Ant Colony Based Optimistic Route Discovery and Packet Distribution Approach

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Abstract - *Energy consumption, time requirement and speed management are the most important problem in wireless sensor networks. So considering the non-uniform network, new method called power control optimization based on the PACA (parallel ant colony algorithm) is presented for the energy consumption optimization. The new mechanism can search the multiple paths and optimize the route of data transmission to homogenize the energy consumption of the nodes. In the simulation, three different network nodes distribution are adopted and the new mechanism is compared with the fixed power routing method. The results show that the new mechanism can homogenize the nodes' energy consumption, required less time to route discovery and relatively high speed and extend the whole network's life effectively.*

***Key Words*: Parallel Ant Colony Algorithm, Power Control, Wireless Sensor Networks, Energy Consumption**

1. INTRODUCTION

The nodes of WSN (wireless sensor networks) are widely distributed in the harsh area and hard to maintain, so that WSN is an energy constrained network. In the design of a wireless sensor networks, time management, balancing of speed and energy consumption are critical issues, which are the key factors to extend the life of the network effectively. There are already some researches which show that the nodes nearest to the sink node always have much higher energy consumption than others, leading the whole network to collapse quickly. In this case, it is necessary to develop an effective method to decline these nodes' energy consumption to let their energy be similar to others'. The existing power routing method required more time to route discovery. Also data transmission speed is very less. The power control mechanism is the effective way to solve these problems. The power control mechanism is a kind of methods to reduce the energy consumption by optimizing data transmission power.

In this paper, we deals with the concept of dividing the algorithm into a some smaller parts and multiple routes are discovered using individual parallel ACO algorithm and then the pheromone factors and probability measure is computed for each of the routes and more packets will be send to those routes which having maximum probabilistic measure and less packets to a route which has low probabilistic measure. The mechanism of algorithm be operated all by the nodes.

In real life, a single ant's ability and intelligence are very simple, but they can complete quite complicated work such as nesting, foraging, migrating and cleaning nest by coordinating, dividing the work and cooperating. Through observing and researching the foraging of the ant colony, scientists found that ants can always seek a shortest path between the food and the nest. The ants leave the pheromone by which they communicate with each other when they are passing the path. At first, ants search the route randomly and then concentration of the pheromone increases more quickly in the shorter path than that in the longer as time passes. The following ants will be attracted by the higher concentration of the pheromone so that they are more likely to choose the shorter path and at last the ants can find a shortest route from the nest to the food.

Ant colony algorithm has natural parallelism. In the algorithm, artificial ants explore the solution space independently so that the algorithm can be separated into some parts which execute concurrently and through communicating with each other, the whole algorithm is complicated. Because of this feature the parallel ant colony algorithm is used to achieve the power control mechanism. By this method, computer is not needed any more, and the nodes can complete the task of choosing the data transmission power all by themselves.

2. LITERATURE SURVEY

In this paper, a new mechanism for the optimal energy consumption in WSNs is presented on the basis of the ant colony algorithm (ACA). The proposed mechanism can realize a best allocation of the energy for each single node in a given network. Simulation results show that, comparing with the directed diffusion routing method, the new routing mechanism can reduce the main nodes' energy consumption and lengthen the whole network's life effectively [1].

This paper discusses the relevant theoretical problems of ant colony algorithm, analyzes the defects of the traditional ant colony algorithm, and proposed an improved ant colony algorithm to solve these problems. Wireless sensor network routing should satisfy both to ensure data transmission and reduce the amount of communication requirements. The paper presents development of routing protocol for wireless sensor network based on improved ant colony algorithm technology. The simulation results show the effectiveness of this algorithm [2].

Previous work on topology control usually assumes homogeneous wireless nodes with uniform transmission ranges. In this paper, we propose two localized topology control algorithms for heterogeneous wireless multi hop networks with non-uniform transmission ranges: directed relative neighborhood graph (DRNG) and directed local minimum spanning tree (DLMST). In both algorithms, each node selects a set of neighbors based on the locally collected information. We prove that (1) the topologies derived under DRNG and DLMST preserve the network connectivity; (2) the out degree of any node in the resulting topology by DLMST is bounded; while the out degree of nodes in the topology by DRNG is not bounded; and (3) the topologies generated by DRNG and DLMST preserve the network bi-directionality [3].

In this paper, we present a minimum spanning tree (MST)-based algorithm, called local minimum spanning tree (LMST), for topology control in wireless multi hop networks. In this algorithm, each node builds its LMST independently and only keeps on-tree nodes that are one-hop away as its neighbors in the final topology. We analytically prove several important properties of LMST: 1) the topology derived under LMST preserves the network connectivity; 2) the node degree of any node in the resulting topology is bounded by 6; and 3) the topology can be transformed into one with bidirectional links (without impairing the network connectivity) after removal of all unidirectional links. Simulation results show that LMST can increase the network capacity as well as reduce the energy consumption [4].

Underwater sensor networks are typically distributed in nature and the nodes communicate using acoustic waves over a wireless medium. Such networks are characterized by long and variable propagation delays, intermittent connectivity, limited bandwidth and low bit rates. Due to the wireless mode of communication between the sensor nodes, a medium access control (MAC) protocol is required to coordinate access to the shared channel and enable efficient data communication. However, conventional terrestrial wireless network protocols that are based on RF technologies cannot be used underwater. In this paper, we propose PLAN - a MAC Protocol for Long-latency Access Networks that is designed for use in half-duplex underwater acoustic sensor networks. We utilize CDMA as the underlying multiple access technique, due to its resilience to multi-path and Doppler's effects prevalent in underwater environments, coupled with an RTS-CTS handshaking procedure prior to the actual data transmission. Using simulations, we study the performance and efficiency of the proposed MAC protocol in underwater acoustic networks [5].

Transmit power control is a prototypical example of a cross-layer design problem. The transmit power level affects signal quality and, thus, impacts the physical layer, determines the neighboring nodes that can hear the packet and, thus, the network layer affects interference which causes congestion and, thus, affects the transport layer. The challenge is to determine where in the architecture the power control problem is to be situated, to determine the appropriate power level by studying its impact on several performance issues, to provide a solution which deals properly with the multiple effects of transmit power control, and finally, to provide a software architecture for realizing the solution. We distill some basic principles on power control, which inform the subsequent design process. We then detail the design of a sequence of increasingly complex protocols, which address the multidimensional ramifications of the power control problem. Many of these protocols have been implemented, and may be the only implementations for power control in a real system. [6].

3. SYSTEM DESIGN

Self-organized networks are potentially very large and not regularly distributed. For example, one single network can cover the entire world. Also, self-organized networks are highly co-operative, the tasks at any layer are distributed over the nodes and any operation is the results of the cooperation of a group of nodes. People believe that WSN will be the main architecture of the future wireless networks where the normal wireless networks are impossible to build, especially in military usage or emergency. They think the most important characteristic which sets Wireless Ad-hoc networks apart from cellular networks is the fact that they do not rely on a fixed infrastructure. They also think Light MAC networks are very attractive for tactical communication in military and law enforcement. Again, they believe that Wireless Ad hoc Networks will play an important role not only in military and emergency application, but also can be applied in civilian forums such as convention centers, conferences, and electronic classroom.

In our study, a general model of WSN is used. In that model we do some assumptions:

1) The entire wireless network coverage area is round and all network nodes are distributed in a circular area which sink node is located above the center of the circular area.

2) All the nodes in the network non-uniformly distribute. And all the nodes belong to the same type, which have the same function, energy, etc. Each node is all utility nodes, and has the ability to send and receive and transmit data.

3) On the network nodes, the RF modules have fixed launch distance, which won't change because of energy reducing or interference.

4) Don't consider mutual interference problems in the process of the signal transmission, namely the signal from the send node must be received by the receive node, and that there are no problems for channel.

5) Don't consider data fusion.

6) Sink node receives and processes all the data sent to it.

The sink node locates in the center of the area and all nodes do not distribute uniformly.

The whole monitored area is divided into some zones.

IV PROPOSED SYSTEM

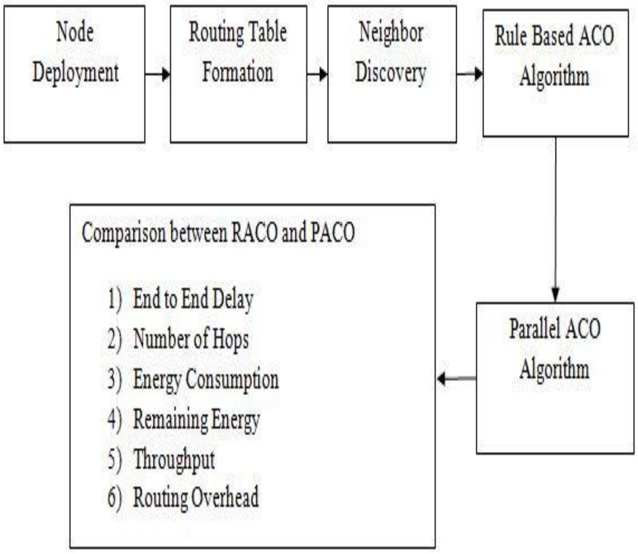

Fig. 1: Proposed Methodology

The Node Deployment is the algorithm which is used to place the nodes in the network in the given area of x*y. Route table formation algorithm is used form the routing tables for the nodes in the network. The number of routing tables will be equal to number of nodes in the network. Each of the routing table will have N entries where each record will have {nodeid, distance}. Neighbor Discovery is a process of finding the neighbor nodes. These are a set of nodes which fall within the transmission range.

Rule based ACO Algorithm is used to first find the rules and then the number of routes will be equal to number of rules with a multiplicative factor of neighbors. For each route discovery route is discovered between source node to destination node based on rule. Also the algorithm will find several such routes per neighbor. The RACO protocol (RACO) is based on source routing, which means that the originator of each packet determines an ordered list of nodes through which the packet must pass while traveling to the destination. The key advantage of a source routing design is that intermediate nodes do not need to maintain up-to date routing information in order to route the packets that they forward, since the packets source has already made all of the routing decisions. This fact, coupled with the entirely on-demand nature of the protocol, eliminates the need for any type of periodic route advertisement or neighbor detection packets.

Parallel ACO Algorithm is used to compute multiple routes between source node to destination node and each route is computed based on grade level and residual power level. Finally for the paths the pheromone, delta pheromone and probalistic measures are computed and then the route which has highest probabilistic measure that will transmit maximum packets as shown in the fig 2.

PACO algorithm is used to find multiple routes as shown in the below flowchart

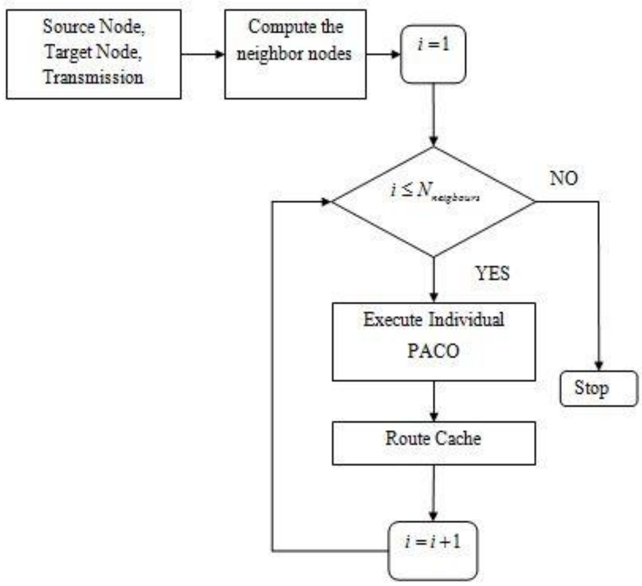

Fig. 2: PACO Algorithm

Individual routes are discovered using the below flow chart

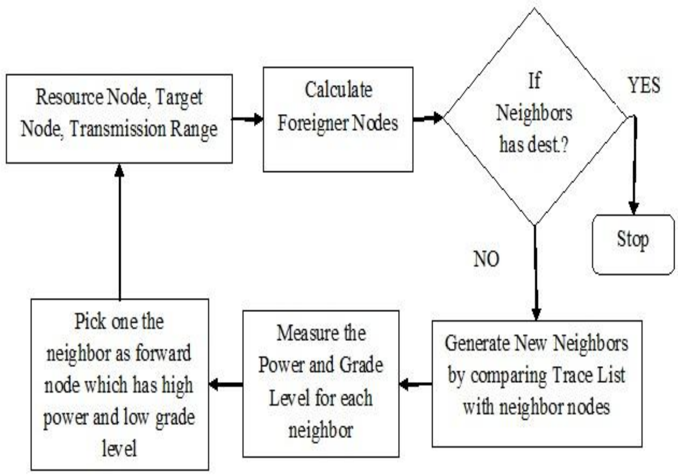

Fig. 3: Individual Route Discovery

The Individual Route Discovery Algorithm can be described as follows

1. Source Node, Destination Node, Transmission Range acts as an input.

2. The neighbor nodes for the source node are found.
3. If the neighbor nodes have the destination node then stop the process.
4. If the destination node is not present then go to step5
5. Compare the neighbor nodes with Trace List (TL) and then new neighbors are found.
6. For each of the new neighbors find the grade level and power link
7. Pick the forward node which has maximum of above measure
8. Repeat from step1 to step7 until destination is reached.

Algorithm for best route discovery is as follows,

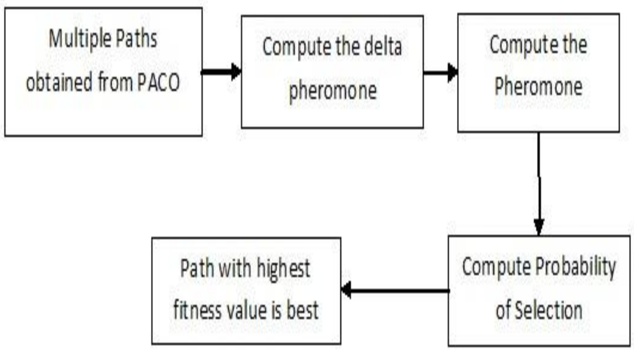

Fig. 4: Best Path Selection

4. RESULTS AND DISCUSSION

The simulation results obtained in the Parallel Ant Colony algorithm and Rule base ACA analyzed and discussed by taking few examples in this chapter. Using MATLAB the simulated results obtained, also entire coding is done in MATLAB.

Energy Consumption

From the figure 5 the energy consumption in Rule based ant colony algorithm is more compared to parallel ant colony algorithm. So for example PACA consumed 31J and RACA consumed 280J for the 25 iterations of data transmission. Thus Parallel Ant Colony is better compared to Rule based ant colony algorithm.

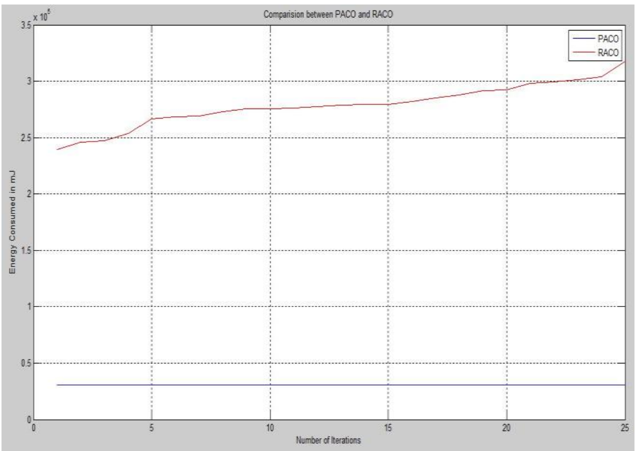

Fig. 5: Energy Consumption of nodes between PACA and RACA

Route discovery time

From the figure 6 the time required in Rule based ant colony algorithm is more compared to parallel ant colony algorithm. So for example PACA required around 0.02ms and RACA required around 0.25ms for the 25 iterations of data transmission. Thus Parallel Ant Colony is better compared to Rule based ant colony algorithm.

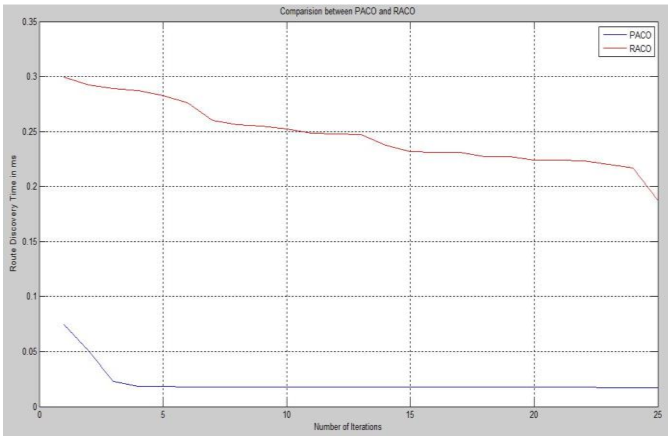

Fig. 6: Time required between PACA and RACA

Routing Overhead

Total control packets to the total data packets is called routing overhead. Control packets is equivalent to 2 * number of hops and data packets kept fixed value like 1000. Algorithm is good if the routing overhead is less, because more number of data packets can send by using less number of control packets. In figure 7 routing overhead of PACO is very less compared to RACO, hence PACO performs well.

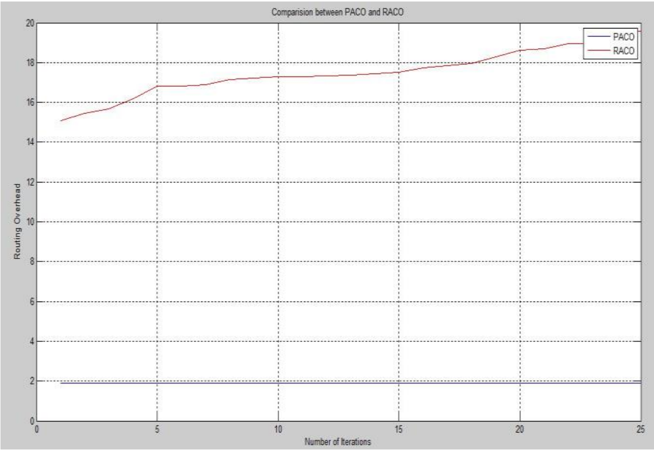

Fig. 7: Routing overhead between PACA and RACA

Number of Hops

Figure 8 shows, Parallel ant colony algorithm required less number of hops compared to existing power routing algorithm, i.e., Parallel ant colony considered 100 hops to for 25 iterations whereas rule base ant colony considered around 850 links for 25 iterations. Hence PACA performs better.

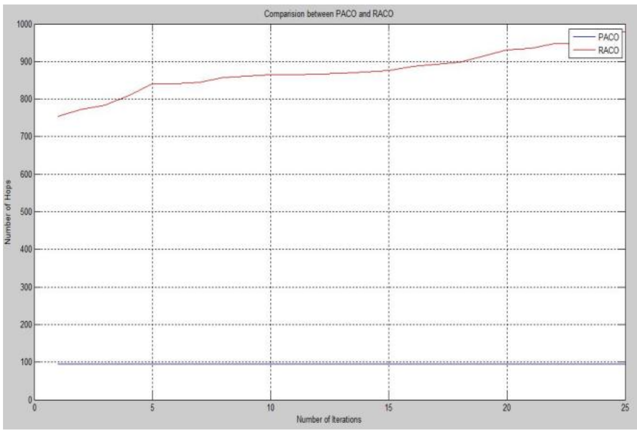

Fig. 8: Number of Hops between PACA and RACA

5. CONCLUSION

In this Project, a new mechanism based on parallel ant colony algorithm is presented to reduce the maximum and the sum of the energy consumption, reduce the time requirement, increase transmission speed and homogenize the energy cost of the nodes. In the network model, the nodes distribute unevenly. And the proposed mechanism is better compared to existing power routing method.

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