**Designing 3D Mobility Model For Flying Ad – Hoc Networks Using NS3**

***Submitted by***

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**ABSTRACT:**

In the last decade, the purpose of UAVs to perform various tasks has attained much attention. In addition to its use for the military for censorious operations, UAVs are being used to deliver goods, reconnaissance for researchers to observe endangered species and photography. The flexibility of controlling UAVs remotely makes them optimum solutions to perform operations with cost, time and labour minimized. In this project, we use Flying Ad – Hoc Networks as access points to provide signal coverage in difficult areas where access points and base stations are difficult to install. This project aims to determine and control the UAV’s behaviour in a swarm of UAVs in which the flight plan can be predetermined while varying the area’s physical conditions. To address this issue, the Gauss - Markov Outdoor mobility model will be deployed by measuring the drone’s speed, transmission attempt, and area coverage. The result after implementation will reflect GMM’s efficiency in terms of latency, speed and direction estimation, correction, and area coverage.

Index Terms: Gauss – Markov Model (GMM), UAV, Speed, Latency, Flying Ad-Hoc Networks

1. **INTRODUCTION:**

UAVs (Unmanned Aerial Vehicles), also called RPA (Remotely Piloted Aircraft) are a pilotless aerial vehicles that can be controlled either remotely by a pilot on the ground or autonomously by an on-board computer. In the initial years of its advancement, UAVs were primarily deployed in critical military missions consisting of tactical strikes, reconnaissance and, in recent cases, ammo delivery. However, its accessibility has increased from military to domestic and industrial purposes in the last decade.

It is a known fact that there are demands for providing high-quality services (QoS) in light of recent growth in many aspects of human life, exceptionally in the telecommunication division. Due to rapid population growth, it has bought many challenges that need addressing in telecommunications, including installing base stations and access points, data traffic capacity, and signal coverage in remote areas. One optimal solution to mitigate some of these challenges is utilising Flying Ad-Hoc Network, also called FANET. FANET is an Ad-Hoc network structure formed by a swarm of UAVs, and at least one of them must be connected to a ground control station (GCS) or satellite. FANET differs from existing Ad-Hoc networks, but it can be viewed as a unique form of MANET or VANET.

Conventionally, the solution to the problem addressed can be categorised into indoor and outdoor mobility models. The indoor mobility model algorithms focus on Random – walk, Random waypoint, Random direction. However, to evaluate Flying Ad – Hoc networks, the simulation environment required variable physical conditions than just monitoring of movement in a 3D plane. Hence outdoor Mobility models were introduced, and, in this project, GMM is used as the primary model for the simulation of personal communication service between two dynamic nodes. GMM addresses the FANET’s localization, monitors transmission and thus helps in deploying protocol to reduce power consumption.

The main contribution of the work is mentioned as below:

* The present exposition introduces the need for access points in remote areas for FANETs.
* A model–based algorithm is used to the issue addressed in this work for the FANET.
* The correctness properties of the proposed model are defined and simulated.
* The static performance of GMM is analysed.
* The dynamic performance of the GMM along with previously produced results from different algorithms is cited and compared.

The report is organised in such a way that it achieves and shows the proposed idea. The current section gives the importance of FANET and GMM, its benefits. Section 2 shows the related work concerning the research work carried out.

1. **RELATED WORKS:**

Fadi Al - Turjman *et al.*[1] proposed an optimal framework for the localisation of drones hence minimizing the drone count and maximizing the coverage area for static and dynamic target monitoring. For static targets, by decreasing the energy consumption and moving the drone in a further y-axis direction, the framework maintains the battery capacity and further increases the drone’s vertical height and hence the coverage. For dynamic targets, the framework proves by simulation stating the inverse relationship between the trajectory of the target and the number of drones.

Mayank Namdev *et al.* [2] proposed a whale optimization algorithm for FANET to maximize optimum routing technique for communication and secure data transmission. Whale optimization algorithm - optimized link state routing (WOA-OLSR) protocol provides an energy-efficient routing solution for a secure FANET. The efficiency is measured in terms of parameters such as throughput and end to end delay against various OLSR protocols. Hence, by simulation WOA-OLSR visualized better results in throughput and packet delivery ratio and OLSR for the case of E2E delay and energy efficiency.

Fadi Al - Turjman *et al.* [3] proposed two mathematical models by forming linear optimization equations which determine the drones’ exact location and an optimum number of drones. The models will highlight the selected area covered with the least cost considering communication relevant parameters such as Data rate, jitter and throughput. Simulated Annealing (SA) and Genetic Algorithm (GA) were chosen as the mathematical models and were deployed in UAV swarms in a multi-hop fashion due to their efficiency and low latency to service providers. After simulation, GA was proved as an optimal solution for long-range UAV systems and SA was proved for faster solution generation.

Luis Antonio L.F. da Costa *et al.*[4] proposed a novel routing protocol based on existing features of reinforcement learning exquisite routing protocol called Q - FANET. The performance of Q-FANET is compared with other existing routing protocols, namely, Q-Noise+, QMR and Q-Geo using the WSNet simulator. The simulation resulted in lower maximum E2E delay and jitter than other existing protocols.

Ashish Khanna *et al.*[5] proposed Local Mutual Exclusion (LME) which is a variant of classical Mutual Exclusion (ME) problem for FANET’s resource allocation issue. This problem has been addressed using Request Collector Local Mutual Exclusion (RCLME), a leader-based algorithm, which uses fuzzy logic-based leader election that takes into account the drones’ speed, direction, distance from the resource and link quality. After the result analyzed from simulation some major trends were visible namely, significantly better waiting time, RCLME surpasses other existing algorithms in terms of synchronization delay and throughput results were better than other algorithms.

Vishal Sharma *et al.*[6] proposed a protocol namely, Distributed Priority Tree-Based Routing Protocol (DPTR) which configures a priority network for selecting an appropriate node and a channel for relaying and is adapted to solve the problem of network partitioning. DPTR uses R-BTree’s properties to formulate distributed routing trees by adding up the specific ordinances that provide a solution for routing to be performed simultaneously over operating distributed ad-hoc networks. The protocol is simulated using Network Simulator (NS-2) and MATLAB provides exemplary results in terms of high transmission rate, throughput and E2E connectivity with low latency.

Ghassan A. QasMarrogy [7] proposed a comparative study to analyze the performance of various mobility models, routing protocols by mearing several performance metrics like throughput and delay. The simulation for this analysis used 30 drones with each of their speed varying from 1.4 to 20 meters per second by using GMM, SRCM and RWP mobility models and the OLSR and AODV routing protocols by transmitting both the formats: HD and 2K videos. These simulations were performed using NS3 simulation and the process is repeated 10 times and the mean of all the results were considered for the optimal solution. Thus, resulted in the Gauss Markov mobility model (GMM) proving lower delay and higher throughput.

Muhammad Asghar Khan et al. [8] proposed different communication architectures which includes existing wireless technologies to ensure efficient and low-cost deployment of FANETs to provide seamless wireless connectivity. In order to address the above-mentioned issue a hybrid scheme has been proposed in this paper where two short range communication technologies (Wifi 802.11 and Bluetooth 802.15.1) are associated. By utilizing this scheme strong features of both these technologies such as low-cost, low power consumption and maximum range and speed is attained. From the simulation results we inferred that the desired QoS requirements are met by the Hybrid scheme.

Alex V. Leonov [9] proposed that the localization of UAVs in a swarm can be optimized to its maximum extent using Bee Algorithm. As the name suggests the algorithm is a bio-inspired model which facilitates the daily activities of how bees as a swarm or colony work. Using star with control centre topology, this paper proves the efficiency of this algorithm by simulating the swarm of drones using ns3 and OMNET++. The performance parameters that was achieved by this algorithm were E2E delay was minimised, Throughput was pushed to its maximum limit resulting in better convergence rate and hence lowering the requirements to the nodes’ hardware.

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