A NOVEL TECHNIQUE FOR HETROGENIOUS FLYING ADHOC NETWORKS BASED ON DIFFERENTIAL EVOLUTION

Ranweet kaur[1], Anita Suman[2], Parveen kumar[3]

[1]M.tech (Scholar) [2]Assistant professor, [3]Associate professor

[1,2,3] Department of Electronics and Communication, Beant college of Engineering and Technology, Gurdaspur

Email:[1] kranweet@gmail.com, [2]suman_a1@yahoo.com, [3] parveen.klair@gmail.com

Abstract: Communication is actually the most complicated concern of desingning in Flying ad hoc networks. FANET stands out as equivalently latest perception of MANET and possess capabilities to withstand with the situations where standard MANET can never be. Because of the more flexibilty in nodes and high speed of UAVs, it is very necessary to put forward an accurate routing creteria or protocol by taking account of its various applications fields. In this paper, at first we basically outline FANET along with some common FANET architectures and its advantages over other adhoc networks. We also focus on the distinctions concerning FANETs and remaining other adhoc networks accounting with nodes mobility, density of UAVs, variations in topology, model of propagation, consumption of power and localization. The review has been found that the majority of existing routing protocols for Flying Adhoc Network (FANETs) suffer from packet dropping rate. The use of differential evolution based routing is ignored in existing literature which can find optimum values for efficient routing for FANETs. The effect of heterogeneous UAVs is also ignored by the most of existing researchers in the field of FANETs. Therefore, in this paper, a novel optimistic Differential Evolution (DE) based routing protocol for FANETs is proposed. Comparison of proposed and existing protocols is done on parameters like normalized routing load, communication overheads and packet delivery ratio.Comparative analysis reveals that the proposed technique outperforms competitive techniques.

Keywords: FANETs, characteristics of FANETs, Architecture of FANETs, UAVs Ad Hoc Network

I. INTRODUCTION

FANETs structure validates that each one UAV is communicating with another and also to the base station at the same time with not having any kind of predetermined fixed system [9]. By doing this it cannot just provide the aggregated information to the ground station promptly besides can also possess the ability to reveal it to the other associated UAVs. Furthermore in the procedure when a few of the UAVs tend to be shut off because of the weather it may possibly create their connection to the network via other UAVs. Likewise because of the ad-hoc network on the list of UAVs, it could possibly solve the particular problems just like small range, system failure and also confined assistance which will happen a single UAV technique. MANET is actually a wireless system associated with autonomous cellular gadgets without any central source or even infrastructure however shows self-configuring characteristics. MANETs have numerous application spots for example, tragedy reduction relief, army conversation, immediate business conferences etc. The benefit of MANETs is the flexibility or perhaps mobility. The endemic uses of MANETs provides sub kinds of ad-hoc network technology just like Vehicular Ad hoc Networks as well as Flying Ad hoc Networks. Generally these kinds of systems posses higher flexibility with topology alterations other than MANETs, simply because both in VANET and in FANET, many of the nodes tend to be vehicles and UAVs (Unmanned Ariel Vehicles), respectively. VANETs would be the networks in which vehicle to goals of VANETs are to increase traffic proficiency along with traffic over-crowding, having access to facts and information to prevent crashes, and for fun purpose while driving. FANET is a extension of MANET with support of very high mobility. In FANETs, the nodes are normally Unmanned Aerial Vehicles (UAVs) in Unmanned Ariel Systems (UASs) environment. These networks are aimed to construct self-organizing networks with flying aircrafts in the sky. UAVs are involved in both military and civilian applications.

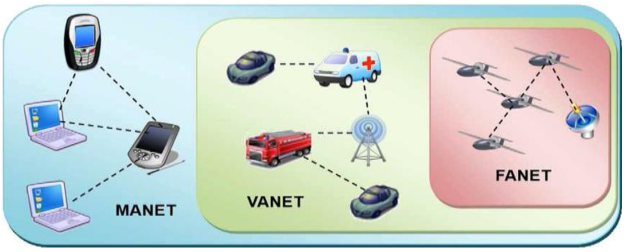

Figure 1: MANET, VANET and FANET

A. FANET characteristics

- Mobility of Nodes
  In this, the degree is actually bigger than mobile ad hoc network along with Vehicular ad hoc network.

The UAV possesses a running velocity of 30-460 km/h, and also it leads to the connection issue between UAVs.

- Models of Mobility
  In these models, the plan of the flight is already known and on every single step there is a variation, map is calculated again. various models are actually using arbitrary velocity and routes for the UAVs.
- Density of nodes
  The majority of Unmanned Aerial Vehicles in particular region is called Node Density. In Flying ad hoc network, there has to be a short density with actually a big difference in kilometres within them in accordance with the flying nature.
- Topology of network
  Because of the more mobility and usually change in topology, the communication between UAVs can be break down oftenly due to the more speed, also there is possibility that if the UAV is not in reach due to position change. On each and every UAV communication distortion, processing needs to be updated.
- Radio Propagation model
  In accordance with the trends in FANETs and more ranges in UAVs, they needs a line-of-sight in between them and with the ground station also. However, MANET really does not require any type of radio signal in its present nodes.
- Consumption of power and network lifetime
  Survival of a Network is a most dominant matter for it, that contain a battery-powered devices to compute. Connecting hardware that are being utilized in FANETs is energized by node power source. Moreover in cases like this, designs in FANETS cannot be very sensitive in power as in MANET applications. where it is still a issue in small UAVs.
- Position localizing
  Finding the position of every UAV is known as Localization. Because of more velocity and rapid changes in place, so there is a big requirement of localizing information after every short interval of time. with the help of GPS, the information of the fresh position of the UAV will be submitted to the network after every one second. Hence, every UAV must contain a GPS and Initial measurement unit to propagate its site to the nearby UAVs present in the particular network at any possible time.

B. Advantages Of FANETs

- It can process request faster than Single UAV system..
- Instead of Using one big UAVs, small multi UAVs can be more beneficiary in case of maintenance and cost. Big UAVs are more expensive than smaller one
- More UAVs can be added to the system if required anywhere. Therefore multi UAVs increases the scalability of the system
- Network is more sustain as compare to single UAV. Failure of one UAV does not stop the operations as work can be completed by other UAVs

C. Architecture of FANET

Accounting on a few similarities in FANET, MANET and VANET; FANET has taken some of the concerns and challenges from other ad hoc networks. But due to additional features, such as very high mobility of UAVs in FANET, the routing communication protocols need more evaluations and research. So, the data routing in between UAVs goes through a serious task. The routing protocol should be capable to update routing table dynamically in accordance with the changes in the network topology. Prior protocols do not offer a trusted communication. So, new communication protocol is required to provide a versatile and efficient communication. There are also different concerns about transmission like security overheads, data packets losses, and the energy uses. However, a FANET is not similar to MANETs and VANETs; but the main concept remains the same: presence of some active nodes in an ad hoc manner. As a result, in a FANET, a few troubles are usually considerable as in a VANET while dealing with additional difficulties. Many queries have done to build the functionality of the system along with few flying nodes; there are still many unresolved issues, which needs to be find out.

- UAVs Ad Hoc Network
  In “UAVs ad Hoc network” structure, all nodes are interconnected with one another and also with the ground station independently with no already present connection set-up. In it, very node remains busy in sending the information of FANET system. A controller UAV behaves as being a gateway in the base station and other present UAVs .This UAV takes devices of wireless communication which can work in low power , small range and also at large power and long ranges communications with base station. Main UAV is only connected with the base station, because of this communication range can be easily enlarged. Moreover, the calculated distance in the different UAVs are comparatively less, the transceiver that is installed in a node is less expensive and less in weight, that possibly makes it quite suitable for small UAVs and their network.

- Multi-Group UAV Ad hoc Network
  This architecture is the network of UAVs which is combination of both virtual and centralized network. In this nodes are interconnected in a

manner such that they behaves like to be in ad hoc network and this network of UAVs or group of UAVs are connected to the ground station through a center UAV can be called as cluster head. Intergroup communication can be done without the help of base station nut intergroup communication is done with base station only. This type of ad hoc network is applicable in cases UAVs operate with instinct flight and specified communication. But due to its partial centralized quality, architecture is not so strong.

- Multi-Layer UAV Ad Hoc Network
  This network is actually formed when more than one group consisting UAVs form a network that is ad hoc in nature. It can be divided into different layers. The lowermost is for connection with the other UAVs and uppermost is for communicating with the base station. All the UAVs are very much interconnected with each other and only one of them is connected with backbone UAV of other group network. This backbone UAVs of all the groups are interconnected and only one of them is connected with the base station. Intergroup communication does not require interference of base station. Load is less on backbone station in this network as it is not involved in all transmissions

II. RELATED WORK

A. Purohit et al (2012) [1] describes about the sensor fly. He explained that these are small, very low in cost and novel wireless serial networks. It is not fixed network and is automatic in nature. They are very adaptive to the environment and also maintenance is easy. they give forward the capabilities of sensor flies system. Sensorfly nodes were placed to search the area and send the collected data to the base station.

Iiker Bekmezci et al. [2] (2013) investigates the implementation of HAP and FANET architectures. He proposes a Medium access control protocol which was given name as LODMAC i.e Location Oriented Directional MAC. this protocol can easily find neighbours and data was transmitted with directional antenna.

A. A. Razzaqi , et al. (2014) [3] proposed a micro strip patch antenna of dimensions 1×2, 1×4 and 2×4 arrays for FANET. The antenna was developed for more bandwidth and eventual gain. The antenna was developed with the help of rogers RT/duroid 5880LZ substrate. The gain and directivity of antenna was finally increased.

K. Singh et al. (2014) [4] presented how OLSR can be applied in FANETS and study of this protocol in different mobility models in FANETS. It optimizes the parameters of FANETS using OLSR

Samil temel et al. (2014) [5] presented a study that shows the max number of node pairs for 3D scenarios. They analyze the different flight scenarios of different flights and give forwards the effects of the analysed distance in between two nodes during communication.

R. B. Chiaramonte et al. (2014) [6] provided a study for obstacle avoiding in UAVs. HE studies on the strengthening the signal with respect to distance and then after investigates the fashion of speed with the signal strength. Eventually they evaluate distance by obtaining RSS values with the help of path loss formula.

A. Ören et al (2014) [7] proposed a model by adding delays in network which were caused by infrastructure in FANETS. Additionally they analyze the velocities effect of the UAVs and operator dimensions for the maximum number of UAVs that can be operated by the controller.

L. Pimentel, et al. (2014) [8] proposed a packet drop mechanism that brings the minimum distortions in the video message. The given adapted mechanism shows multimedia dissemination with supporting QoE for the wireless network locations.

Rosati et al (2014) [10] introduced a new protocol called P-OLSR. OLSR was the extended version of OLSR; it brings the advantage of the usage of GPS to carry information. P-OLSR is now the only FANET technique so far for Linux implementation.

Vasiliev et al (2014) [11] analyzed Protocols such as AODV, HWMO and OLSR for its QoS in FANETs using NS-3 Simulation tool. They do comparison of reactive, proactive and hybrid methods to find the path between two nodes in FANET. Parameter such as hop count, overhead metrics and Packet delivery ratio is used to analyze the results.

Samil Temel et al. (2015) [14] introduced a LODMAC of directional antenna in FANETs He presents a new MAC protocol that is named as Location oriented Directional MAC. This protocol basically uses directional antennas. Distance estimation of neighboring nodes is done with these directional antennas.

III. Methodology

Differential Evolution

Differential Evaluation is one among the recent population based mostly random evolutionary optimization techniques. DE is a method of minimizing non-differentiable continuous space functions. Differential evaluation is upgraded form of Genetic algorithm. It is the most powerful algorithm among the other optimising techniques due to its best convergence property and simple process. The process of DE is performed with four basic main methods namely. Initialization, Mutation, Crossover and Selection**.**

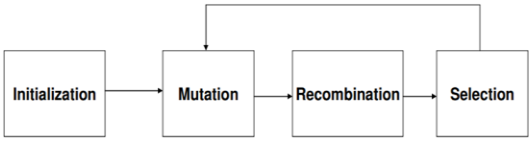

Figure 2. Block diagram of Differential Evolution

A. Initialization: Data is intialized by taking all the paths that are possibly developing between source and destination. Value of nodes are converted into binary form for further processing

B.

Speed of vehicle (m/s)	Guranted time slots or virtual TDMA	Differential Evolution
10	1.1411	1.2201
20	1.2881	1.4865
30	1.2107	1.4286
40	1.2319	1.4314
50	1.2781	1.3601
60	1.2054	1.3080
70	1.4305	1.4951
80	1.4781	1.5783
90	1.5891	1.6496
100	1.5430	1.6305

Mutation:In binary form of mutation only one bit is altered to get another possible value. Changes can be done with more than one bits to get possible routes.

for eg.

parent : 1 1 0 1 1 0 1 1

×

offspring : 1 1 0 1 1 1 1 1

C. Crossover or Recombination: In this step Two parents or mutant possibilities are recombine to form two more another options and results are called offsprings.

parent1 : 1 1 1 1 | 1 1 1 1

parent2 : 0 0 0 0 | 0 0 0 0

offspring1 : 1 1 1 1 | 0 0 0 0

offspring2 : 0 0 0 0 | 1 1 1 1

D. Selection: Value of the offsprings and parents are evaluated and minimum among all is taken as resultant for further operation.

IV. Experimental Results

For communication in the FANET network between the source node and the destination node the file is being transferred. From all the nodes the source node and the destination node is selected.

For experimentation and implementation the proposed technique named as optimistic differential evolution based routing protocol for heterogeneous flying adhoc networks is evaluated using MATLAB tool R2013a. Here we will compare the performance of existing technique guranted time slots and proposed technique differential evolution algorithm to evaluate the parameters packet delivery ratio, signal to noise ratio and normalized routing load.

A. Packet delivery ratio

Packet delivery ratio calculate the total packets that are received at the destination. It is the ratio between the total packets received at the receiver node to the total packets that are being transmitted from the sender node. PDR is expected to be more for better results.

$$PDR=\frac{\sum_1^N D_{packet}}{\sum_1^N S_{packets}}$$

Here, $D_{packets}$ are the packets that are received at receiver node. $S_{packets}$ are the packets that are transmitted from the source nod N = Total number of packets. Higher value of PDR corresponds to low packet loss

Table 1: Packet delivery ratio

ISSN: 2393-9028 (PRINT) | ISSN: 2348-2281 (ONLINE)

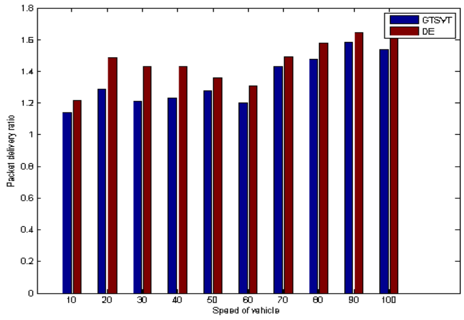

Figure 3: Packet delivery ratio graph

Here GTSVT stands for Granted time slots and virtual TDMA which is existing technique and DE stands for Differential evolution that is a proposed technique. From results it can be seen that that proposed technique gives better results than the existing.

B. Signal to noise ratio

Signal to noise ratio is calculated to see the strength of the signal at receiver terminal. it can be calculated with the following formula

$$\text{SNR} = \log_2 \frac{peak}{mse}$$

Where, Peak = 255(maximum frequency value) mse (maximum signal error) = ½(Actual frequency – Received signal frequency) Higher the value of SNR, more the quality of the received signal

Table 2: Signal to Noise ratio

Speed of vehicle (m/s)	Guranted time slots or virtual TDMA	Differential Evolution
10	29.7930	28.8200
20	29.1990	27.8193
30	29.0813	28.8160
40	29.9558	29.8162
50	30.7773	28.8178
60	29.8004	29.8254
70	30.1161	27.8248
80	29.7981	28.8285
90	28.7991	27.8286
100	28.0035	27.8311

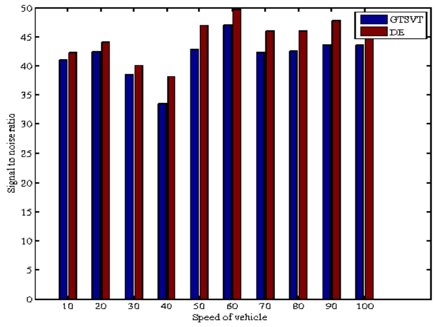

Figure 4: Signal to noise ratio graph

Here GTSVT stands for Guranted time slots and virtual TDMA which is existing technique and DE stands for Differential evolution that is a proposed technique. From results it can be seen that that proposed technique gives better results than the existing.

C. Normalized Routing load

It is defined as total number of routing packet transmitted per data packet. It is calculated by dividing data packets received by the routing packets transmitted

$$\text{NRL} = \frac{\sum_1^N \boldsymbol{D}_{\textbf{packet}}}{\sum_1^N \boldsymbol{R}_{\textbf{packets}}}$$

$D_{packets}$ = number of data packets received. $R_{packets}$= number of routing packets transmitted. N = Total number of packets

Table 3: Normalized routing Load

Speed of vehicle (m/s)	Guranted time slots or virtual TDMA	Differential Evolution
10	41.0612	42.2843
20	42.5164	44.0623
30	38.4378	40.0884
40	33.4411	38.1360
50	42.8784	46.9768
60	47.1201	49.7812
70	42.3062	46.0130
80	42.5388	46.0317
90	43.6444	47.8908
100	43.6036	47.6230

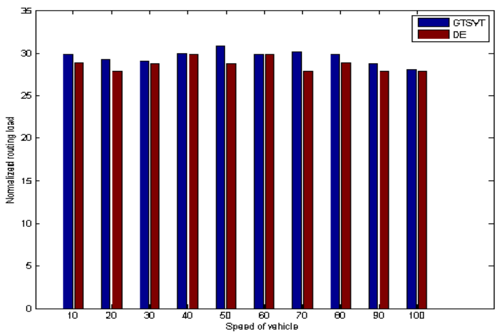

Figure 5: Normalized

routing load

Here GTSVT stands for Granted time slots and virtual TDMA which is existing technique and DE stands for Differential evolution that is a proposed technique. It can be seen that Normalized routing load in proposed technique comes less as compare to existing technique. Hence it can be stated that proposed technique gives better results than the existing.

V. CONCLUSION AND FUTURE SCOPE

In this research paper intially we have reviewed about different architectures of FANET. Also advantages of multi UAV system over single UAV system is discussed. Further we have analyzed previously used routing protocol and proposed a new routing criteria based on optimization. For Optimization, Diffrerential evolution is performed. Differentail evolution is taken in binary form. we evaluate our proposed technique and existing one with the help of performance parameters like packet delivery ratio, signal to noise ratio and normalized routing load. Experiments are done with using matlab tool R2013a. It has been observed that the proposed technique outperforms existing techniques.

Finally we suggest that in future work can be done on security issues and also variation in system performance can be seen if any new UAV will be added to the presently working network.

REFERENCES

[1] A. Purohit, F. Mokaya, P. Zhang, Collaborative indoor sensing with the sensorfly aerial sensor network, in: Proceedings of the 11th International Conference on Information Processing in Sensor Networks, IPSN, ACM, New York, NY, USA, 2012, pp. 145–146

[2] S. Temel and İ. Bekmezci, "On the performance of Flying Ad Hoc Networks (FANETs) utilizing near space high altitude platforms (HAPs)," *2013 6th International Conference on Recent Advances in Space Technologies (RAST)*, Istanbul, 2013, pp. 461-465

[3] A. A. Razzaqi, M. Mustaqim and B. A. Khawaja, "Antenna array design for multi-UAVs communication in next generation Flying Ad-Hoc Networks (FANETs)," *2014 11th Annual High Capacity Optical Networks and Emerging/Enabling Technologies (Photonics for Energy)*, Charlotte, NC, 2014, pp. 25-28.

[4] K. Singh and A. K. Verma, "Applying OLSR routing in FANETs," *2014 IEEE International Conference on Advanced Communications, Control and Computing Technologies*, Ramanathapuram, 2014, pp. 1212-1215

[5] S. Temel and I. Bekmezci, "Scalability analysis of Flying Ad Hoc Networks (FANETs): A directional antenna approach," *2014 IEEE International Black Sea Conference on Communications and Networking (BlackSeaCom)*, Odessa, 2014, pp. 185-187.

[6] R. B. Chiaramonte and K. R. L. J. C. Branco, "Collision detection using received signal strength in FANETs," *2014 International Conference on Unmanned Aircraft Systems (ICUAS)*, Orlando, FL, 2014, pp. 1274-1283.

[7] A. Ören and Ç. Temel, "Impact of the average network delay on the operator capacity for FANETs," *2014 22nd Signal Processing and Communications Applications Conference (SIU)*, Trabzon, 2014, pp. 1299-1302.

[8] L. Pimentel, D. Rosário, E. Cerqueira, T. Braun, A. Abelém and M. Gerla, "Context-aware adaptation mechanism for video dissemination over Flying Ad-Hoc Networks," *2014 IFIP Wireless Days (WD)*, Rio de Janeiro, 2014, pp. 1-3.

[9] Bekmezci, M Ermis and S Kaplan, "Connected multi UAV task plannin for flying ad hoc networks," Communications and Networking (BlackSeaCom), IEEE International Black Sea Conference, 2014, pp. 28- 32

[10] Rosati, Stefano, Karol Kruzelecki, and Gregoire Heitz, Dario ´ Floreano "Dynamic Routing for Flying Ad Hoc Networks."IEEE (2014).

[11] Vasiliev, Danil S., Daniil S. Meitis, and Albert Abilov. "Simulation-based comparison of AODV, OLSR and HWMP protocols for flying Ad Hoc networks." Internet of Things, Smart Spaces, and Next Generation Networks and Systems. Springer International Publishing, 2014. 245-252.

[12] L. Gupta, R. Jain, and G. Vaszkun, "Survey of important issues in UAV communication networks," IEEE Communications Surveys & Tutorials, vol. 18, no. 2, pp. 1123–1152, 2015.

[13] Bekmezci, İ., and Ulku, E, "Location information sharing with multi token circulation in flying Ad Hoc networks," Proceedings of 7th International Conference on Recent Advances in Space Technologies (RAST) Istanbul, Turkey,2015

[14] Temel, Samil, and Ilker Bekmezci. "LODMAC: Location oriented directional MAC protocol for FANETs." Computer Networks 83 (2015): 76-84.