

FANET Path Planning with Optimized Distance and Angle based Parameters

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Abstract— The unmanned aerial vehicles (UAV) have been used in the various types of real-time applications such as weather applications, military applications, remote sensing, oceanography etc. The UAVs suffers from some of the major issues in finding the absolute paths, optimized obstacle free point-to-point flight management and obstacle detection and path turn calculation. In this paper, a novel method has proposed model for the obstacle free UAV routing by using the multi-factor distances. The proposed model is entirely based upon the UAV turn calculation based shortest path with minimum number of obstacles and turns. The multi-factor distance has been computed which includes the distance between the source and destination, UAV and obstacles, obstacles and obstacles, angle of rotation (Degree of rotation) and other several factors. The experimental results have been obtained in the form of various network parameters of throughput, end-to-end delay, network load and packet delivery ratio (PDR). The experimental results have advocated the robustness of the path planning solution for the UAV path planning.

Keywords—UAV Routing, collision avoidance, alternative path planning, collision detection.

I. INTRODUCTION

An pilotless aerial vehicle (UAV), usually referred to as a drone AND conjointly brought up as an unpiloted aerial vehicle and a remotely piloted craft (RPA) by the International Civil Aviation Organization (ICAO), is an aircraft without a human pilot aboard. ICAO arrange unmanned air ship into two sorts under Circular 328 AN/190: 1) Autonomous aircraft – right now thought to be unsatisfactory for regulation because of legitimate and obligation issues; 2) Remotely piloted aircraft – subject to common regulation beneath International Civil Aviation Organization and beneath the many national flight power .There ar many alternative names for these craft. they're referred to as UAS (unpiloted air system), UAV (unpiloted aerial vehicle), RPAS (remote piloted aircraft systems) and model aircraft. It has likewise ended up famous to allude to them as drones. Their flight is controlled either independently by installed PCs or by the remote control of a pilot on the ground or in another vehicle. The run of the mill dispatch and recuperation technique for an unmanned aircraft is by the capacity of a programmed framework or an outer administrator on the ground. Generally, UAVs were straightforward remotely guided airplane, yet self-ruling control is progressively being utilized. One of the

best known and generally utilized sorts was the Nazi-German V-1, that flew independently fueled by a heartbeat plane. Its successor was the Nazi-German V-2, likewise self-governing however rocket controlled, and somewhat working ballistically.

Unmanned aerial vehicles (UAVs) are effectively utilized for military operations and considered for regular citizen applications, for example, natural observing. Innovative advances around there have been noteworthy, and it appears to be presently that a noteworthy test for future improvements will be to expand the level of robotization of these frameworks [1]. For this we require arrangements with satisfactory levels of execution to troublesome optimization problems, for example, variations of the weapon-target task issue [2]. Frequently, the issues tackled are static combinatorial optimization problems bringing about open loop arrangements. Yet, for most utilizations of UAVs, including observation and checking, we might want to calculate the choice making handle the (stochastic) advancement of the environment, which brings about significantly harder stochastic control issues.

Path planning for small Unmanned Aerial Vehicles (UAVs) is one of the exploration ranges that has gotten huge consideration in the most recent decade. Little UAVs have as of now been field tried in regular citizen applications, for example, fierce blaze administration [1], weather and hurricane monitoring [2], [3], and pollutant estimation [4] where the vehicles are utilized to gather applicable sensor data and transmit the data to the ground (control) stations for further handling. Contrasted with extensive UAVs, little UAVs are moderately easier to work and are fundamentally less expensive. Little UAVs can fly at low heights and can maintain a strategic distance from obstructions or dangers at low elevations all the more effortlessly. Indeed, even in military applications, little vehicles [5] are utilized habitually for knowledge assembling and harm evaluation as they are less demanding to fly and can be hand propelled by a person with no dependence on a runway or a particular kind of terrain.

Despite the fact that there are a few focal points with utilizing little stages, they additionally accompany other asset requirements because of their size and constrained payload. As little UAVs ordinarily have fuel requirements, it may not be workable for a UAV to finish an observation mission before refueling at one of the Station. For example,

consider a typical surveillance mission where a vehicle begins at a stop and is required to visit an arrangement of targets. To finish this mission, the vehicle might need to begin at the stop, visit a subset of targets and after that achieve one of the stations for refueling before beginning another way. One can sensibly accept that once the UAV achieves a warehouse, it will be refueled to full limit before it leaves again to visit any remaining targets. In the event that the objective is to visit each of the given focuses in any event once, then the UAV might need to over and over visit a few terminals keeping in mind the end goal to refuel again before going to every one of the objectives.

II. LITERATURE REVIEW

In [8], the authors had proposed an algorithms for routing an unmanned aerial vehicle in the presence of refueling depots. The objective of the problems to find a path for the UAV such that each target is visited at least once by the vehicle, the fuel constraint is rarely profaned on the trail for the UAV, and also the total fuel needed by the UAV may be a minimum. In [9], had planned the routing rule for 2 pilotless Aerial Vehicles with communication constraints. Contact with UGS is strictly maintained, that permits the UGS act as beacons for relative navigation eliminating the necessity for dead reckoning. This downside is brought up because the Communication strained UAV Routing downside (CCURP). to resolve the CCURP, shortest methods between targets ar computed by means that of a graph transformation. Given the shortest methods between targets, 2 resolution ways ar given .In [10], have worked on multi-Objective UAV routing methodology. the aim of the study, given during this paper, has been to use a multi-objective graph-based methodology for arrange routes of a simulated UAV taking under consideration situations with danger zones or prohibited areas, characteristic of civil airspace, similarly as areas with time and speed restrictions and a few negotiable "safe corridors". In [11], have worked on UAV routing protocols for distributed sensing element information exfiltration. the matter self-addressed during this paper is information exfiltration from a group of sensors that ar unable to determine ad-hoc communication owing to their widespread preparation, geographical constraints, and power issues. sensing element information is exfiltrated by one or additional unoccupied aerial vehicles (UAVs) that act as information mules by visiting every sensing element so as to determine a communication link.

III. EXPERIMENTAL DESIGN (PROPOSED WORK)

One of the most issues in artificial intelligence, referred to as automaton UAV path designing, is to search out a collision-free path amidst obstacles for a automaton UAV from its beginning position to its destination. the trail of a automaton UAV is viewed as a sequence of translations and rotations from beginning position to the destination within the work area. the trail designing is incorporated by translation, $R(0, 0)$ is initial placed at $R(7, 9)$, then $R(7, 9, 0)$ is turned by 45° to $R(7, 9, 45)$.

The idea of the degrees of freedom has been used so as to set up the trail of the given UAV in conjunction with hurdle detection and fuel-out state of affairs detection. A placement of a automaton UAV is mere by a collection of parameters that corresponds to the amount of degrees of freedom of the automaton UAV. This variety is two if planar robots will solely translate. This variety is three if planar robots will each translate and rotate. In 3 dimensional area, a automaton UAV which will solely translate has three degrees of freedom. In 3 dimensional area, a automaton UAV that's liberated to translate and rotate has vi degrees of freedom. The configuration area for the UAV path designing has been used by victimization the varied parameters. The parameter area of a UAV denoted R is termed configuration area. some extent p within the configuration area corresponds to an explicit placement $R(p)$ of the UAV R within the work area. The configuration area of a translating UAV R within the plane is that the 2 dimensional euclidian plane, and so a dead ringer for the work area. The configuration area of a translating and rotating UAV R within the plane is that the 3 dimensional area R two $x(0 : 360)$, and so isn't the euclidian third-dimensional area.

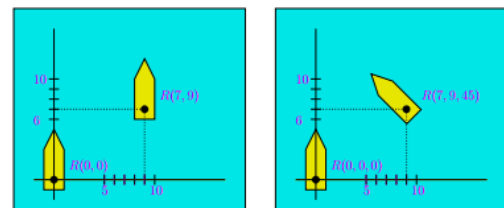


Figure 4.1: The path planning on given graph

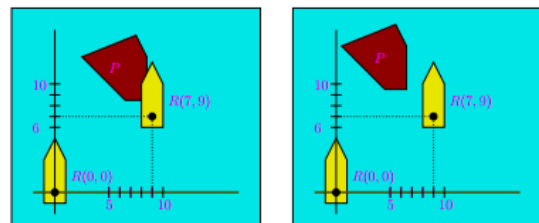


Figure 4.2: The placement of the UAV in the given position for path planning

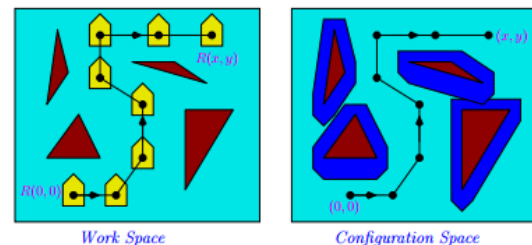


Figure 4.3: The planned path after the surrounding environment scanning

If a placement of a UAV R intersects associate obstacle P within the work area, then the corresponding purpose lies within the prohibited configuration area. Otherwise, the corresponding purpose lies within the free configuration area. Each collision free path of a UAV R lies within the free configuration area.

A collision-free path of a coplanar mechanism beneath translation within the work area is mapped to a path of a degree mechanism within the free configuration area. Inflated obstacles within the configuration area unit referred to as configuration-space obstacles or C-obstacles.

Computing C – obstacles under translation

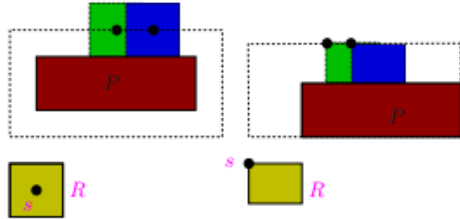


Figure 4.4: The path planning in the C shaped obstacles

The C-obstacles of a obstacle P for a golem R beneath translation is that the set of all points within the configuration area such the corresponding placements of R within the work area intersects P. If R is slid on the boundary of the obstacle P, then the boundary of the C-obstacle is that the locus of the indicator of R. The C-obstacle will be computed exploitation the mathematician total of P and R using the Minkowski sum theory.

Minkowski sum

The Minkowski sum of two sets $S1 \subset R^2$ and $S2 \subset R^2$ is defined as $S1 \oplus S2 := \{p + q : p \in S1, q \in S2\}$, where $p + q$ denotes the vector sums of the vectors p and q , i.e., if $p = (px, py)$ and $q = (qx, qy)$, then we have $p + q := (px + qx, py + qy)$. The C - obstacle of P for a planar robot R under translation is $P \oplus (-R(0, 0))$. The Minkowski sum of two convex polygons with n and m edges can be computed in $O(n + m)$ time.

Algorithm 1: Computing a collision free path

- i. Take a degree s of the planate mechanism R because the reference.
- ii. Victimisation detection using Minkowski sums by figuring the C-obstacles in the set of obstacles given within the work house.
- iii. Figure the free configuration house by constructing trapezoids.
- iv. Construct a road map through the free configuration house victimisation trapezoids.
- v. Victimisation the road map, figure a path from the beginning position $(0, 0)$ of s to the destination purpose (x, y) .

Algorithm 2: sorting out a target on a line

- vi. Suppose, the target purpose t is placed on a line L in Associate in Nursing unknown location.
- vii. Ranging from a given position O on L, the matter is to style a web algorithmic program for a degree mechanism for locating t .
- viii. It's assumed that the mechanism will find t if it stands on high of t or reaches t .

- ix. The matter could also be viewed as Associate in Nursing autonomous mechanism is facing a awfully long wall and it needs visit the opposite aspect of the wall through a door on the wall however it doesn't renowned whether or not the door is found to the left or right of its current position.
- x. Suppose the mechanism is aware of that t is found specifically d distance off from O.
- xi. Then the mechanism initial walks d distance to the proper.
- xii. If t isn't found, then the mechanism returns to O so walks d distance to the left.
- xiii. So, the competitive quantitative relation of this easy on-line algorithmic program is three.

IV. RESULT ANALYSIS

The results analysis is the analysis of the proposed model on the basis of various performance parameters. The performance parameters are the specified entities which defines the result of the implemented model. The performance parameters have to be selected on the basis of the nature of the project, algorithms being used and the testing data. The result analysis of the proposed model has been entirely based upon the various network performance parameters. The network performance parameters of throughput, delay, network load, packet delivery ratio and data drop rate has been obtained from the proposed model simulation.

Throughput

Throughput or Network throughput is the ratio of total amount of data (which receives by the receiver from the sender) to the time it takes for the receiver to receive the last packet. It is represented in bytes per second or packets per seconds.

$$\text{Throughput} = \sum_{t=1}^n \frac{\text{total data processed}}{\text{capacity to process}} \times 100$$

Eq. (5.1)

Where, t = Time interval

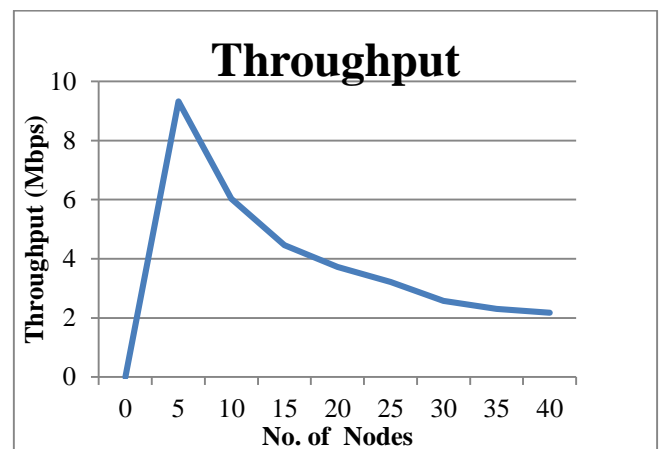


Figure 5.1: Throughput Graph of proposed model simulation

The throughput graph has been obtained from the simulation parameters. The throughput as shown in the Figure 1 has been recorded on the interval on every 0.5 seconds for the proposed UAV path planning simulation. The maximum throughput has been recorded nearly at 9.0 Mbps which show efficient and high performance of the FANET path planning method.

End to End Delay

The end-to-end delay is the time from the generation of a packet by the source up to the destination reception, so this is the time that a packet takes to go across the network. This time is expressed in seconds (sec).

$$\text{Delay} = \sum_{t=1}^n \frac{\text{time length}}{\text{total no.of packets}}$$

Eq. (5.2)

Where, t = Time Interval

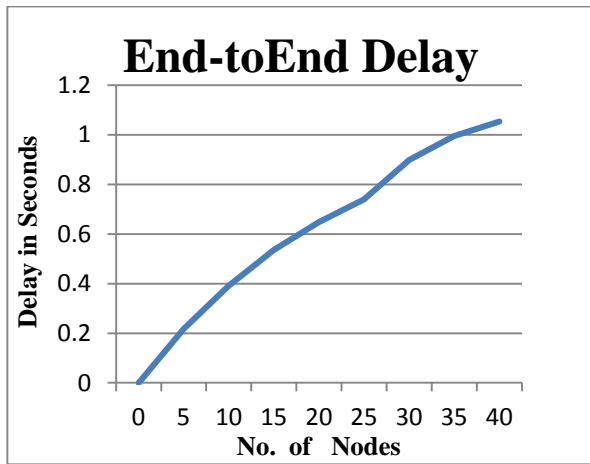


Figure 5.2: End-to-End Delay

The end to end delay has been recorded in the form of increasing curve as shown in the Figure 2. The latency increases with the rise in the traffic volumes. The traffic volumes have been increased gradually with the increase in the attacker nodes.

Network Load

Network Load is the amount of data (traffic) being carried by the network at a particular time. The network load varies from time to time. It is represented in bytes per second or packets per seconds.

$$\text{Network Load} = \sum_{t=1}^n \frac{\text{total data in processing}}{\text{capaty to process data}} \times 100$$

Eq.(5.3)

Where, t = Time Interval

The above Table 5.4 shows the network load parameter in the cases of different number of nodes. The less network load indicates the better performance. The proposed model has been recorded with the network load with minimum value of 0 and maximum of 16 Mbps.

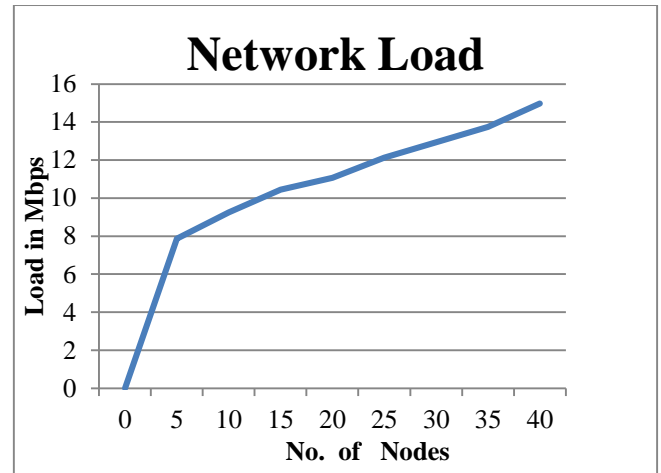


Figure 5.3: Network Load

The network load is the indicator of the resource engagement. The higher resource engagement increases the computational delay, which directly affects the performance of the VANET model as shown in the Figure 5.3.

Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets generated or sent from the source. It describes the loss rate. The Performance is better when packet delivery ratio is high.

$$\text{PDR} = \sum_{t=1}^n \frac{\text{total packets received}}{\text{total packets sent}} \times 100$$

Eq. (5.4)

Where, t = Time Interval

The packet delivery ratio is the parameter to indicate the successfully propagated data in comparison with the data volumes from the sender's node. The higher packet delivery ratio indicates the high trust factor of the given network as shown in the Figure 5.4. The higher packet delivery ratio indicates the high trust factor of the given network as shown in figure 4. The PDR has been recorded more than 95% in the proposed model simulation.

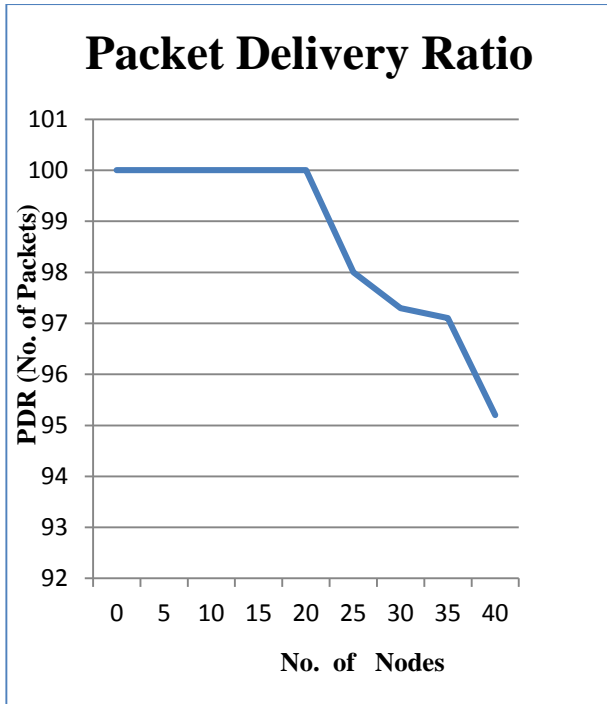


Figure5. 4: Packet Delivery Ratio

V. CONCLUSION

The proposed model is offering the complete solution for the path planning of unmanned aerial vehicles (UAV) in the obstacle environment based upon computing the obstacle free path selection for the UAV from the source to destination. The path planning works as the continuous event based process and is empowered to calculate the path with minimum obstacles and optimized angles of rotation. The proposed model is aimed at detection the hurdles and calculating the hurdle avoidance to create the hurdle free path computed with minimum degree of rotation. The experimental results have proven the efficiency of the proposed model in computing the optimized path for the UAV in the obstacle full environment.

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