ANT COLONY OPTIMIZATION ALGORITHM GPS CLUSTERING APPROACH

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Abstract: The geometry of the GPS satellite recipient (s), which reflects the recipient (s) of the satellites, has a major influence on the total positioning precision. The more precise the position, the stronger the geometry of the satellite. This article provides the geometry of satellite clustering for the selection of suitable satellite navigation subsets. This technique is based on the GDOP (Geometric Precision Dilution) satellite factor cluster with the Ant Colony Optimization (ACO) algorithm that has been created by simulating real and artificial ways to locate the quickest route between nesting resources and food. Pheromones are utilised in the suggested technique to assess the iterative outcome of single colonies. The ACO method can measure all subsets of satellites while reducing computer load by eliminating the need for a matrix inversion. Based on the simulation results, the GPS GDOP clustering technique is more efficient at achieving its optimum value.

Key words: ACO, GDOP, GPS, Clustering.

1. Introduction
The Global Positioning System (GPS) is a global navigation system created by the United States Department of Defence. It consists of 24 or more Earth-rounds in at least six aeroplanes, five control stations, and user receiving equipment. The GPS receiving signals are sent by these satellites. The distance (range) of each satellite may be calculated by timing when the signal arrives. The user's position may be calculated in three dimensions using the non-linear equation system below, with a range of at least four satellites [1-3].

\[ p_i = \sqrt{(X - X_i)^2 + (Y - Y_i)^2 + (Z - Z_i)^2} + b - c \delta_i \]  

The ACO algorithm mimics a real group's collaborative route. Each ant individually searches the solution space for the solution and gives some information about the solution found. Ameisen leaves more information about the best-performing option, which has a higher probability of getting selected. All solutions have the same information in the early stages of
the algorithm. The improved solution acquires more and more information with the development of computers. This ensures that the algorithm obtains the answer for optimization or almost optimization [4]. Compared to others, such as the Genetic Algorithm (GA), the ACO is able to look for optimal solutions both locally and globally by altering parameters. The list contains the best places. ACO may escape the optimal locally and reach the ideal globally. Moreover, the calculation procedure for ACO is faster since it does not use complex operators like aberration and intercross [5].

Conventional clustering techniques under supervision assume that all of the topic classes present in this dataset are known ahead of time. Unattended clustering, on the other hand, does not need any prior data knowledge. The main objective of clustering unsupervised learning is to split a data set into groupings (clusters) such that the data points in a cluster are more similar than those in other clusters [6-12]. To create an unsupervised clustering method, we used the Ant Colony Optimization (ACC) algorithm for GPS GDOP.

2. Ant Colony Optimization with Algorithm

The quickest route to food may be found by leaving a pheromone trail as travel. More ants follow the path to the summit. Ants that take the shorter route leave a stronger pheromone trail than those who take the longer route. Because the stronger the pheromone, the better it attracts the ants, the shortest route is increasingly chosen until all the ants choose the shortest route. Take three potential routes to the food supply, one shorter than the other. Ants have the same probability for each route. Ants that travel the shortest distance and return cause the most pheromones to be released as quickly as possible. New ants will then pick the track and a local optimiser will be linked to another algorithm. One issue is the early convergence towards an improper solution because too many virtual pheromones have been deposited quickly. Pheromone evaporation is carried out to prevent this standstill. In other words, over a period of time, the pheromone with a solution will disappear [13-15].

The objective of the GPS GDOP clustering is to achieve an optimum distribution of N satellites in one of the K clusters, where N is the satellite number and K is the cluster number. Artificial ants are referred to as software ants or agents in the algorithm and the number of agents is indicated by R. In the first iteration, bits begin with empty solution strings, and pheromone matrix components begin with identical values. The pheromone matrix is updated with a progression of iterations according to the quality of the products produced [16-20]. The solution strings stated in S of length N are specified by each algorithm agent and the solution string of each element is empty at the start of its algorithm. Each string element is equivalent to one of the test samples, and its value contains the cluster it is allocated. The agent utilises pheromones to assign each element of string S to a suitable class label for the purpose of building a solution. The pheromone matrix $\beta$ is initialised at the beginning of the procedure at a modest value of $\mu_0$. Each solution string S element of each agent is thus allocated to one of the K clusters during the first iteration.

The optimal solution is the one that minimises the objective function value. If the best memory solution value is updated with the best solution value in the current iteration, if it is less objective than the best memory solution, the best memory solution is kept; otherwise, the best memory solution is kept. This method explains the completion of one algorithm iteration. The method iterates through these steps indefinitely until the optimal partitioning of subjects in a given dataset into different groups is reached by the required number of iterations and the solution with the lowest function value is obtained.

The ACO problem clustering method is summarised below [8];

1. New R solutions were produced employing software ants with information from earlier iterations of the pheromone trail modified.
2. A local search for newly created solutions is conducted.
3. Pheromone trail matrix update
3. **Comparison with other algorithms**

Advantages of ACO are inherent parallelism, positive feedback required for proper solutions, efficiency for problems similar to travelling sale man. It can be used in dynamic application by adapting to changes such as new distances. Further convergence is guaranteed though the time may me uncertain. ACO is more applicable to problems where source and destination are relatively specific and predefined whereas PSO is a clustering algorithm for multi objective optimization and constriction handling. It is more applicable for getting crisp results while PSO is applicable to problems which are fuzzy in nature. ACO as advantages over GA and simulated annealing as the ant colony algorithm and run continuously and adaptive to changes in real time. This feature makes it useful in network routing transport systems and GPS related problems.

**Figure 1.** The flow chart of ACO algorithm developed for solving data-clustering problem

**Figure 2.** The visible GPS constellation's geometry
4. ACO algorithm for GPS GDOP clustering

Superb satellite geometry may be achieved at high elevations. Better geometry is provided with wider satellites. The DOP may be determined using precision dilution (DOP). As the DOP is lower, the geometric force is better. The DOP number is determined by relative satellite geometry (i.e., it requires the availability of both the receiver and the satellite coordinates). With early data, we can predict the DOP's value. The DOP will move due to the receiver and satellite movements (S). In today's world, many DOPs are being deployed. For example, consumers may wish to examine the geometry and the resultant quality of the three-dimensional location (latitude, longitude, and height). The value of the DOP position may be examined (PDOP). PDOP increases the three-dimensional positioning precision of the satellite geometry. Vertical and Horizontal DOP: (VDOP). Normally, GDP is larger than GDOP. Low precision response to GPS elevation. The VDOP may be enhanced by other sensors with GPS sensors. PDOP and TDOP are most often referenced in DOP (GDOP) variations.

Figure 3. The GPS GDOP diagram using an ACO algorithm.

The GDOP determines the resultant solution's measurement noise magnification factor. The GDOP idea is a strong GPS utility. The receivers use an algorithm called GDOP to monitor the optimal set of satellites from a group of up to 11 satellites. After that, multiply the range precision by the dilution factor to get the precise location. The dilution factor (DOP) is solely dependent on geometry. Geometric differences are often considerably more significant than changes in the nominal satellite's constellation range. If the nominal satellites are not visible, the GDOP method calculates the effect. In order to provide position precision, the multiplier will receive accuracies from the GDOP calculation for the still-monitored satellites. Figure 2 depicts the 'Good DOP' and 'Poor DOP.'

$$G D O P = \sqrt{A_1^{-1} + A_2^{-1} + A_3^{-1} + A_4^{-1}}$$

5. Simulations and Results

A DOP rating of less than 2 is considered outstanding, although it does not happen as often, and needs a clear vision of the sky to the horizon. The 2 to 3 DOP values are considered good. DOP values of 4 or less are typically shown if device accuracy capabilities are given. DOP ratings of 4 to 5 are usually considered good and appropriate for all but the highest accuracy requirements of the survey. A 6 DOP would only be suitable for low accuracy circumstances, such as rough positioning and navigation. The position data should not be recorded when the DOP value exceeds 6. The threshold dose selection affects the parameters and performance of the clustering algorithms minimally. One of the allowable subsets of satellites for navigation may be selected from the GDOP classification (e.g., one with a modest GDOP factor). In this study, the ACO classifier generates three types of output according to the GDOP parameters (the small, medium, and large GDOP). Similarly, it is feasible to organise into other categories based on the same idea. In "Microsoft Visual C#.Net," the application software was developed to provide the best solutions for the ACO algorithm for the problem of GPS GDOP clustering. Table 1 shows the number of clusters, agents, local search agents, pheromone iterations and
beginning levels, evaporation rates of pheromones, and other variables needed for the technique.

### Table 1 The parameters of ACO

| Parameters | Value |
|------------|-------|
| K          | 3     |
| R          | 10    |
| L          | 2     |
| T          | 1000  |
| $\tau_0$   | 0.01  |
| $\rho$     | 0.01  |
| $q_0$      | 0.98  |
| $p_{IS}$   | 0.01  |

The algorithm parameters must be chosen carefully. The algorithm settings recommended in this article are based on experimental results. When a large number of repetitions are conducted, it is possible to get very good clustering. The results show that the recommended approach's correct percentage of clustering is higher than 98 percent.

### 6. Conclusions

GDOP must be reduced to improve the performance of a GPS receiver. It's also crucial to construct a GPS receiver that can receive signals from four or more GPS satellites at all times. Natural and biological systems have been the focus of recent advancements in heuristic optimization techniques. One of the most well-known swarm intelligence optimization techniques is the ACO. Ants' real power lies in their colony's brains and pheromone-driven communication. A technique based on GPS GDOP clustering with ACO algorithms was proposed in this article. The ACO technique can evaluate all satellite subsets without requiring a matrix initialization, reducing the computational burden. The simulation results in the programme indicated that the recommended technique is favored and successful, with an accurate clustering percentage of more than 98 percent for the method presented.

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