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LOCATION INFORMATION SHARING USING FANET BASED ON PSO AND GA

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Abstract: Flying Ad-Hoc Networks (FANETs) are formed which is basically an ad hoc network for UAVs. This is relatively a new technology in network family where requirements vary largely from traditional networking model, such as Mobile Ad-hoc Networks and Vehicular Ad-hoc Networks. In this dissertation, Flying Ad-Hoc Networks are surveyed along with its challenges compared to traditional ad hoc networks. The routing protocols are also described. In this paper proposed work is discussed briefly through firefly algorithm with PSO. Firefly algorithm is a Meta-heuristic algorithm inspired by flashing behavior of fireflies. PSO is population based optimization technique inspired by social behavior of bird flocking or fish schooling.. The objectives of firefly algorithm include localization of other nodes where each node using proposed algorithm for conflict fee flight.

Keywords: FANET, UAV, MAC, PSO

1.0 Introduction

FANET is one of most common ad-hoc network with lot of problems related to congestion and routing. It is providing one of the solutions to secure the transmission over the network. Security aspects play an important role in almost all of the application scenarios given the vulnerabilities inherent in wireless ad-hoc networking from the very fact that radio communication takes place (e.g. in tactical applications) to routing, man-in-the-middle and elaborate data injection attacks. Security has become a primary concern in order to provide protected communication between mobile nodes in a hostile environment. In this proposed approach, author is presenting a mechanism to secure route and data. FANETs enable wireless communication between mobile devices without relying on a fixed infrastructure. Hence, routing in dynamic network is a new challenge.

1. The objective is to minimize the required number of aerial vehicles to complete the tasks within predefined time windows.
2. The problem is to detect various user stations using UAV and to select the best optimal user station that can guide all other intervening nodes. However, the proposed schema aimed only at detection of user stations in a particular and pre-defined range.

2.0 Motivation for The Present Work:

The area of UAV networks is challenging to researchers because of the outstanding issues that provide motivation for research. In mobile and vehicular networks the nodes join and dissociate from the network frequently and, therefore, ad hoc networks have been found to be suitable in most situations. In addition, for quick and reliable communication between nodes, mesh network topology is quite appropriate. Does this apply to the UAV networks as well? In UAV networks, the nodes could almost be static and hovering over the area of operation or scouting around at a rapid pace. Nodes could die out for many reasons and may be replaced by new ones. Some similarities encourage researchers to explore the applicability of the work done for Mobile Ad hoc Networks (MANETs) and Vehicular Ad hoc Networks (VANETs), but works in these areas do not fully address the unique characteristics of the UAV networks. It gives important characteristics of MANETs, VANETs and UAV networks which bring out similarities.

The motivation of FANET is as follows:

2.1 Decreases the mission completion time: The missions, such as reconnaissance, surveillance, search and rescue, can be carried out faster with proportional to the number of UAVs.

2.2 Decreases total/maintenance cost: Instead of using a large and expensive UAV, the usage of multi-mini-UAVs costs are lowered in terms of acquisition and maintenance.

2.2.1Increases Scalability: It increases the area of operation plays by easily adding new UAVs. UAS dynamically reorganizes nodes' routing tables by taking into account newly added UAVs.

2.2.2 Increases Survivability: Multi-UAV systems are more tolerant to faults of hardware/ sensors. In the case of some sensors failing or a loss of control of a UAV, the mission can continue with any remaining UAVs.

2.2.3 Decreases detect Ability (Low radar cross section): A radar cross-section is extremely crucial for military applications. Mini-UAVs have low radar cross-sections, low infrared signatures, and low audio signatures due to their sizes and composite structures. Therefore, they may not be easily detectable by radars (especially compared to airplanes and large UAVs).

3.0 Related Work

Samil Temel et al. Proposed a Medium Access Control (MAC) protocol which name as Location Oriented Directional MAC (LODMAC) protocol. LODMAC successfully handles the neighbor discovery and data transmission in parallel with the help of directional antennas. Also they present the capacity gain of LODMAC protocol which verifies that it is a good alternative for HAP&FANET based scenarios [1]. **Denis Rosario et al.** introduces a Cross-layer Link quality and Geographical-aware beaconless opportunistic routing protocol (XLINGO). It enhances the transmission of simultaneous multiple video flows over FANETs by creating and keeping reliable persistent multi-hop routes [2]. **Perez, D. et al.** described theFANETs are relatively newer ad hoc family, thus most of the previous work focuses only on single UAV guided mobile ad hoc network. Ground control surveillance for multi-UAV system is developed but its scope is limited to few UAVs without capability to form enhanced ad hoc network that can guide various user station on ground and **Daniel et al.** proposed an approach that aimed at formation of air controlled ground ad hoc network [3]. Then **Cevik, P. et al. (2013)** described the Flying ad hoc networks are also studied as swarm of flying nodes that have neural sensing capability that allows path selection on basis of artificially designed neurons. But, these require mini UAVs instead of extensively small UAVs as heavy hardware is required to handle automatic algorithmic updates in between the mission. The UAV swarm is based upon selecting the UAV, which is capable to connect and communicate as main controlling node for connectivity with ground station [4].

4.0 Methodology:

The collision-free trajectory planning algorithm will be based on a heuristic global optimization algorithm named Firefly algorithm. The firefly algorithm (FA0000) is a met heuristic algorithm, inspired by the flashing behavior of fireflies. The primary purpose for a firefly's flash is to act as a signal system to attract other fireflies formulated this firefly algorithm by assuming

1. All fireflies are unisexual, so that any individual firefly will be attracted to all other fireflies;
2. Attractiveness is proportional to their brightness, and for any two fireflies, the less bright one will be attracted by (and thus move towards) the brighter one; however, the intensity (apparent brightness) decrease as their mutual distance increases;
3. If there are no fireflies brighter than a given firefly, it will move randomly.
4. The brightness should be associated with the objective function.

Firefly is iterative, and the solution improves with time. Thus, it is guaranteed that a feasible solution is available at any time, and that this solution will improve its quality if there is more execution time available.

4.1 Particle Swarm Optimization Algorithm (PSO):

The PSO is developed by Kennedy et al., inspired by social and cognitive behaviour of Ants, bird flocking. The PSO algorithm simulates social behaviour among bird individuals (particles) flying through a multi-dimensional search space, each particle representing a point. The particles assess their positions by a fitness function and particles in a local neighbourhood share memories of their best position, while using those memories to update their velocities and positions.

$$vid = wvid + c1 \$ r1 \$ (pid - xid) + c2 \$ r2 \$ (pgd - xid)$$

$$xid = xid + vid$$

Particle updates in basic PSO are accomplished according to (4.1) calculates a new velocity for each particle based on its previous velocity (*v*id), the particle's location at which the best fitness has been achieved (*p*id) so far, and the best particle among its neighbours (*p*gd) at which the best fitness has been achieved so far. Equation (4.1) updates each particle's position (*x*id) in the solution hyperspace. The two random numbers *r*1 and *r*2 are independently generated and *c*1 and *c*2 are learning factors. The use of the inertia weight *w* provides improved performance. The first part is the velocity part, which represents the influence of the previous velocity of the particle. The second part is the cognition part, which represents the private thinking of the particle. The third part is the social part, which represents the collaboration of the particles [5].

4.2 Genetic Algorithm (GA):

GA was first introduced by Holland in the early 1970. Generally, GA comprises three different phases in the searching process:

Phase 1: creating an initial population.

Phase 2: evaluating a fitness function.

Phase 3: producing a new population.

A genetic search starts with a randomly generated initial population, within which each individual is evaluated by means of a fitness function. Individuals in this and subsequent generations are duplicated or eliminated according to their fitness values. Individuals are further manipulated by applying GA operators. There are usually three GA operators in a typical genetic algorithm.

4.2.1 Production Operator: The production operator (elitism) which makes one or more copies of any individual, with a high probability that possesses a high fitness value, conversely the individual with a low fitness value is eliminated with a high probability from the solution pool.

4.2.2 Crossover Operator: This operator selects two individuals from the population current generation and a crossover point (taking the one point crossover for example) and carries out a swapping operation on the elements to the right hand side of the crossover point of both individuals.

4.2.3 Mutation Operator: This operator acts as a background operator and is used to explore some of the invested points in the search space. Since frequent application of this would lead to a completely random search, a very low probability is usually assigned to its operation[5].

4.3 Algorithm Step:

4.3.1 Computing the Weight of Each Node Using PSO

In this algorithm, the best state is determined based on the following measures:

The best location of the node in comparison to surrounded unmanned aerial vehicles. The speed that is closer to the mean speed of the group.

PBest: the best state of the node in comparison to previous states and GBest: the best public state of the node; the lower the absolute difference of these two values, the more the node has an appropriate weight. The best state is computed based on speed and frequency.

- The speed of this node is closer to the mean speed of the group.
- It has a better frequency.

01: function Calc My Group Weigh t(…)

02: GBest = Best global position for nodes based on PSO algorithm;

03: PBest = This node position based on PSO algorithm;

04: return ABS (PBest - GBest);

05: end function

4.3.2 Group Formation Invitation Using PSO

In this stage, the leader node i invites other nodes to form a group. The group is formed based on the optimal weight computation function that was explained before.

01: Function Call For Create Group (…)

02: return Calc My Group Weight ();

03: end function

4.3.3 Optimal Group Formation Using PSO: At the group formation stage, the aerial vehicle is not close to any leader node. This node checks if there are at least X neighbor nodes that belong to no other groups and the variable Y indicates that the aerial vehicle is turned off or separate from the groups. If the number of neighbor nodes that belong to no group is less than group formation threshold, the aerial vehicle waits one time interval (time1) to form a group and reruns the detection function. If then number of neighbor nodes is larger than X+Y threshold, the aerial vehicle begins forming a new group; in other words, it sends a group formation request to its neighbors and nodes can reply to this request. If the number of neighbor nodes is larger than X, the aerial vehicle invites them to form a group. If in comparison to other nodes, this node has a smaller weight; it is selected as the leader node. The leader of the group sends an encryption key to all nodes accepting the request and a public key to all nodes. Otherwise, the remaining Y nodes (not accepting the group formation request) are added to the group.

01: Function Group Creation (...)

02: if (number Of Neighbors>= X + Y) then

03: Accepted Neighbors = 0;

04: n = 1;

05: l = 0;

06: Multicast Neighbors (Neighbors List[]);

07: for (n=1; n _ number Of Neighbors; n++) do

08: Receive Group Election (n);

09: if (neighbor (n) accept) then 1

0: accepted Neighbors(l) = neighbor(n);

11: l++;

12: accepted Neighbors++;

13: end

14: end

5.0 Result Analysis

In Figure 5.1 Fireflies produce luminescent flashes as a signal system to communicate with other fireflies, especially to prey attractions. Following are the assumptions made in the firefly algorithm:

- All fireflies will be attracted to every other firefly regardless of their sex i.e. to say that they are unisex.
- The attractiveness and brightness decrease as the distance increase and are also proportional to each other. The less bright will be moving towards the brighter one. It will move randomly if there is no brighter one.
- The brightness of a firefly is determined or affected by the shape of the objective function.

The final location of 20 fireflies (Iteration)

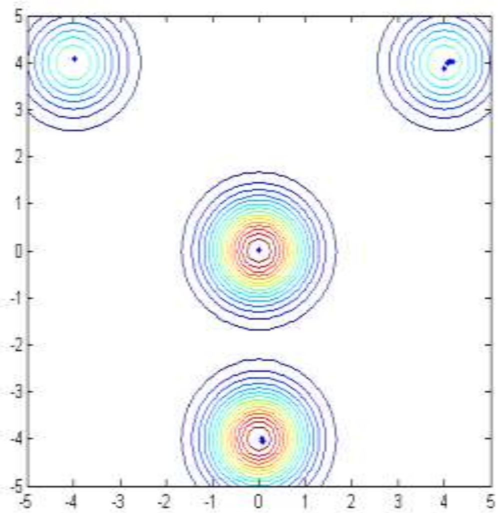

Figure 5.1

Case 1: In figure 5.2, we can see that the network is defined with 30 Iteration. As we can see the Iteration are numbered from 1 to 30. Blue nodes are showing source node and the destination node. All other nodes are the intermediate nodes.

Table-5.1: Information about 30 Iteration and objective value, search position, objective value variance, search position variance of PSO using GA for linear mathematical model

Iteration	FBEST	FVAR	XVAR
1	1.568e+001	2.042e+003	8.397e+000
2	1.067e+001	2.973e+003	5.949e+000
3	5.967e+000	3.495e+003	3.185e+000
4	1.063e+000	3.462e+003	1.976e+000
5	9.433e-001	3.649e+003	1.396e+000
6	9.433e-001	1.906e+003	1.034e+000
7	8.960e-001	1.224e+003	3.833e-001
8	2.318e-001	1.738e+002	3.629e-001
9	2.318e-001	5.743e+002	2.861e-001
10	1.212e-001	2.532e+002	1.111e-001
11	5.603e-002	9.928e+001	1.000e-001
12	5.178e-002	1.871e+001	8.375e-002
13	5.178e-002	2.015e+000	2.435e-002
14	5.178e-002	4.786e+000	4.381e-002
15	2.145e-002	3.366e+000	2.612e-002
16	5.994e-003	4.861e+000	1.850e-002
17	8.794e-004	2.175e+000	1.833e-002
18	8.794e-004	7.515e-001	9.998e-003
19	8.794e-004	5.431e-002	6.684e-003
20	8.794e-004	1.387e-001	3.335e-003
21	1.486e-005	1.272e-001	3.574e-003
22	1.486e-005	8.734e-003	1.019e-003
23	1.486e-005	7.345e-003	7.911e-004
24	1.486e-005	1.392e-002	1.019e-003
25	1.486e-005	3.346e-003	6.769e-004
26	5.902e-006	1.763e-004	1.331e-004
27	5.902e-006	1.895e-003	3.595e-004
28	5.902e-006	2.666e-003	3.207e-004
29	5.902e-006	6.789e-006	4.235e-005
30	5.902e-006	9.374e-005	7.939e-005

Random FANET Network Architecture of 30 Iterations

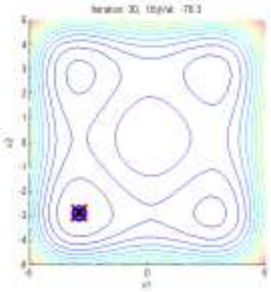

Figure 5.2

Because we have to minimize the energy of overall system, the objective function must be decreased as number of iterations started to increase. Both mean, mean best and mean global best values decreases and iteration gets improved. The Search position indicates exact position of start. It can be seen that in 30 iterations, target position has been achieved. The Objective variance describe change in target position.After only 30 iteration variance mimimzes.As variance increases collision get increases. The search position variance which tells accuracy in search position.State variance indicates changes in state.More changes in state will result in bad affect.

Case 2: In figure 5.4 we can see that the network is defined with 36 Iteration. As we can see the Iteration are numbered from 1 to 36. Blue nodes are showing source node and the destination node. All other nodes are the intermediate nodes.

Objective value,Search position,Objective Value variance,Search position variance of 30 iteration

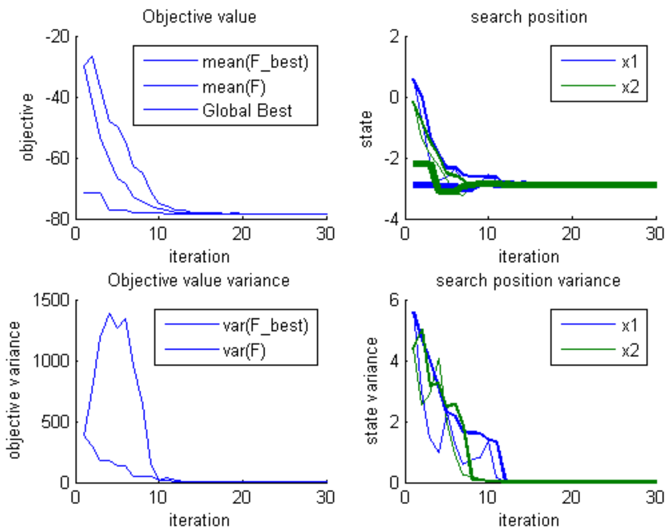

Figure 5.3

Table-5.2: Information about 36 Iteration and objective value, search position, objective value variance, search position variance of PSO using GA for linear mathematical model

Iteration	FBEST	FVAR	XVAR
1	2.231e+001	2.619e+010	1.541e+000
2	2.231e+001	1.187e+007	5.386e-001
3	1.852e+001	8.004e+008	9.262e-001
4	1.852e+001	4.703e+008	4.433e-001
5	1.902e+000,	3.130e+008	1.917e-001
6	1.902e+000	3.100e+007	2.516e-001
7	3.833e-001	5.249e+006	1.411e-001
8	2.349e-001	7.635e+003	3.534e-002
9	2.349e-001	1.238e+005	5.356e-002
10	3.997e-002	6.316e+002	2.321e-002
11	3.997e-002	3.719e+002	1.583e-002
12	3.886e-002,	1.422e+003	2.049e-002
13	1.242e-002	2.545e+003	1.588e-002
14	3.676e-003	1.183e+003	9.220e-003
15	9.648e-004	1.447e+001	420e-003
16	2.447e-004	9.082e+000	2.038e-003
17	1.378e-004	3.334e+000	1.671e-003
18	1.378e-004	9.978e-001	1.142e-003
19	1.378e-004	4.364e-001	6.457e-004

20	1.378e-004	7.520e-002	3.194e-004
21	1.378e-004	7.787e-002	3.380e-004
22	1.378e-004	6.568e-003	1.021e-004
23	1.170e-004	4.011e-003	5.772e-005
24	7.810e-005	1.702e-003	5.607e-005
25	7.810e-005	3.585e-004	2.723e-005
26	7.810e-005	6.478e-004	3.260e-005
27	2.468e-005	6.093e-004	2.814e-005
28	2.468e-005	1.000e-004	1.199e-005
29	1.226e-005	1.807e-004	1.446e-005
30	6.401e-006	1.706e-004	1.021e-005
31	4.775e-006	8.214e-006	4.146e-006
32	8.722e-007	4.647e-005	5.640e-006
33	4.325e-007	2.032e-006	1.113e-006
34	2.819e-007	4.354e-006	2.463e-006
35	2.759e-007	1.302e-006	1.221e-006
36	9.338e-008	6.023e-008	3.096e-007

Random FANET Network Architecture of 36 Iterations

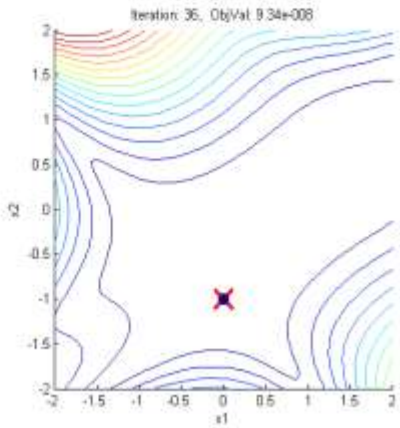

Figure 5.4

Objective value,Search position,Objective Value variance,Search position variance Of 36 iteration

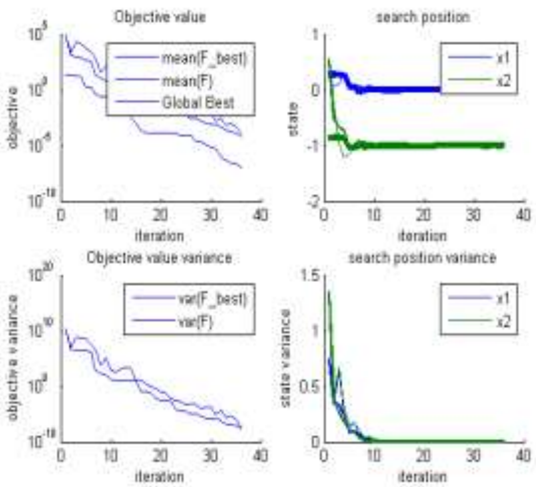

Figure 5.5

This graph shows (5.5) the objective function of flying ad hoc networks. Starting point is described in blue and end point s describes in red. Because we have to minimize the energy of overall system, the objective function must be decreased as number of iterations started to increase. Both mean, mean best and mean global best values decreases and iteration gets improved. The Search position indicates exact position of start. It can be seen that in 36 iterations, target position has been achieved. The Objective variance describe change in target position. After only 36 iteration variance mimimzes.As variance increases collision get increases.The search position variance which tells accuracy in search position.State variance indicates changes in state.More changes in state will result in bad affect.

6.0 Conclusion and Future Scope

In this paper, To raise the scalability of the arrangement, there is a demand of new networking standards thoughts in multi-FANET systems. Networking of multi-FANETs is not merely desirable but additionally a critical feature to raise the efficiency of the arrangement by safeguarding connectivity of the arrangements in non-LOS, city, hostile, and/or loud environmental association systems. Because of the exceedingly mobile nodes, the networking construction ought to be crafted in ad-hoc manner, and is shouted as Hovering Ad-Hoc Web (FANET), that needs scalable, reliable, real-time and peer-to-peer mobile ad-hoc networking amid FANETs and earth stations.

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