area, the changeability of the mobile sensors' positions can be used. There is no priori information about the area of the interest, so initial deployments of the WSNs are chosen randomly. Each sensor knows its position. The mobile sensors can communicate with others and can change their positions by using information from the others.

II. PROPOSED FRAMEWORK USING MACHINE LEARNING ALGORITHMS

The ABC algorithm [2] a new swarm intelligence method inspired by the intelligent foraging behavior of honey bees, is used for the dynamic deployment problem of WSNs. The aim of the optimization technique is to maximize the coverage rate of the network.

In the ABC algorithm, the position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. Therefore, the deployment of the sensors in the sensed area (each solution of the deployment problem) refers to a food source in the algorithm. The coverage rate of the network, i.e. the total coverage area, corresponds to the fitness value (nectar) of the solution.

In the ABC model [9] artificial bee colonies, in which the goal of the bees is to find the best solution comprise 3 groups of bees: employed bees, onlookers, and scouts. A bee waiting in the dance area to determine the choice of a food source is an onlooker, and when a bee goes to a previously visited food source, it is an employed bee. A bee that carries out random searches is called a scout.

ACO algorithms have been shown to react quickly to changes in the network. Insects like ants, bees and termites live in

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colonies. Every single insect in a social insect colony seems to have its own agenda.. Swarm Intelligence is emerged with collective intelligence of groups of simple agents. This approach emphasizes on distributedness, flexibility, robustness and
direct or indirect communication among relatively simple agents. The agents are autonomous entities, both proactive and reactive and have capability to adapt, cooperate and move intelligently from one
location to the other in the communication network. The basic idea of the ant colony optimization (ACO) meta-heuristic [4]is taken from the food searching behaviour of real ants.

When ants are on the way to search for food, they start from their nest and walk toward the food. When an ant reaches an intersection, it has to decide which branch to take next. While walking, ants deposit pheromone, which marks the route taken. The concentration of pheromone on a certain path is an indication of its usage. With time the concentration of pheromone decreases due to diffusion effects. This property is important because it is integrating dynamic into the path Searching process.

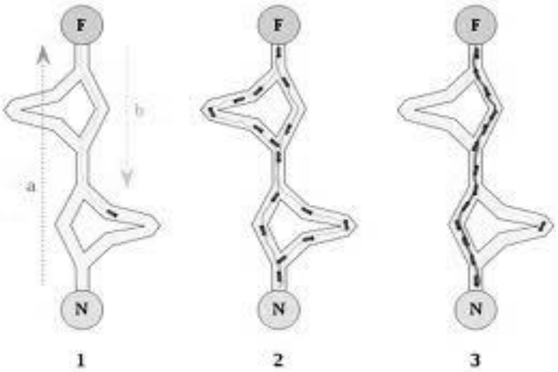

Figure1 All ants take the shortest path after an initial searching time

The Three Phases of Ant Based Algorithm

- Route discovery phase
- Route maintenance phase
- Route failure handling

A. Route Discovery Phase

Route discovery phase uses control packet to discover route from source to destination. The control packets are sensor agents which walk through the network to establish routes between nodes. Route discovery uses two ant agents called Forward Ant (FANT) and Backward Ant (BANT). These two ants are similar in structure but differ in the type of work they perform. A FANT is an agent, which establishes the pheromone track to the source node, and BA establishes pheromone track to the destination. A forward ant is broadcast by the sender and relayed by the intermediate nodes till it reaches the destination. A node receiving a FANT for the first time creates a record in its routing table. The record includes destination address, next hop and pheromone value.

The node interprets the source address of the FANT as the destination address, the address of the previous node as the next hop and computes the pheromone value depending on the number of hops the FANT needed to reach the node. Then the node forwards the FANT to its neighbours. FA packets have unique sequence number. Duplicate FANT is detected through sequence number. Once the duplicate ants are detected, the nodes drop them. When the FANT reaches the destination, its information is extracted and it is destroyed. BANT is created with same sequence number and sent towards the source. BANT reserves the resources at along the nodes towards source. BANT establishes path to destination node.

Tour construction

- Ant k is located in city i
- N_i^k is the neighborhood of city i
- Probability to go to city $j \in N_i^k$

$$p_{ij}^k = \frac{\tau_{ij}^{\alpha} \cdot \eta_{ij}^{\beta}}{\sum_{l \in N_i^k} \tau_{il}^{\alpha} \cdot \eta_{il}^{\beta}}$$

- $\alpha = 0$ – greedy algorithm
- $\beta = 0$ – only pheromone is at wor0k
  - quickly leads to stagnation

update pheromone trails – evaporation

Evaporation for all connections $\forall(i, j) \in L$:

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

$\rho \in [0, 1]$ – evaporation rate

- T^k – path of ant k
- C^k – *length of path* T^k

Ants deposit pheromone on visited arcs:

$$\tau_{ij} \leftarrow \tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij}^k, \forall(i, j) \in L$$

$$\Delta\tau_{ij}^k = \begin{cases} 1/C^k, (i, j) \in T^k \\ 0, otherwise \end{cases}$$

B. Route Maintenance Phase

Route Maintenance plays a very important role in WSN’s as the network keeps dynamically changing and routes found good during discovery may turn to be bad due to congestion, signal strength, etc. Hence when a node starts sending packets to the destination, it is essential to find the goodness of a route regularly and update the pheromone counts for the different routes at the source nodes. To accomplish this, when a destination node receives a packet, it probabilistically sends a Congestion Update message to the source which informs the source of the REM value for that route. This Congestion Update message also serves an ACK to the source.

C. Route Failure Handling Phase

This phase is responsible for generating alternative routes in case the existing route fails. Every packet is associated with acknowledgement; hence if a node does not receive an acknowledgement, it indicates that the link is failed. On detecting a link failure the node sends a route error message to the previous node and deactivates this path by setting the pheromone value to zero. The previous node then tries to find an alternate path to the destination. If the 11111alternate path exists, the packet is forwarded on to that path else the node informs its neighbours to relay the packet towards source. This continues till the source is reached. On reaching the source, the source initiates a new route discovery phase. Hence ant algorithm does not break down on failure of optimal path. This helps in load balancing. That is, if the optimal path is heavily loaded, the data packets can follow the next best paths.

III. RESULTS

Step1: In the proposed system rules can be defined based on the data that is received by sensors at each stage.
Step 2: These rules can be given as an input to the ABC algorithm[5] which will generate number of neighboring nodes which have a match to the given optimization value.
Ex: Input String 1001001
Generates the nodes 1,4,&7
Output of ABC is calculated by No.of matched nodes / Total no.of nodes. Loop is continued until the requirements are satisfied, if it fails go to Step 3.
Step 3: Inputs of ACO gets from outputs of ABC and generates upto 90% best optimization level. i.e ACO selects the node which is at a shorter distance.

Following example clearly explains how packets are transmitted form one node to another using machine learning algorithms in WSN's.

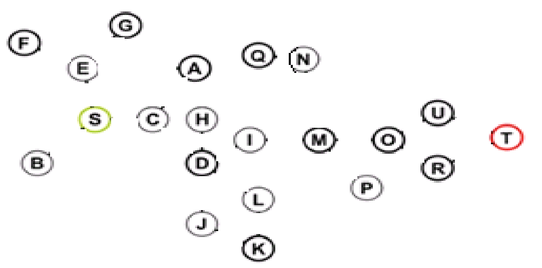

Figure2 S wants to send data to T

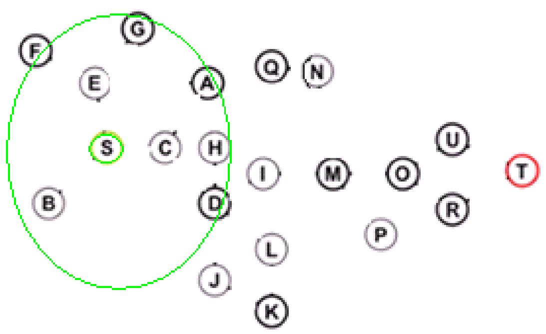

Figure 3 T not in Zone. S sends external forward ant to pheripheral nodes.

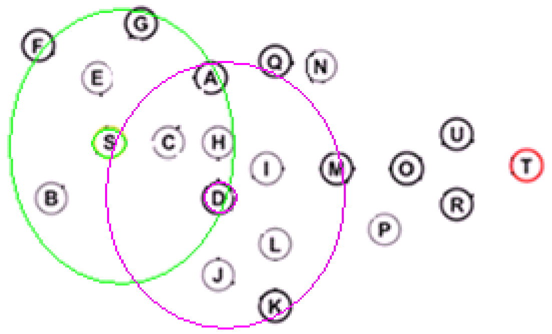

Figure 4 D sends external forward ant to K and M, the other ants are destroyed

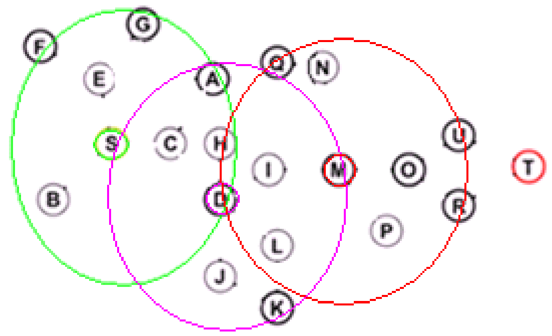

Figure5 M sends external forward ant to pheripheral nodes,Except of S and A

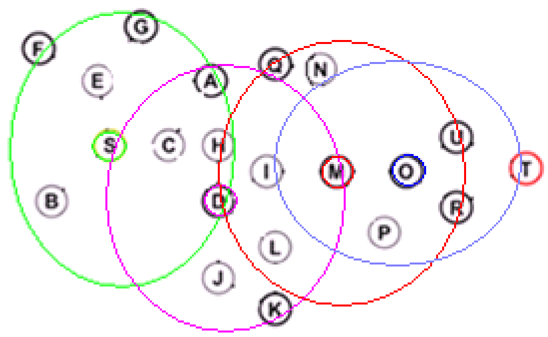

Figure 6: T is in intrazone routing tables. Two paths were found. A backward ant is launched.

IV CONCLUSION

In the proposed system, Artificial Bee Colony(ABC), Ant Colony Optimization(ACO) algorithms gives a better decision, though we do not have robust production rules. It optimizes routing paths, providing an effective multi-path data transmission to obtain reliable communications in the case of node faults. We aimed to maintain network life time in maximum, while data transmission is achieved efficiently. Our proposed algorithm can control the overhead generated by ants, while achieving faster end-to-end delay and improved packet delivery ratio. The algorithm used in the system can be treated as quite effective, in most cases it finds a solution which represents a good approximation to the optimal one and fast enough for the number of iterations. The future work could be to investigate different methods to further limit the traffic or load in WSN. The functionality of the System can be extended further to many more areas in and around the world.

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