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MULTIOBJECTIVE VEHICLE ROUTING WITH ANT COLONY OPTIMIZATION SUPERVISED BY PARTICLE SWARM INTELLIGENCE

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***Abstract*—**Networks can be defined as agroup of nodes connected together generally for purpose of communicating with each other. Multi objective vehicle routing challenges to satisfy all the required constraints like distance, capacity and interlinking conditions. Various routing algorithms are used to determine the optimal solution to this problem. In this project combinatorial approach using ant colony optimization (ACO) and particle swarm intelligence (PSI) is carried out in order to determine optimal path for vehicle routing problems (VRP) ACO is supervised by PSI to reduce the possibility of ants revolving in the local optima. In ACO local search (ACOLS) Floyd Warshall algorithm, which is all pair a shortest path technique is applied in order to check all possible routes. This paper focuses on finding an optimal routing strategy based on linear networks. It is achieved by avoiding greedy algorithm and focusing on ACO and PSI methods.

***Keywords*—**Vehicle routing problems, Ant colony optimization, Particle swarm optimization, Floyd Warshall algorithm, colony supervised by particle swarm.

I. Introduction

Logistic management is the new and rising problem for organizations with manufacture and supply. These problems received increasing attention from government and business organizations. Green manufacturing is one of the top concerns of every product based organization. One of the actions taken by such companies towards this is to optimize the end product supply using proper routing strategies. The distribution and collection within the system depends upon customer needs and satisfaction provided with concerns about the nature. In the case of most of delivery and pickups, utilization of vehicles will produce a measurable amount of tangible and intangible cost. This will impact in bothn production and in natural concerns. Utilization of vehicle increases significantly when product brought to customer with returning back to a depot. Hence vehicle routing is more effective in bi-directional logistics. There are many categories in vehicle routing problems and strategies. Most of these variants are based on objectives of routing strategy. Objectives can be time, time window, capacity of vehicle, traffic conditions and so on. Capacitated vehicle routing problems [1-3] and VRPSDPTW are more challenging combinatorial optimization problems [4]. Studies on such problems are scarce since capacity constraints along with time windows are more complex problems and difficult to solve. Optimization strategies on such problems will be considering a bounded service area and the techniques will be chosen according to the areas.

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II. ANT COLONY OPTIMIZATION

In computer science and operations research, the Ant Colony Optimization algorithm (ACO) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. [5] This algorithm is a member of the Ant Colony Algorithms family, in swarm intelligence methods, and it constitutes some Meta heuristic optimizations. Initially proposed by Marco Dorigo in 1992 in his PhD thesis, the first algorithm was aiming to search for an optimal path in a graph, based on the behavior of ants seeking a path between their colony and a source of food. The original idea has since diversified to solve a wider class of numerical problems [6-8] , and as a result, several problems have emerged, drawing on various aspects of the behavior of ants.

III. PARTICLE SWARM OPTIMIZATION

Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr.Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling. PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations [9, 10]. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles. The detailed information will be given in following sections. Compared to GA, the advantages of PSO are that PSO is easy to implement and there are few parameters to adjust. PSO has been successfully applied in many areas: function optimization, artificial neural network training, fuzzy system control, and other areas where GA can be applied [11, 12]. After finding the two best values, the particle updates its velocity and positions with following equation (a) and (b). v[] = v[] + c1 * rand() * (pbest[] - present[]) + c2 * rand() * (gbest[] - present[]) (a) present[] = present[] + v[] (b) [13] v[] is the particle velocity, present[] is the current particle (solution). pbest[] and gbest[] are defined as stated before. rand () is a random number between (0,1). c1, c2 are learning factors. Usually c1 = c2 = 2.

IV. FLOYD WARSHALL ALGORITHM

Floyd Warshall algorithm is an algorithm for finding shortest paths in a weighted graph with positive or negative edge weights (but with no negative cycles).[1][2]A single execution of the algorithm will find the lengths (summed weights) of the shortest paths between all pairs of vertices, though it does not return details of the paths themselves. Versions of the algorithm can also be used for finding the transitive closure of a relation, or (in connection with the Schulze voting system) widest paths between all pairs of vertices in a weighted graph. The Floyd–Warshall algorithm compares all possible paths through the graph between each pair of vertices. It is able to do this with Θ (|V|3) comparisons in a graph. This is remarkable considering that there may be up to Ω (|V|2) edges in the graph, and every combination of edges is tested. It does so by incrementally improving an estimate on the shortest path between two vertices, until the estimate is optimal.

V.EXISTING SYSTEM

The multi objective algorithm of the existing model uses a simple shortest path strategy with simultaneous pickup and delivery choice. It provides an interconnection of local searches. Time windowing technique is applied which sets a maximum time limit after which the trip will stop.

A.Multi objective local search (MOLS)

It uses different local search procedures to optimize different objectives. The different solutions are based on the amount of weight to be collected from each area.In denser areas with less traffic large capacity vehicles are used (MOLS 1).
In denser areas with high traffic vehicles with largest capacity are took in to practice (MOLS 2).In scarce areas with less traffic vehicles with minimum capacity are used (MOLS 3).In scarce areas with high traffic medium capacity vehicles are used (MOLS 4).

B.Multi objective mimetic algorithm *(MOMA)*

It's used for solving simultaneous delivery and pick up problems.It divides the system in to n sub problems using a weighted sum approach.It uses a crossover operator to determine the paths.By using crossover operator the path for the second vehicle route is obtained by inheriting routes from parents. MOMA acts as supervisor to MOLS algorithm.

VI. PROPOSED SYSTEM

A multi objective routing algorithm that emphasize on finding the shortest path from currently located node satisfying some other objectives such as weight, traffic etc. A linearly expanded network model could make the application of such algorithm in the real world problems .Using a routing algorithm that will avoid the creation of a tree formatted network. This will avoid complexities in the real world applications. A linear network model will reduce the overhead due to the traversal inside a minimum spanning tree. Using ant colony optimization (ACO) and particle swarm optimization (PSO) for node selection can reduce the total distance travelled.

ALGORITHM 1: For startup main cycle

1: phero_max = 2
2: perform Initial ()
3: for i 1 to values do
4: perform add_bond() and update pheromone
5: calculate Dist_min(i) and update shortest distance in dist_min
6: end for
7: for i 1 to values do
8: phero_ini = phero_max(i)
9: perform update_pheromone(i) with updated_ant(i)
10: end for

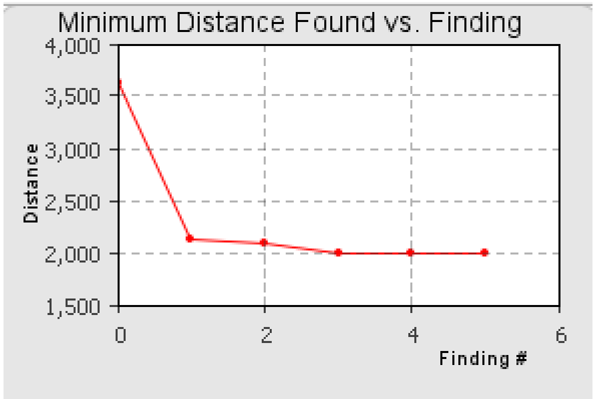
This algorithm initializes the pheromone and distance values and add a link between each of the node points by using add_bond() . It then determines the shortest distance from the current node using Dist_min() and update the pheromone using update pheromone() . This action is carried out in cycles until the total shortest distance is achieved. The total shortest distance is by adding all the selected bond dist_min values.

ALGORITHM 2 : ACOLS-PSI

1: Initialize gbest and pbest to infinity
2: for a 1 to values do
3: for b 1 to values do
4: for c 1 to values do
5: check if bond(b,a) + bond (a,c) > bond (b,c) ,if true go to step 6 else continue
6: update bond(b,c) = bond(b,a)+ bond (a,c)
7: end for
8: end for
9: end for
10: for i 1 to values do
11:perform ACO search using distance(i) and allocate to pbest
12: add local pbest values
13:end for
14:check if pbest<gbest,if true go to step 15
15:assign dist_min as pbest

VII. EXPERIMENTAL ANALYSIS

The ACOLS-PSI algorithm when compared with greedy algorithm (prims algorithm) produced an improvement of 8% on average. Also, another key notable point was that the efficiency of the algorithm improves when the system is wide and sparse. In denser areas the proposed system performs more or less similar to current system.



VIII. CONCLUSION AND FUTURE SCOPE

This paper introduces a new approach towards vehicle routing problems by using a combination ACO and PSI. ACO is implemented using Floyd Warshall algorithm which determines all pair shortest paths instead of the commonly used greedy algorithm techniques. Another contribution of this paper is supervising the ACO local search by PSI to reduce the probability of ant wandering in the local optima. To further improve vehicle routing problems especially on wider and sparse network, this algorithm can be used as a benchmark. Furthermore, ACOLS-PSI algorithm can be combined with various other all pair shortest path or similar methods to generate a mematic algorithm to improve performance of vehicle routing problems.

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