Contrasting Orthophotos by Height, Overlap, and Drone

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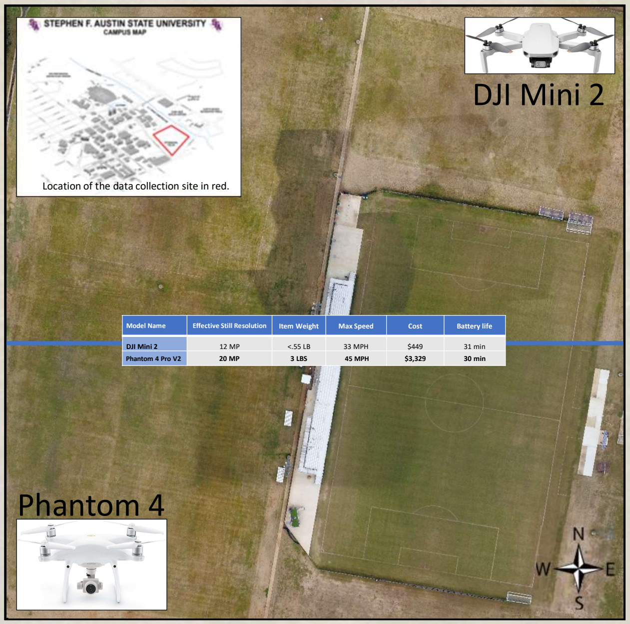
Introduction

Drones have recently become a mainstay for surveying and modeling of small areas of land in a cost-efficient manner. Yet there are many variables that affect the time, quality, and cost of capturing and generating such products. We look at several of these parameters and discuss the alternatives to minimize cost over a series of projects. The parameters in question include height, overlap, sensor resolution, processing time, drone costs, computer costs, processing costs, time in the field, storage, drone endurance and the likelihood of costly delays. A series of flights using different drones and flight parameters were then used to validate the hypothesis. The results indicate that for a particular need and sensor resolution there exists a curve of height vs overlap that produces similar results. Thus, selecting the point on the curve that minimizes flight time will produce the lowest cost for a series of projects.



Model Name	Effective Still Resolution	Item Weight	Max Speed	Cost	Battery life
DJI Mini 2	12 MP	<.55 LB	33 MPH	$449	31 min
Phantom 4 Pro V2	**20 MP**	**3 LBS**	**45 MPH**	**$3,329**	**30 min**

Figure 1 - Comparison of the 80% forward overlap/80% side overlap flights at 200 ft for both DJI Mini 2 and Phantom

DJI Mini 2	200 ft		400 ft	
Forward/Side Overlap	Time (min)	Photos	Time (min)	Photos
60/50	2	47	2	12
70/70	7	107	3	24
80/80	12	212	5	65

Phantom	200 ft		400 ft	
Forward/Side Overlap	Time (min)	Photos	Time (min)	Photos
60/50	14	94	9	78
70/70	19	233	11	128
80/80	20	347	15	178

Table 2 - Comparison of the flight time and number of photos for both DJI Mini 2 and Phantom.

Methodology

Using Phantom 4 and DJI Mini2 drones, we flew a series of flights at 200 ft and 400 ft. Each series was repeated with an overlap of 60/50, 70/70, and 80/80 (where 60/50 denotes an overlap of 60% forward and 50% on the side). The drones were controlled using the Map Pilot Pro software installed on an iPhone 8. The results were then processed with Drone2Map to generate the orthomosaic shown in Figures 1, 3, and 5. The photos in Figure 4 indicate the differing flight plans generated by changing the height, overlap, or drone for the same area. The orange lines denote the flight path, the blue dots represent where the photos were taken. Note the photos were taken on an overcast day with the clouds at 9000 ft and winds at 9 knots. Both of the flights at 200 ft with a 60/50 overlap had problems with gusts later in the day. The Mini 2 orthophoto shows the blurred results found in both runs. The Phantom orthophoto was from a previous day for comparison.

DJI Mini 2

Figure 3 – Orthophotos from a DJI Mini at various heights and overlap percentages

Shared Flight Plans

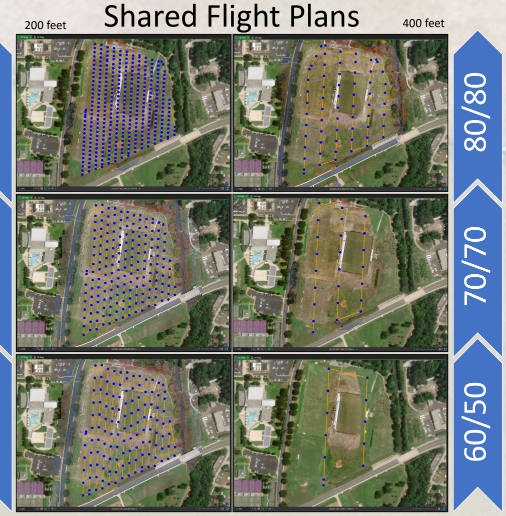


Figure 4 – Shared flight plans at various heights and overlaps percentages

Phantom 4

Figure 5 – Orthophotos from a Phantom 4 at various heights and overlaps percentages

Conclusion

For a fixed drone and given level of quality, you can increase the height, but you must increase the overlap to compensate, or vice-versa. Since there are often obstructions up to a certain height, there may be a lower limit on height, and regulation 14 CFR 107 places an upper limit on height. Similarly, for overlaps past 90/90 there is a marginal rate of return for increases in overlap and a lower limit of 50/50 for good quality mosaic output. Within those bounds, for a given sensor, the higher the flight, the lower the total flight time. Thus, minimizing the total time in field, minimizes the most expensive aspect of the project, the in-field labor costs.

Discussion

Most of the fixed costs in producing orthophotos (including the cost of any sensors, drones, and computers) can be spread across multiple projects. So, the most significant cost to any single project is the time to collect the data. Thus, to minimize costs you must minimize the flight times, while maintaining the desired quality.

There is a direct relationship between overlap and quality. The greater the overlap between adjacent photos, the better the quality of the resulting orthophoto. This can be seen above where orthomosaics derived from the same drone and height at three different overlaps (the rows in Figures 3 and 5) show differences in quality. Most notable are the hose, the sidewalk cracks, rough bleacher edges and bench braces. In a similar manner the lower the height, the greater the quality. See the images taken from 200 feet and 400 feet (the columns of Figures 3 and 5).

It is important to note that for a given planned overlap, the effective overlap decreases at the edges as seen in Figure 6. Thus, two similar benches captured using the same drone, height, and overlap generated very different results, because the left bench was at the edge of the flight path and the right bench was in the middle of the flight path. Since areas with higher overlap produce more accurate results, we recommend extending the flight path by one row and one column width to increase overlap at the edges of the area of interest.

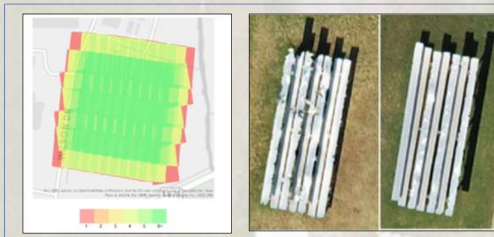


Figure 6 – The edge effect

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