UAV with RTK GPS for Coverage Disaster Area Utilizing Genetic Algorithm

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Abstract

Implementing precision mapping is a method to effectively shift towards employing intensive search, detection, and rescue techniques in regions affected by disasters. Research on the application of unmanned aerial vehicles (UAVs) for addressing rescue and mapping challenges is now being conducted. The UAV is capable of doing tasks such as monitoring, mapping, and object recognition. However, successfully utilizing UAVs requires dealing with flight planning tasks while considering the diversity of available attachments and the challenges addressed throughout the flight. This study examines determining optimal coverage routes for traveling in disaster-stricken regions. A coverage path planning approach for UAVs is introduced, utilizing a genetic algorithm. This system integrates a genetic algorithm and an RTK GPS to pinpoint the position of UAVs precisely.

Ⅰ. Introduction

Unmanned Aerial Vehicles (UAVs) are extensively utilized for tasks such as surveying, power plant inspection, search and rescue (SAR) operations, precision agriculture, and a range of other applications [1]. The UAVs are devoid of human pilots. Individuals handle these platforms manually from a distance, but they also carry out pre-programmed flights automatically. By utilizing intelligent technologies with onboard sensors, autonomous flights are possible.

The coverage path planning problem falls within the domain of action planning for UAVs, wherein a path must be constructed for the UAV to examine all areas inside a given scenario systematically. The self-navigating capability of UAVs greatly impacts the efficiency of surveying and monitoring disaster-stricken areas inaccessible to humans. This capability significantly reduces the time required for thorough coverage and detection. Although there have been significant technological advancements in autonomous flight for this category of aerial platforms, it is crucial to note that human assistance is typically required for the take-off, mission execution, and landing phases of each UAV. Humans oversee the mission, switch the flying mode to manual in case of a failure or emergency, and monitor navigation data during the operation.

This research uses a Genetic Algorithm (GA) to determine the optimal coverage path. GA is a heuristic algorithm that relies on genetic and random selection. John Holland discovered it 1960 to identify optimal solutions to NP-hard problems using bio-inspired operators such as mutation and crossover [2]. The purpose of applying GA is to get recommendations for UAV paths to achieve optimal coverage.

This paper presents a survey of coverage path planning. GA will be employed to figure out the optimal route. At the same time, real-time kinematic (RTK) GPS will guarantee that the UAV is precisely positioned at the desired location with a minimal margin of error.

Ⅱ. Method

1.1 Environment

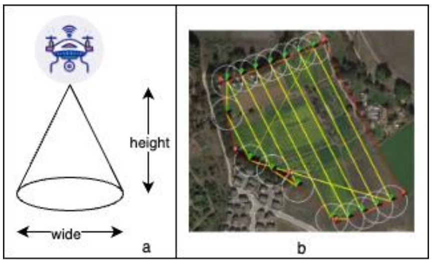


Fig 1. System Model

Fig 1 illustrates the system model used in the conducted research. Fig 1.a illustrates the UAV's capability to detect objects. When analyzing this scenario, it is essential to consider the altitude of the UAV and the camera's range of view to identify objects. Figure 1b illustrates the specific area that is intended to be explored. The graphic displays the measurement of the distance between the yellow lines. The spacing between the curved lines is calibrated to match the camera's range of view on the UAV being utilized.

1.2 RTK GNSS

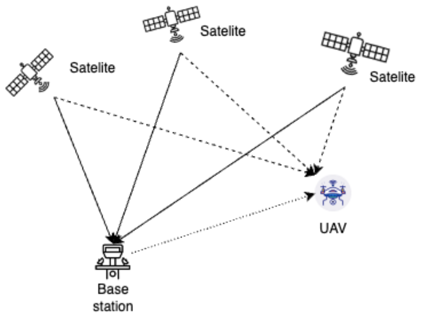
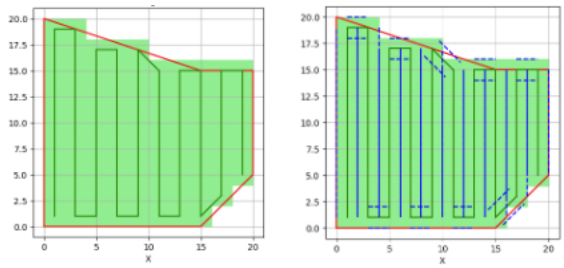


Fig 2. RTK GPS GNSS

GNSS signals emitted by satellite constellations, such as GPS, GLONASS, Galileo, and BeiDou, are susceptible to inaccuracies. RTK leverages supplementary GNSS carrier wave measurements to mitigate inaccuracies and ascertain a more accurate measurement of the distance between the receiver and the satellite. RTK positioning operates by rectifying GNSS inaccuracies, including satellite clock deviation, ionospheric and tropospheric delay, orbit fluctuation, and multipath propagation [3]. RTK UAVs equipped with RTK receivers can gather and organize data that RTK base stations transmit. Implementing a network of real-time kinematic base stations, known as a Continuously Operating Reference Station (CORS), can enhance the precision of GNSS data. Utilizing several base stations minimizes redundancy time and mitigates faults in the data transmitted from each base station, augmenting reliability.

1.3 Path coverage area

The GA is a stochastic classical evolutionary algorithm. When we refer to "random" in this context, we mean that the GA applies random modifications to the current solutions to develop new ones. GA frequently produce excellent answers for optimization and search problems by utilizing biologically inspired operators, including mutation, crossover, and selection. It produces a set of points at each iteration, and the population converges towards an optimal solution. Determines the subsequent population by a computational process that employs random number generators.



a. Path of UAV

b.Path of UAV with range of view camera

Fig 3. Path Coverage

Ⅲ. Conclusion

In order to ensure the success of a coverage mission, coverage algorithms must consider many factors, including the intricacy of the covered area and the existence or absence of a restricted atmosphere. Moreover, the algorithms should develop coverage paths for the application's requirements.

As depicted in Figure 3, the output generated by the Genetic Algorithm (GA) takes the shape of a path representing the coverage area. The image shown in 3.a represents the path taken by the UAV, whereas the image in 3.b displays the UAV's path along with the camera's field of view. The UAV can comprehensively assess the entire area by employing optimal path optimization techniques. During field testing, the UAV strictly adheres to the flight route defined by the genetic algorithm.

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REFERENCES

[1] J. Modares, F. Ghanei, N. Mastronarde, and K. Dantu, “Ub-anc planner: Energy efficient coverage path planning with multiple drones,” in 2017 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2017, pp. 6182– 6189.
[2] S. Gupta and P. Panwar, “Solving travelling salesman problem using genetic algorithm,” International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, pp. 376– 380, 01 2013.
[3] Kim, E.; Kim, S.-k. Global Navigation Satellite System Real-Time Kinematic Positioning Framework for Precise Operation of a Swarm of Moving Vehicles. Sensors 2022, 22, 7939. https://doi.org/10.3390/s22207939