

## 2019 “ShuWei Cup”IMCM

### Problem B: Optimization of the Flight Route of UAV Shooting

As one of the important achievements in science and technology innovation, drones have been widely used in national defense, digital earth, ecological protection, public safety and advertising photography in recent years. The aerial image of the drone has the advantages of high definition and being easy to take off and land. The most outstanding features of drone aerial photography are small-size, light-weight, low-noise, energy-saving, high-efficiency, and clear-image.

Aerial photography with drones can give us a broader perspective and show the overall setting. Shooting with a drone often takes a certain height from the ground to form a high-pitched effect. This effect can bring some advantages on the screen, enabling a wider range of shots and a wider field of view. Figure 1 shows the schematic of the drone aerial photography.

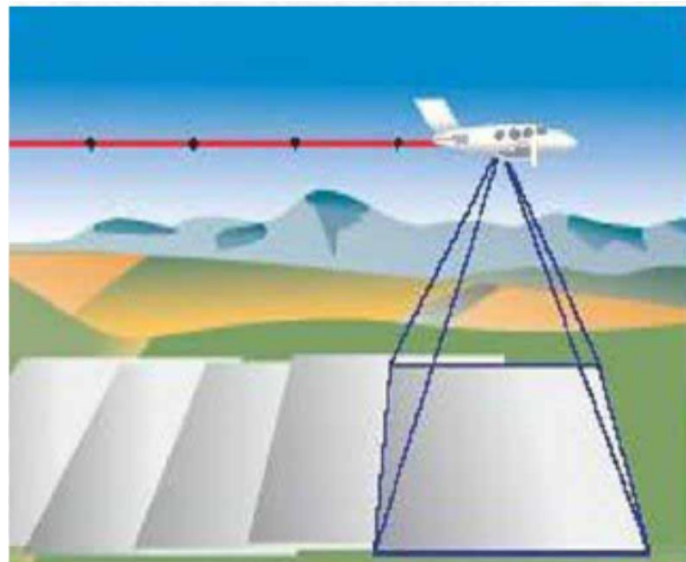


Figure 1 schematic of the drone aerial photography

However, for the first-time drone operator, it is difficult to master the techniques of flying height, flying speed and the shooting angle. If the flying height of the drone is too high, the range collected by the camera will be relatively large, but the pixel points per unit area will be less; if the flying height of the drone is too low, the range will be relatively small, the number of pixels in the area will increase and the accuracy of the collected information will be improved; If the flying speed of the drone is too fast, the number of frames taken by the camera will be reduced per unit time, and the difficulty of image analysis will be increased. The size of the shooting angle is related to the effect of image shooting. How to use the drone to take a satisfactory picture is one of the most urgent problems to be solved.

Please solve the following four problems using the knowledge of mathematical

modeling.

Your tasks are the following:

**Task1**: Assume that the drone is not affected by external factors such as wind direction and humidity during flight, and the flight speed and shooting angle are constant, and the drone performs aerial photographing in a straight-line flight mode for an area with a certain width. What is the height range of the flying drone performing this aerial photographing and propose the best aerial photographing height at the specified shooting angle.

**Task2**: Assume that the UAV's flight altitude is fixed and the flight speed is constant and the UAV needs to perform more accurate image acquisition on the actual ground conditions and please calculate the optimal range of the UAV shooting angle.

**Task3**: Assume that the flying height of the drone is fixed and the flying speed is constant and the drone is collecting the trajectory of a certain moving object on the ground. Please calculate the changing pattern of the UAV shooting angle.

**Task4**: If the drone encounters obstacles such as signal towers, telephone poles, houses, etc. during its flight, please calculate the optimal flight speed, flight altitude and the shooting angle, and provide the relevant data simulation experiment.

Your submission should consist of:

- One-page Summary Sheet.
- Your solution of no more than 20 pages, for a maximum of 22 pages with your summary.
- Note: Reference list and any appendices do not count toward the 22-page limit and should appear after your completed solution.