Accuracy in UAS GPS Coordinates in Response To Speed

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Abstract

The purpose of this experiment was to find how much of a difference in GPS accuracy on a UAS system in relation to speed there was (if any) in comparison to an absolute (1-2 cm accuracy) known location provided by a ground station. We began by placing identification makers in a straight line, setting up a TopCon ground station and positioning each of them to an absolute GPS coordinate, and flying a Mavic Pro UAS with GPS positioning abilities over each of the identification markers. After many runs at different hover times, speed and altitude, we found that the GPS coordinates from the UAS would not match with the absolute location of the TopCon.

Purpose

If a UAS is used in a crop field to identify insect problems or concerns, would you be able to accurately find that location based off of the GPS coordinates provided by the UAS? The purpose was to understand the margin of error.

Questions, Hypotheses, and Predictions

Question: What affect does UAS speed have on the accuracy of the GPS coordinates assigned to images?

Hypothesis: Aircraft speed affects satellite acquisition and GPS accuracy associated with aircraft imagery

Predictions: The faster the aircraft is moving, there will be an decrease in accuracy of image locations compared to absolute positions.

Study System

TopCon Hyper V Ground Station

DJI Mavic Pro UAS

Methods and Experimental Design

We began by placing 15 identification markers on 1 x 1' tiles at the KSU Agronomy North Farm. We recorded "absolute" GPS coordinates using a TopCon ground station and rover, which provided a position accuracy of 1-2 cm. Next, we flew the Mavic Pro over our transect to measure variation in GPS positions using the image-based sensor, which assigns coordinates to each acquired image.

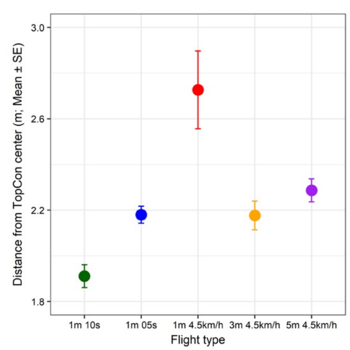
Treatments included a combination of aircraft speed and/or hover time at different altitudes:

- 1-m high,10 second hovering time
- 1-m high, 5 second hovering time
- 1-m high, aircraft speed at 4.5 km/hr
- 3-m high, aircraft speed at 4.5 km/hr (R1)
- 3-m high, aircraft speed at 4.5 km/hr (R2)
- 5-m high, aircraft speed at 4.5 km/hr

We measured the distance between UAS-derived coordinates and absolute estimates using the distance measuring tool within ArcMap (software info). We modeled the variance between estimates using a simple one-way analysis (ANOVA) of variance using R-Studio. P-values were adjusted using the Bonferroni method and means were compared across all treatments.

Results

UAS coordinates were significantly affected by speed, but all were 2-3 meters from the absolute position. The longer the aircraft hovered over the position, the closer it was to the absolute and once we reached 1-m high at 4.5 km/hr, the distance was greater. Interestingly, the next two runs at 3-m and 5-m high at 4.5 km/hr showed relatively the same distance in meters from the absolute position as the 1-m high, 5 second hover time's trial.



Conclusions

The hypothesis was that the aircraft speed would satellite acquisition and GPS accuracy, this was true. If you are in a crop field and want to find an area of interest via UAS coordinates, the ease of finding it just based off its data can prove to be difficult. Even with the variance in meters from the absolute location, it is a far more viable solution rather than physically walking into a given crop field and finding the position of interest yourself.

More interestingly, it seems the UAS and its ability to receive coordinates accurately is not only determined by the speed at which the aircraft is moving, but its position in relation to the satellites it is receiving from. As found, the UAS at a higher speed can pick up relatively the same coordinates as it could at a hover time, thus giving the idea that satellite positioning is as important of a factor as aircraft speed.

Future Directions

Many variables should be accounted for and further tested. For one, I would have many more positioning runs with the UAS. A measure of coordinate positions with longer hover time would significantly improve upon data. Further more, I would have flown the aircraft in large gaps in time to determine if the same coordinates would be picked up or if the satellite acquisition has more of an influence than the speed of the UAS.

Another possibility of testing the satellite's influence in receiving coordinates would be to have the Mavic Pro grounded on top of the absolute position for an extended period of time, all while continuously capturing GPS coordinates. The data received from this would be beneficial in understanding the margin of error the passing satellites contributes to the UAS' ability to capture coordinates accurately.

References

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