TECH TALK

Comparison Between the DJI L2 LiDAR and the PLS RIEGL Mini 3 Lite LiDAR on the Same Project, and a overview of our results of Combining Aerial and Terrestrial Scan Data

BY: Robert L. Young - RPLS, Alexis Cardona López

The original plan was to compare the methods of data collection from both terrestrial and aerial scanning, followed by more efficient data extraction for CAD.

If your company has ventured into the world of drone LiDAR and terrestrial scanning, you've likely had to do extensive research and self-learning, as most of us have. In 2015, we entered the drone world, just like many small companies, through DJI.

This article is not intended to promote the DJI products, the Harris H6E drone, or the PLS (Phoenix Lidar Systems) Riegl Mini 3, but to compare the results obtained from both sensors on the same project for learning purposes.

SITE:
Texas Amphitheater – Glen Rose, Texas – August 2024

PURPOSE OF SURVEY:
Conduct an ALTA boundary survey.

HYPOTHESIS:
To determine the utility of combining aerial and terrestrial LiDAR with point cloud data from the LEICA RTC360, and to assess the potential of TopoDot and Carlson Point Clouds software for automatic or manual extraction. We also aim to identify the best use of LiDAR sensors for our future projects.

EQUIPMENT USED:
- DJI M300 with L2 LiDAR sensor and 35mm P1 camera with 48 megapixels.
- Harris Aviation H6E drone with Riegl Mini 3 Lite LiDAR sensor.
- Carlson BRX7 for static and RTK GNSS.
- LEICA RTC 360 terrestrial laser scanner.
- DJI Terra and Virtual Surveyor for processing DJI data.
- Lidarmill for processing Riegl data.
- TopoDot within Bentley Open City.
- Cyclone REGISTER 360 Plus for processing RTC 360 data.
- Carlson CAD – AutoCAD.

1. DRONE LIDAR EQUIPMENT COMPARISON REPORT: DJI AND RIEGL
Report detailing my observations and comparisons of the data collected using DJI and RIEGL drone systems. Below are the results of the various analyses performed.

A1 - GCP Elevation Comparison (RIGHT)
In three tables compare the elevation differences in Ground Control Points (GCPs). Elevation for each point was obtained by creating a surface from the XML files generated from each flight. Points were then created in CAD at the exact location of each GCP, using the elevation from the relevant surface.

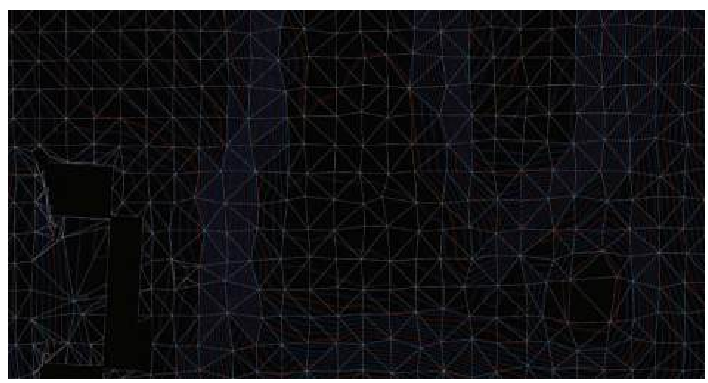
In the tables, numbers in red indicate differences greater than 0.2, while values in blue represent the average of all differences. My observations indicate that there was no significant difference between the first and second flights with the RIEGL system.

The LidarMill comparison report shows better accuracy in elevation differences with the GCPs, with an error of 0.0568. However, this is an internally generated report by the processing system.

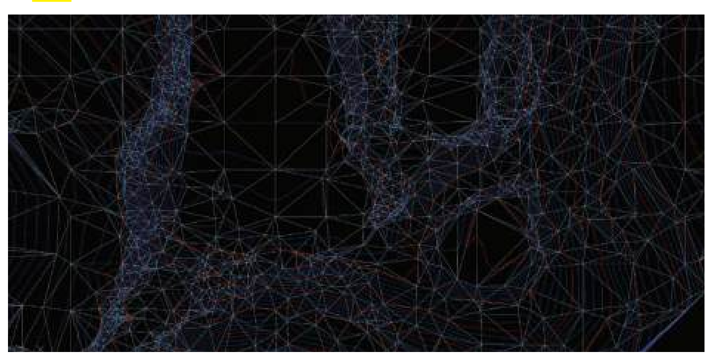
On the other hand, the DJI comparison report presents an acceptable average elevation. However, it's observed that GCP 8 has a significant difference of 0.76218, and GCPs 5 and 11 show differences greater than 0.40.

B1 - Surface Creation and Contour Lines (BELOW)
Here the, XML files were used to generate TINs to create surfaces and topographic contour lines. It was observed that the RIEGL system produces less noise in the data, which aids in the Automatic generation of break lines. In contrast, the DJI system captures more noise, complicating the precise delineation of break lines.

RIEGL



DJI



GCP#	RTK-ELV	REIGL-ELEV	DIFFERENCE
REIGL 1	08-14-24		
3	797.805	798.004	-0.199
4	796.764	796.902	-0.138
5	788.025	788.168	-0.143
6	784.812	784.957	-0.145
7	795.748	795.963	-0.215
8	756.915	757.172	-0.257
9	736.239	736.472	-0.233
10	788.577	788.381	0.196
11	753.543	753.822	-0.279
12	794.468	794.566	-0.098
13	797.411	797.556	-0.145
14	798.203	798.372	-0.169
15	796.947	797.146	-0.199
16	800.5	800.701	-0.201
17	795.658	795.784	-0.126
			-2.351
		AVG. ERROR	-0.156733333

REIGL 2	08-29-24			Lidar Mill report		
3	797.805	797.89061	-0.08561	797.805	797.871	0.066
4	796.764	796.94345	-0.17945	796.764	796.827	0.063
5	788.025	788.37484	-0.34984	788.025	788.1	0.075
6	784.812	784.79613	0.01587	784.812	784.874	0.062
7	795.748	795.93881	-0.19081	795.748	795.819	0.071
8	756.915	757.31699	-0.40199	756.915	756.809	-0.106
9	736.239	736.49347	-0.25447	736.239	736.319	0.08
10	788.577	788.76323	-0.18623	788.577	788.623	0.046
11	753.543	753.75588	-0.21288	753.543	753.564	0.021
12	794.468	794.48405	-0.01605	794.468	794.538	0.07
13	797.411	797.41964	-0.00864	797.411	797.488	0.077
14	798.203	798.24845	-0.04545	798.203	798.279	0.076
15	796.947	797.04783	-0.10083	796.947	797.025	0.078
16	800.5	800.55338	-0.05338	800.5	800.576 795.658	0.076
17	795.658	795.70959	-0.05159		795.755	0.097
		-2.12135				0.852
		AVG. ERROR	-0.141423333		AVG. ERROR	0.0568

GCP#	RTK-ELV	REIGL-ELEV	DIFFERENCE
DJI	08-14-24		
3	797.805	797.92343	-0.11843
4	796.764	796.7679	-0.0039
5	788.025	788.44591	-0.42091
6	784.812	784.63101	0.18099
7	795.748	795.70443	0.04357
8	756.915	757.67718	-0.76218
9	736.239	736.33706	-0.09806
10	788.577	788.92417	-0.34717
11	753.543	753.13186	0.41114
12	794.468	794.3927	0.0753
13	797.411	797.33889	0.07211
14	798.203	798.22571	-0.02271
15	796.947	797.12881	-0.18181
16	800.5	800.4817	0.0183
17	795.658	795.51861	0.13939
			-1.01437
		AVG. ERROR	-0.067624667

Note: Although there were no significant differences between the first and second flights with RIEGL on the GCPs, DJI, despite having a better average elevation, showed high differences in some GCPs. The automatic report from LidarMill, though showing a smaller difference, is comparable to the results presented here, especially on GCP 8.

Note for Images on Left: DJI, by capturing more returns, generates more data, including noise points. The RIEGL processing is considerably more accurate in defining the natural terrain and in delineating break lines.

C1-PoiBnt Cloud Comparison

As shown in these two images generated in Carlson Point Cloud Advanced from LAS files are presented. The point cloud produced by DJI is denser than RIEGL's, and the DJI LAS file size is three times larger. Additional flights with RIEGL, with closer flight lines, yielded similar results.

RIEGL-Single beam sensor
.LAS size 9,759,891 KB

DJI-Multi beam sensor
.LAS size 23,183,872 KB

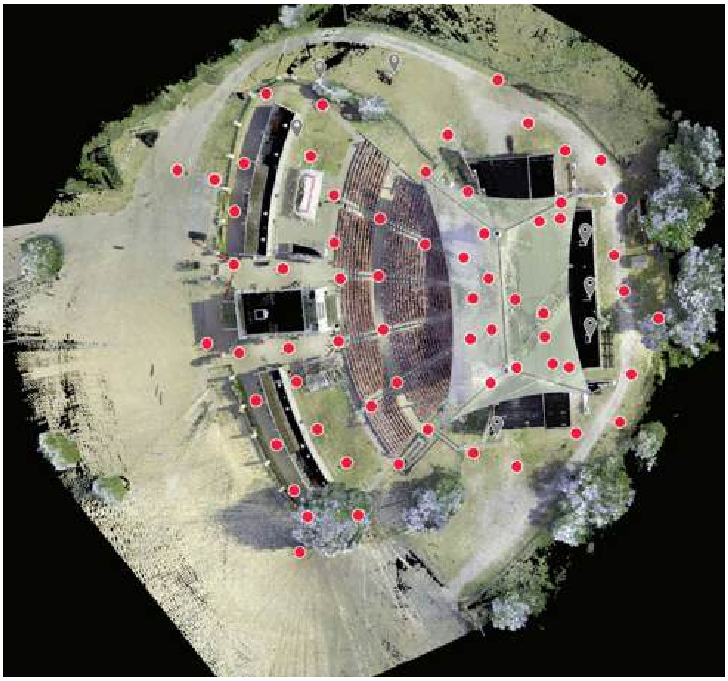
Note: In Topic A-1, the GCPs align very well with RIEGL, while some points with DJI show errors greater than 0.4. In Exhibit 2, the XML exported by RIEGL for topographies is excellent. In Exhibit 3, it is necessary to consider whether adjustments should be made to obtain a denser point cloud with RIEGL or if, due to its greater precision compared to DJI, the current cloud is sufficient, although it appears less dense visually.

2. TERRESTRIAL SCAN DATA: RTC 360

A2- Data collection (terrestrial scan), which is not adequately covered by aerial Drone Lidar

The terrestrial data was strategically distributed to cover the entire area of the structure, ensuring that we cover all areas that the drone data cannot clearly reach and considering the maximum distance of the RTC equipment to link the setup points, which is 50 feet, and ensuring data consistency to achieve a final bundle with proper calibration.

Another very important thing is Geo-tagging photos of all the small details, example; ICV, clean-out, or other importn details we want to remember during the extraction process.

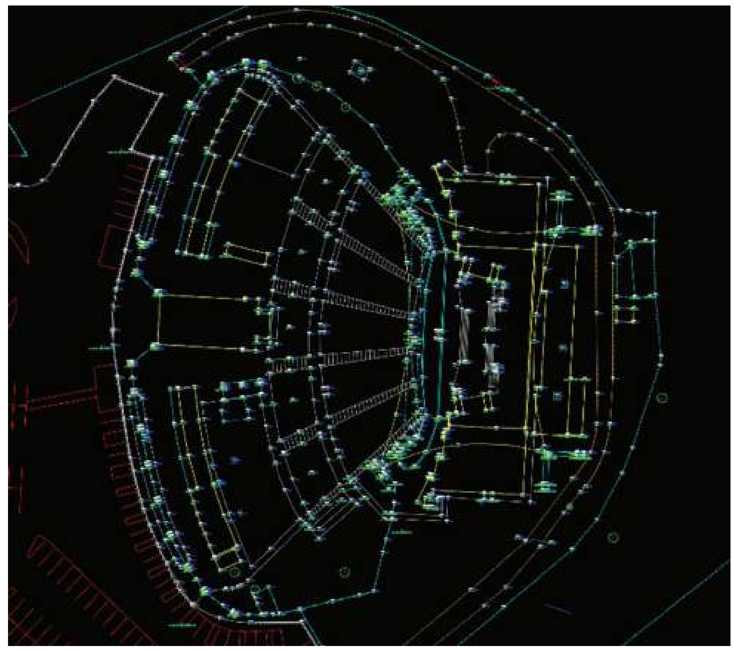


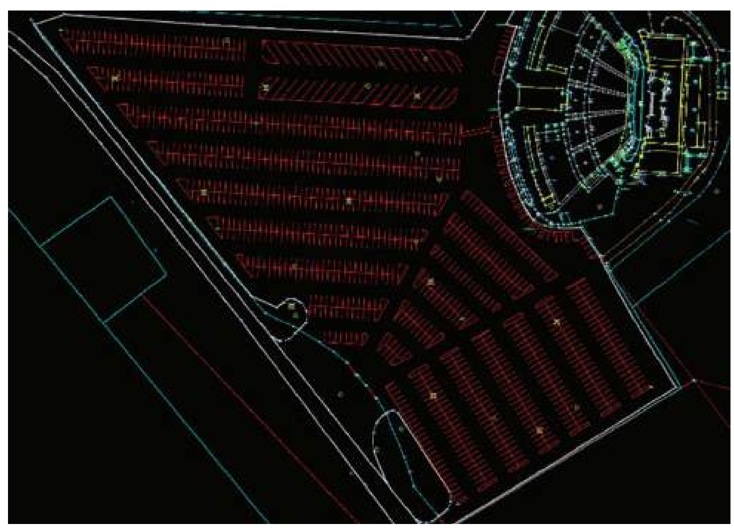
Note: As you can see in the images, there are areas of the structure's roof that are not covered, as we focused more on the lower levels, knowing we have that data from the drones. In a case where we needed to cover the roof, we would move my setups differently and most likely use the spider tripod, which has a 15′ extension. It has its particularities in terms of use, but that could be covered in another article.

3. EXTRACTION FOR CAD

A3- Points and line work

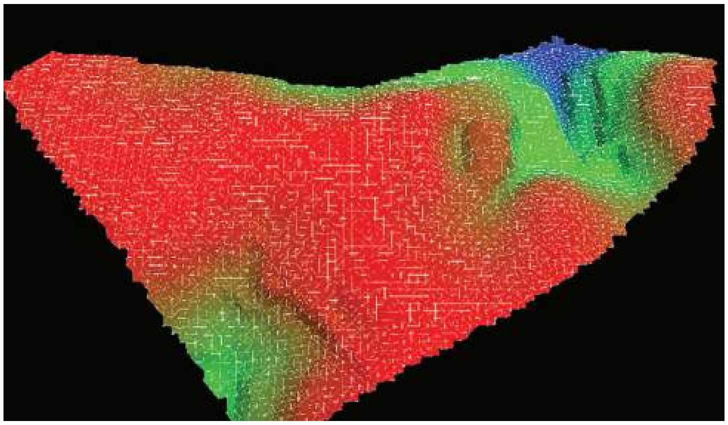
For point and line extraction, we used a combination of two programs: Carlson Point Cloud and TopDOT within the basic version of MicroStation. Neither of these programs offers a "magic" extraction that automatically generates a final product; both have helpful tools, but their effectiveness depends on the type of work needed. In this case, we did 95% of the extraction using Carlson Point Cloud. For road or railroad projects, TopoDOT is more useful.

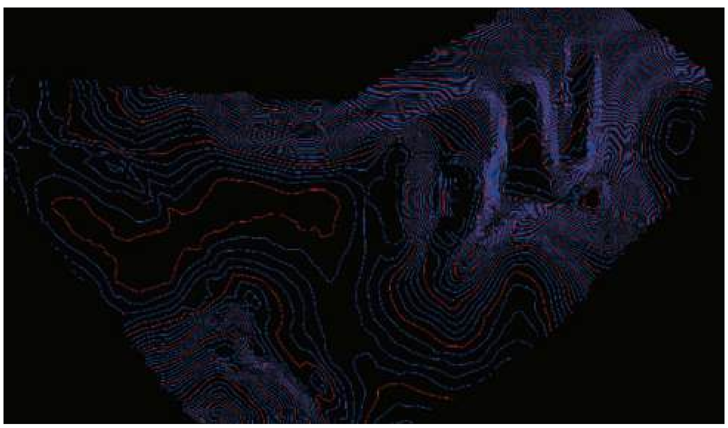




Note: Always keeping in mind the type of data I want to extract. For example, if I need a point for a tree, it doesn't have to be as precise, but if it's a building corner or manhole, in that case, the process needs to be optimized and carefully verified. This project also included the property boundary, which was captured using RTK with an OPUS solution via PPK

B3- Surface extraction to generate contours (topography).
We used the Reigl XML, as the DJI one had more noise. We incorporated the break lines we had already extracted to use them and improve the interpolation of the triangles.





After verifying and modifying the triangle interpolation, we generated the contour lines from my final surface.

CONCLUSIONS:

1. LiDAR sensors produce varying results, and human judgment is always necessary to determine the correct interpolation. Some sensors simplify this process more than others, but each individual or company must decide which one best fits their needs.
2. Data extraction software has improved significantly, making the process more efficient. However, the choice of software depends on the specific type of work being performed. It's crucial to select a tool that meets the project's requirements. These programs are not fully automatic—obtaining accurate data extraction still requires time and expertise. There is no "magic" software or artificial intelligence capable of fully automating the process. I always say, *"when someone invents a technology that can replace a human with a machete and a shovel, then field surveyors will no longer be needed, and we can leave it all to the computers."* —Alexis Cardona López.
3. The integration of terrestrial and airborne LiDAR data is a complex process. If not properly optimized, even the most expensive equipment will fail to deliver satisfactory results.
4. The most effective approach is to analyze each project in advance and carefully plan which equipment and technology to use. In the example I presented, I combined drones with LiDAR and cameras for orthophotos, terrestrial scanning, and conventional RTK. This approach allowed me to maximize the strengths of each technology based on the project's specific needs.

*The key is to plan thoroughly and then execute efficiently and learn from each project.

"Give me six hours to chop down a tree, and I will spend the first four sharpening the axe." — Abraham Lincoln