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Performance Analysis of Travelling Salesman Problem in Ant Colony Optimization in Wireless Sensor Networks

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Abstract: ***Ant colony algorithm is a metaheuristic algorithm which uses nature for finding solutions. Ant colony algorithm, by its performing behavior we know ant performs a series of routes as followed by deposition of pheromones. It is one of the algorithms used in Swarm Intelligence. Other Swarm Intelligence algorithm performs operation on the basis of collection behavior of ants, insects, birds, flies and other animals etc. Ant colony algorithm is used in various types of application such as Vehicle routing problem, Maximum input output detection etc. Ant colony algorithm has been successfully used for solving travelling salesman problem over large number of years. While, it has some drawbacks slow convergence speed, easily sousing into local minimum. Our aim is to find most favorable path through shortest distance and number of interactions accurately and quickly to get improved efficient energy, by using improved Ant colony algorithm.***

Keywords: Ant colony optimization, Travelling salesman problem, Wireless sensor network, Swarm intelligence, Euclidean distance.

1. Introduction

Wireless sensor network buildup international position in recent years. A new technology known as Micro-Electro-Mechanical system (MEMS) which open doors the devilment of smart sensors. These sensors are small with controlled processing and measuring resources, and they are cheap in comparison to traditional sensors. These sensor nodes can measure, feel, share and gather information from the surroundings of environment and based on that local decision process, they can pass collected data to the user. Sensor nodes are low power devices assembled with one or more smart sensors, a processor, memory, power supply, radio, and an actuator. A variety of mechanical, thermal, biological, optical, magnetic sensors etc. may be attached to the sensor node to measure properties of the environment. There is a tremendous growth in wireless sensor network which consist of large figure of homogeneous and heterogeneous sensor nodes which communicate in wireless fashion in order to achieve common objective. Homogeneous nodes are preferred over heterogeneous nodes because of less complex nature and better manageability. Each small sensor node communicates with other nodes within its radio communication range. Nodes can be easily deployed in random or deterministic fashion and are normally battery operated. Network management is the means of managing, supervising, and controlling the behavior of a network.

Wireless sensor networks impose unique challenges for network management that make conventional network management techniques. Wireless sensor network is commonly used in various all-over and wall to wall applications. Due to reserved power resources, the energy saving communication protocols and intelligent data circulation techniques are needed; otherwise, the energy resources will evacuate drastically and the network monitoring will be severely reserved. The network lifetime is described as the number of messages that can be received as far as all the nodes present in working condition. In a data gathering environment, the gathered data are highly correlated and each node is capable of gathering any incoming messages to a single message and limit redundancy of data. As a result all nodes build an augmentation tree which is directed and rooted at the base station.

2. Literature Study

Komal Chadha, Najme Zehra Naqvi, Harmeen Kaur Matheru(2011)[5] Ant colony optimization (ACO) is a meta-heuristic approach to tackle hard combinatorial optimization problems. The basic element of ACO is a solution construction mechanism, which affect the decision-making processes of ant colonies as they forage for food and find the most efficient routes from their nests to food sources. This paper is a review report on ant colony optimization with its algorithms in chronological order and Vehicle routing problem (one of the application of ACO).Following this, there is a brief introduction of Estimation-based ACO.

Zar Chi Su Su Hlaing and May Aye Khine, Member(2011)[6]Ant colony optimization (ACO) is a heuristic algorithm which has been proven a successful technique and applied to a number of combinatorial optimization problems and is taken as one of the high performance computing methods for Traveling salesman problem (TSP). TSP is one of the most popular combinatorial optimization (CO) problems and which has wide application qualification. ACO have great search capability for optimization problems, but it still remnant a computational bottleneck that the ACO algorithm costs too much time to convergence and traps in local optima in order to find an optimal solution for TSP problems. The proposed paper presents an improved ant colony optimization algorithm with two steps. First, candidate set strategy is adapted to fast convergence speed. Secondly, a dynamic updating rule is adapted for heuristic parameter based on entropy to improve the performance in solving TSP.

Algorithm are verified on benchmark problems from TSPLIB and test results are generated. From our experiments, the presented algorithm has better performance than the conventional ACO algorithm and the results of the proposed algorithms are found to be satisfactory.

Kuo-Sheng Hung, Shun-Feng Su, and Zne-Jung Lee (2006)[7] Ant colony optimization (ACO) has been successfully applied to solve combinatorial optimization problems, but still it has some drawbacks such as stagnation nature, long computational time, and premature convergence. These shortcomings will be more evident when the problem size increases. In this paper, we reported the analysis of using a lower pheromone trail bound and a dynamic updating rule for the heuristic parameters based on entropy to improve the efficiency of ACO in solving Traveling Salesman Problems (TSPs). TSPs are NP-hard problem. Even though the problem itself is simple and easy to solve, when the number of city is large, the search space becomes extremely large and it becomes very difficult to find the optimal solution in a short time. From our experiments, it can be found that the proposed algorithm indeed has superior search performance over traditional ACO algorithms do.

Marco Dorigo, Luca Maria Gambardella We describe an artificial ant colony capable of solving the traveling salesman problem (TSP). Ants of the artificial colony are able to generate successively shorter feasible tours by using information accumulated in the form of a pheromone trail deposited on the edges of the TSP graph. Computer simulation observation demonstrates that the artificial ant colony is capable of generating good solutions to both symmetric and asymmetric aspects of the TSP. The method is an example, like simulated annealing, neural networks, and transformative computation, of the successful use of a natural metaphor to design an optimization algorithm.

Anshul Singh, Devesh Narayan(2012) Traveling Salesman Problem (TSP) is about finding a Hamiltonian path with minimum cost. Travelling salesman problem (TSP) finds its application in many real world industrial applications including the areas such as logistic companies, transportation and semiconductor industries. Few potential applications of TSP includes finding an optimized scan chains route in integrated chip testing, parcels collection and sending in logistics companies, and transportation routing problem. This paper gives a brief overview of the various approaches that have been implemented to solve TSP and specifically bee colony optimization (BCO) for solving TSP. The BCO model is constructed algorithmically based on the collective intelligence shown in bee foraging behavior.

Fevrier Valdez, Ivan Chaparro(2013)This paper describes the symmetric travelling salesman problem (TSP) with 22 and 1060 cities with Euclidean distances and its solution with different ACO variants using parallel processing. We implemented the algorithms Elitist Ant System (EAS) and Rank Based Ant System (ASrank) with parallel processing to find optimal\results for TSP.

Jaskiran Kaur, Inderpal Singh(2013)[8]This paper deals with Ant Colony Optimization, a heuristic algorithm with tough robustness and the ability of finding the optimal solution which has been applied to a number of combinatorial optimization problems, of which the most important one is the traveling salesman problem (TSP). Ants of the colony have the ability to generate shorter feasible tours through information, which is accumulated, in the form of a pheromone trail deposited on the TSP graph's edges. For solving the TSP problem, ACO is one of the high performance computing methods but still has some drawbacks, which include stagnation nature, computational time, and premature convergence problem.

3. Problem Description

A. The Traveling Salesman Problem

The TSP is extensively studied in literature survey and has attracted in many ways since a long time a considerable amount of research effort has been made. The TSP also plays an important role in Ant Colony Optimization since the first ACO algorithm, called Ant System as well as many of the subsequently proposed ACO algorithms have initially been applied to the TSP. The TSP was chosen for many reasons: (*i*) it is a problem to which ACO algorithms are easily applied, (*ii*) it is an *NP*-hard optimization problem, (*iii*) it is a standard test-bed for new algorithmic ideas and a good performance on the TSP is often taken as a proof of their usefulness, and (*iv*) it is easily understandable, so that this algorithm behavior is not obscured by too many technicalities. Intuitively, the TSP is the problem of a salesman who wants to find food, starting from his home town, a shortest possible trip through a given set of customer cities and to return to its home town. More formally, it can be represented by a complete weighted graph $G = (N, A)$ in which N represent set of nodes, which represent cities, and A the set of arcs fully connecting the nodes N. Each arc is assigned a value d_{ij}, which is the length of arc $(i; j)$. The TSP is the problem of finding a shortest Euclidean distance of the nodes of G. For symmetric TSPs, the distances between the cities are independent of the direction of traversing the arcs that is, $d_{ij} = d_{ji}$ for every pair of nodes.

4. Proposed Work

A. Ant Colony Algorithm

Ant algorithms are a latterly developed, population-based approach which has been successively applied to number of *NP*-hard combinatorial optimization problems. As the definition of this suggests, ant algorithms have been inspired by the behavior of real ant colonies, in particularly, by their foraging behavior. One of the main aspects of ant algorithms is the indirect communication of a colony of agents, called ants, based on location of pheromone trails (pheromones are also used by real ants for communication that can be used by other ants). The pheromone trails are a kind of scattered numeric information which is used by the ants to retract and point out their experience while solving a particular problem. Recently, the Ant Colony Optimization has been developed which provides a cooperating framework for most of the applications of ant algorithms to solve combinatorial optimization problems. In particular, all the ant algorithms applied to the TSP perfectly into the ACO meta-heuristic

way and therefore, we will call these algorithms as ACO algorithms. The first ACO algorithm, called Ant System has been applied to the Traveling Salesman Problem (TSP). Starting from Ant System, several improvements of the basic algorithm have been proposed. Typically, these improved algorithms have been tested again on the TSP. All these improved latest versions of AS have in common a stronger exploitation of the best solutions found to direct the ants' search process; they mainly differ in some aspects of the search control. Additionally, the best performing ACO algorithms for the TSP improve the solutions generated by the ants using local search algorithms. In this paper we give an overview on the available ACO algorithms for the TSP.

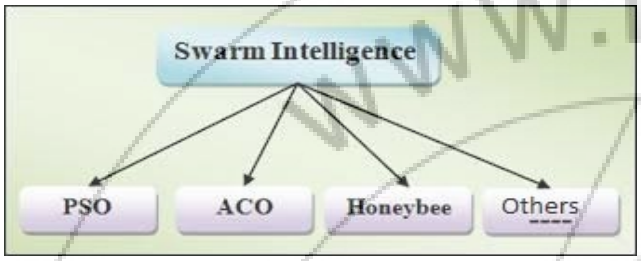

Figure 1: Types of Swarm Intelligence

5. Result

Hence we concluded that as number of cities get either increased or decreased they are always better in performance by traversing nodes as cities and finding the most optimal path for ants by using optimization technique.

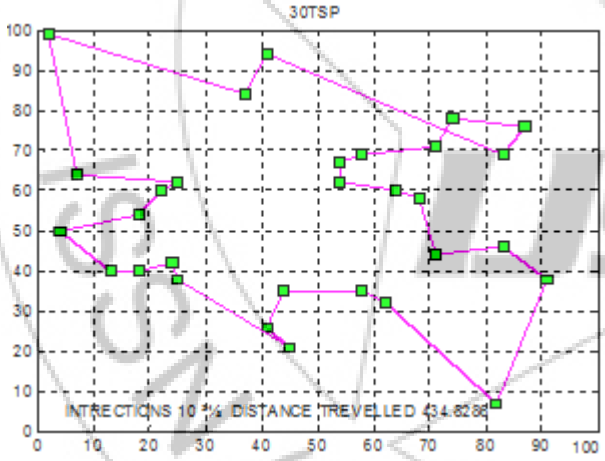

Figure 2: Applying TSP to 30 cities

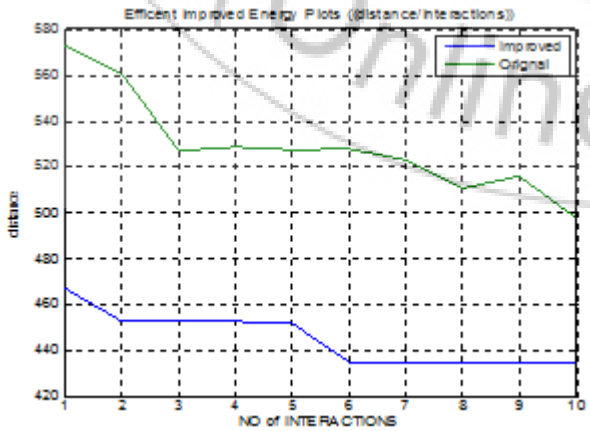

Figure 3: Efficient Energy Plots (distance/interactions)

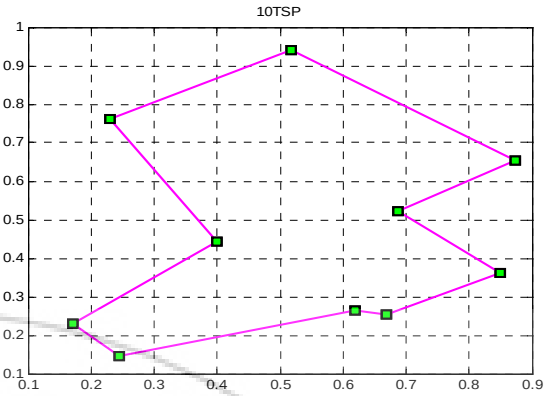

Figure 4: Applying TSP to 10 cities

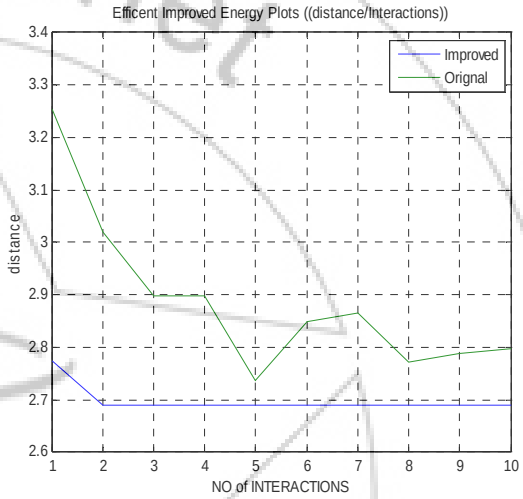

Figure 5: Efficient Energy Plots (distance/interactions)

6. Conclusion

In this paper, we have presented an overview of swarm intelligence applied to network routing. Inherent properties of swarm intelligence as observed in nature include: massive system scalability, emanating behavior and intelligence from low complexity local interactions, self- determining, and stigmery, or communication through the environment with the help of nodes. These properties are usable for many types of networks. Swarm intelligent based approaches hold great promise for solving numerous problems of ad-hoc power aware networks. Swarm intelligence, however is a new field and much work remains to be done. Comparison of the performance of swarm-based algorithms has been done by simulation. Analytic proof and models of the swarm-based algorithm performance remain topics of ongoing research.

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Author Profile

Nancy Goyal received the B.Tech. degree in Computer Engineering from Maharishi Markandeshwar Engineering College, Mullana in 2012, respectively. During 2012-2014, i stayed in networking lab, to do a research on Swarm Intelligence. The technique, I used is Ant colony algorithm to improve the performance of travelling salesman problem.