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Literature Survey on Drone Route Planning

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Abstract - Route planning can be defined as finding the best set of waypoints for the drone. Which will enhance its probability of success in its mission. The problem of planning the path in these applications is to find a collision-free path. A lot of work has been done to solve the drone path planning problem so we are planning to summaries that. In this paper we are going to study the different algorithms and simulators which can be used to visualize drone flying.

Key Words: Drone, path planning, algorithms, simulators

1. INTRODUCTION

A drone, also known as an unmanned aerial vehicle (UAV), doesn't need a human pilot. When defining a mission, path planning is the main element of the whole system. So basically in path planning's target is to plan the path avoiding collision with obstacles. One can calculate the path cost by using the formulas. Simple 2D path planning algorithms are not able to deal with complex 3D environments because there are a lot of uncertainties. Thus 3D path planning algorithms for UAV navigation are urgently needed nowadays because of the complex environment.

When routing the UAV there are many problems such as optimizing path, distance and energy. There are many things that impact the UAVs are their weight, external environment(wind and obstacles), battery and the most important the nodes which are must to be visited by the drone, etc.

In real time drone flying we need to take care of obstacles which may be static and dynamic. So many people use the simulators to fly or test the written algorithm for drones and after that they implement it on the real drone. By doing this we can get the idea of how the drone will fly. This paper discusses the simulators used for path planning.

Basic fundamentals for route planning

- Motion planning- is responsible for all decision-making of the vehicle. Motion planning can be done at different levels of hierarchy like route planning, obstacle avoidance and reacting to a nearby obstacle, etc. The motion planning is responsible for computing easy and safe flight for the drone to follow.
- Planning/Routing- Determining most favorable routes in road networks from a start to end point is a problem mostly addressed in everyday life. Route planning techniques have evolved quickly in terms of efficiency and accuracy during the recent years.
- Road detection- It is easy to attach a camera to a drone so in case there is any emergency then we can take actions.
- Simulations- Simulators are used to make the testing of algorithms easy, so that we can have a generalised idea of the environment in which and how our drone is going to fly. It then becomes easy to make maps and use them for testing.

There are many simulators which are designed for the drone environment such as Gazebo, Mission planner, Unity simulator etc. In the second chapter literature review we are going to cover the work done in this field which can be used as a reference. The third chapter consists of the proposed work, in his chapter we are going to study the flow of the algorithm. Also we are going to study when we can use specific algorithms, like in which condition. We are going to cover some of the simulators which can be used to show the drone flying according to our written program. So that we will be able to get an idea of how our drone will be flying in real time. We are going to compare the different simulators in this chapter.

2. LITERATURE SURVEY

A. Route Planning- Kamil Tulum, Umut Durak, S. Kemal İder. This research paper was published in April 2009.

B. Three-Dimensional UAV Routing With Deconfliction: Sohail Razzaq, Costas Xydeas, Michael E. Everett, Anzar Mahmood, and Thamer Al Qatami. This work was published on April 24, 2018.

C. Autonomous UAV Flight Control for GPS-Based Navigation: Jeonghoon Kwak and Yunsick Sung. This work was published on July 10, 2018.

D. Path planning of unmanned aerial vehicles based on improved gravitational search algorithm: Li Pei1 and Duan HaiBin. This work was published on May 12, 2012.

Summary of Related Work

The summary of literature survey and their important remark

1. "A Real-Time 3D Path Planning Solution for Collision-Free Navigation of Multirotor Aerial Robots in Dynamic Environments". This paper was published by authors Jose Luis Sanchez-Lopez,· Min Wang1 · Miguel A. Olivares-Mendez, Martin Molina, Holger Voos on march 1, 2018. In this research the probabilistic graph is utilized without taking account of obstacles. A* a discrete search algorithm is used. The simulator used is V-REP.

2. "Simulation and path planning for quadcopter obstacle avoidance in indoor environments using the ROS framework". This paper was published by authors Yadira Quiñonez, Fernando Barrera, Ian Bugueño, and Juan Bekios-Calfa on September 9, 2018. Authors used open source ROS environment is used and gazebo simulator is used.

3. Paper on "A Heuristic evolutionary algorithm of UAV path planning" was published by Zhangjie Fu, Jingnan Yu, Guowu Xie, Yiming Chen, and Yuanhang Mao on September 9, 2018. Matlab simulator is used for version 2014a and as the name of paper suggests heuristic algorithm is used to plan the path of the drone.

4. "Drone Path Planning for Secure Positioning and Secure Position Verification" this paper was published by Pericle Perazzo, Francesco Betti Sorbelli, Mauro Conti, Gianluca Dini, and Cristina M. Pinotti in November 2016. In this research the drone flies to different waypoints and it alone acts as a waypoint after reaching a certain waypoint and gives its position, this reduces the excess fixed stations in the path.

3. PROPOSED WORK

We aim to find the shortest path for the drone to travel so that the fuel and time requirement will be less. The Drone just needs to take inputs of start and end point from the user and it will generate the shortest path on its own with or without getting into obstacles.

Proposed Methodology

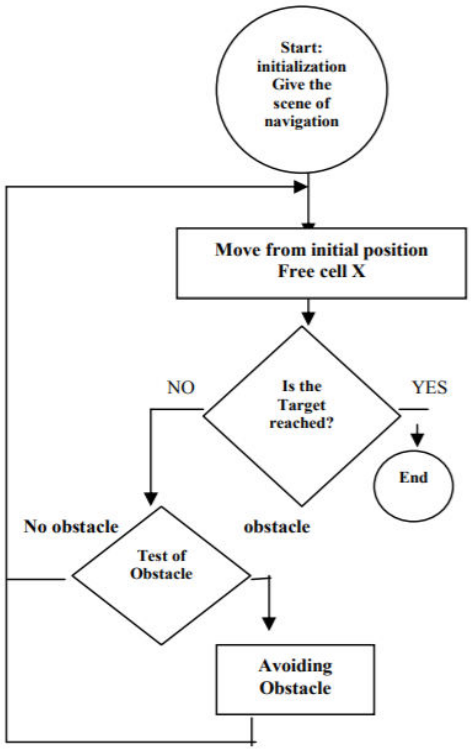

Figure -1: Proposed Methodology

Algorithms

In the route planning we can use many algorithms like BFS, DFS and Dijkstra and A*. So when to use these algorithms?

- If there is only one start point and only one endpoint then we can use A* algorithm because A* will calculate the shortest path in a very short time.
- If any project consists of one start node and many end nodes or destinations then we can use BFS, DFS and Dijkstra's algorithm.
- if there are more than one start and destination nodes then we can use Floyd-Warshall and Johnson's Algorithm

Simulators

There are some simulators to show the algorithm's output. So in those simulators we can code in different languages and are available on some specific operating system.

- **V-REP:** The Virtual Robot Experimentation Platform - is 3D robot simulation software, with an integrated development environment. This simulator allows us to model, edit, program and simulate any robot or robotic system.
- **Gazebo:** Gazebo is an open-source 3D robotics simulator. Gazebo integrated the ODE physics engine, OpenGL rendering, and support code for sensor simulation and actuator control.
- **Matlab:** When we use MATLAB and Simulink together, we combine textual and graphical programming to design our system in a simulation environment.
- **Mission Planner:** The Simulation tab present in mission planner provides a SITL (Software in the Loop) simulation capability. This allows us to see the expected behavior for vehicles in missions, or with a joystick attached, actually be able to fly/drive the vehicle simulation as if with RC.

Simulator	OS type	Open source or paid
V-REP	Linux, Windows, MacOS	Open source
Gazebo	Linux	Open source
Matlab	Linux, Windows, MacOS	Paid software
Mission Planner	Linux, Windows, MacOS	Open source

Table -1: Comparative Study of Simulators

4. APPLICATIONS OF DRONE

- **Military Applications-** The military is one of the most risky jobs in each and every country. The drones can be used for patrolling on the border. Drones can be used to attack an enemy. They can be used as the cameras.
- **Less fuel usage**- Since the drone's route will be planned before hence it will reserve the fuel because the route designed will be the smallest one to reach the destination.

- **Less Traffic and Pollution-** The drones can be used for the deliveries of food, accessories etc. So the traffic will be less since drones will make deliveries by air. Drones will not use petrol or diesel so the pollution will be reduced. Also the natural resources can be saved.
- **Research in high risk areas**- Research in the high risk areas such as Bermuda Triangle , live volcanoes such as Pacific Rim etc. we can use drones so that the risks can be avoided also the human devastation can be reduced.

4. CONCLUSION

So from the research done on simulators and from literature survey we can conclude that if a person wants to show simulation in 3D then every simulator given in above table (Table-1) can be used. V-REP and Gazebo simulators are open source. We can also show simulation in Matlab but we need to download Simulink. In Simulink we can show the representation of drone but is not open source software. Also for mission planner we need to install the SITL software if we need to show the simulation. If we are programming a real drone then there is no need to download SITL software. Also there are various online sites to view the simulation code of our on internet. We can visit them and can check our code visualization without downloading the.

There is lot of work done on drone route mapping with advanced algorithms. Because for each requirement of drone there are different algorithms to carry out the mission and make it a successful flight.

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