Using UAV-based Platforms to Produce More Accurate Geographic Maps

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Objective

Geographic map formations are typically determined through the use of satellite imaging. Although this is useful in most cases, there are some scenarios where this can prove to be ineffective, especially in regions where vegetation is too dense for satellites to see through. This is on top of the fact that these images tend to be of low resolution; therefore, small rivers become increasingly difficult to detect. As such the objective of this project is to find an effective and precise method to determine smaller vegetation-covered waterways through the use UAV-Based LIDAR (Light Detection and Ranging).

In our project, we used a small vegetation-covered river called Little North Prong (Fig. 1) located at the Triple N Ranch Wildlife Management area. The specific region surveyed was 84.4 acres.

Fig.1: Little North Prong River

Devices

Three primary devices were needed: a UAV device (w/ real-time kinematic positioning system), a Sensor, and a GNSS (Global Navigation Satellite system) rover.

Fig.2: DJI Matrice 300 RTK

UAV- DJI Matrice 300 RTK

For the project, the Matrice 300 RTK was the selected UAV primarily due to its large support system and highly precise flying capabilities, as well as large range of compatibilities with software

Sensor – DJI Zenmuse L1

To detect small waterways through tree lines, a very precise remote sensing method must be used, as such a LIDAR Device must be used. The DJI Zenmuse L1 was selected specifically for compatibility with the UAV, and its ease of use in generating point clouds.

Fig.3: DJI Zenmuse L1

Fig.4: Garmin eTrex 32x

GNSS Rover — Garmin eTrex 32x, Rugged Handheld GPS Navigator

No matter what data we obtain we need to determine whether the data is accurate or not. As such we need a ground truth. To do this we used a GPS logger and walked along the river to determine an increasingly accurate estimation as to where the actual river is located

Software/Methodology

In order to obtain an accurate depiction of the waterways, 3 key software's were used: DJI Terra, LP360, and ArcGIS. The process to develop the raw data provided by the UAV survey was as presented in the order and process below

DJI Terra

The objective of DJI Terra was to process the raw data obtained in the UAV survey and convert it to a .LAS format point cloud.

1. Import Data into DJI Terra

2. Set up specifications as needed, in our case we used WGS84-17N because LP360 Software does not accept Geographic Projections

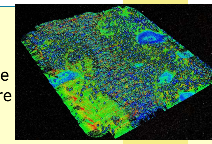

Fig.6: Intensity Point Cloud

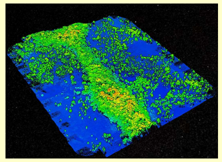

Fig.5: Elevation Point Cloud

3. Run the program, and after some time, an elevation (Fig.5), Intensity (Fig.6), and RGB (Fig.7) point cloud will be generated

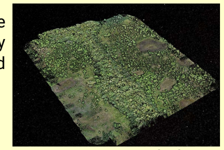

Fig.7: RGB Point Cloud

Import .LAS Data into LP360

LP360

In LP360, the point cloud went through classification where the data was either classified as ground or not ground. This was done to help isolate known ground points from tree points to create an idea of where the river might be for use in ArcGIS.

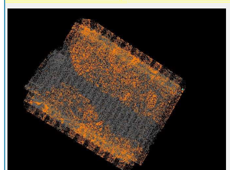

Fig.9: Classified Point Cloud Data

To classify the data, the software used a statistical method. In this system, the point cloud was divided up into grids (Fig.8) and the ground was classified based on a local minimum.

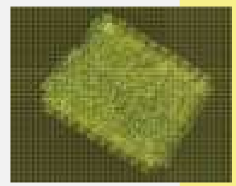

Fig.8: Point Cloud with Grid

After processing, the data will be split between either ground [brown] or unclassified [gray] (Fig.9)

Import .LAS Data with Classification into ArcGIS

ArcGIS

The final step is ArcGIS. In this software, we converted the previously isolated ground data points into a DEM to determine the river location.

1. Import Classified Data into ArcGIS

Fig.10: RGB Image of Region

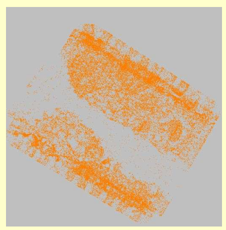

Fig.11: Point Cloud With Ground Points Only

2. Remove all non-ground points from point cloud (Fig.11)

3. Generate a DEM from Ground-classified data (Fig.12)

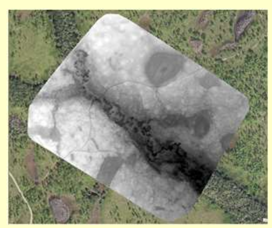

Fig.12: Image of Generated DEM from ground classified data

Results

From data processing, we can obtain three images. In "ARCGIS" section we have our DEM of the ground data (Fig.12). Below on the left, we have our ground truth data of the actual flow of the river as determined by our physical walk through the river (Fig.13), and for clarity, on the right we generated another image of the ground truth data being overlayed on the DEM (Fig.14)

Fig.13: Ground Truth Data Obtained By Walking Through The River Physically

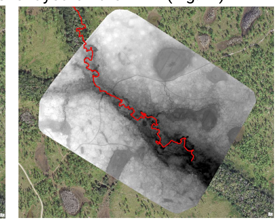

Fig.14: Ground Truth Data Overlayed on DEM (Note: Full river was not traversed, only a portion)

Discussion

Through our results we can see that our data can create an increasingly accurate presentation of the river, converting it from the satellite-based estimation (Fig.15) to our representation of the river which was traced determined by tracing the approximate path using the by using the dark image splotches on the DEM (Fig.16).

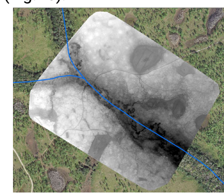

Fig.15: Path of River Assumed by Government Satellites on DEM

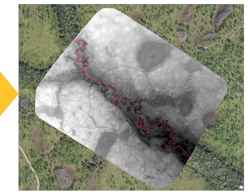

Fig.16: Traced Path of River Determined by Our Process on DEM

Based on the findings of this experiment it can be argued that the method presented can be somewhat applicable for future use; however, further research must be done in different regions to determine the true accuracy of such a process. Furthermore, as the progress of this study continues our group intends to create a software to trace this approximate path instead of simply using eyeball approximation.

In future studies, our group intends to help make this process effective on a large scale so that it can be used in large regions to generate more effective maps of rivers for use in water resources.

References

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