Automatic 3D Object Extraction

NV5 Geospatial

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Abstract

Improvements to LiDAR (Light Detection and Ranging) technology have revolutionized 3D geospatial data acquisition and usage. One example that has made it easier to benefit from LiDAR data is GeoCassini. GeoCassini is a cloud-based platform, which enables users to share, update, and manage geospatial data. NV5 Geospatial, the maker of the industry standard ENVI® geospatial analysis software recently deployed its 3D extraction analytics on GeoCassini. The combination of GeoCassini's cloud processing and ENVI analytics enables users to harness the power of LiDAR data without the need for extensive hardware or infrastructure investments. In addition, the platform facilitates seamless data sharing, collaboration, and accessibility.

This whitepaper explores how users can access data on GeoCassini and apply NV5 Geospatial analysis tools for advanced 3D object extraction. NV5 Geospatial's Custom Solutions Team also offers 3D object extraction for customers who want tailored results to meet specific project requirements.

Introduction

Evolution of LiDAR Technology

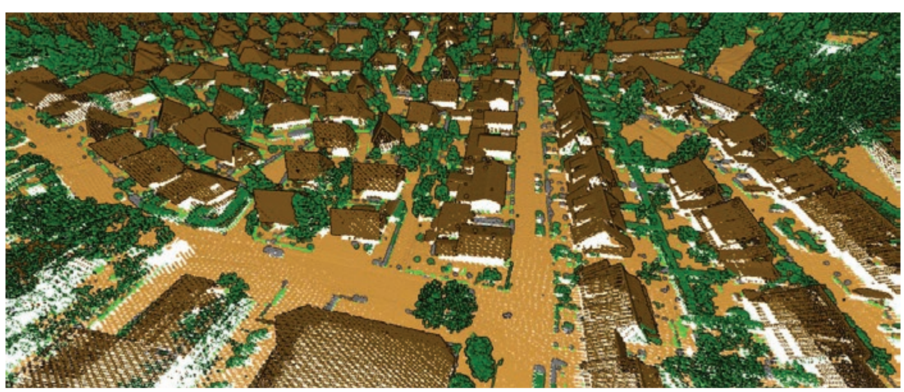
From the mid-1990s to the present, LiDAR technology has evolved rapidly, boasting improved accuracy, speed, and affordability. In the mid-1990s, LiDAR scanners could produce 2,000 to 25,000 pulses per second. During this time, position accuracy was improved when LiDAR was linked with the GPS technology. With the invention of 3D spinning LiDAR in 2005 by Velodyne's founder Dave Hall, 360-degree vision was possible.

Today, LiDAR sensors can acquire more than one million points per second, with 5 mm accuracy, and datasets can include RGB color values. This has led to LiDAR replacing many topographic surveys and aerial photography campaigns. Along with LiDAR becoming more readily available, datasets have also become more affordable. This has led to a dramatic rise of business applications using LiDAR.

Automatic Digitizing of Objects

Advancements in LiDAR technology has enabled automatic object digitization, replacing manual methods. ENVI® software, created by NV5 Geospatial, includes a variety of tools for detecting objects in LiDAR point clouds, including automatic classification and vectorization. NV5 Custom Solutions team has developed additional tools using RANSAC-based detection, and 3D Deep Learning techniques. These tools and techniques are specifically designed to deliver high-quality results that minimize the need for post-processing QA/QC. Along with ENVI software, NV5 Geospatial has expertise in 3D data analysis through its Custom Solutions team which works with customers around the world to deliver results for specific projects.

E-Cassini's cloud marketplace (GeoCassini) offers a centralized platform for LiDAR data and analytics. By leveraging NV5 Geospatial's renowned analytics on GeoCassini data, users can now perform 3D object extraction and apply the results to solve industry-specific problems. The following sections will explore how different LiDAR acquisitions are required for specific 3D object detection.



ENVI LiDAR classification on Strasbourg (IGN France acquisition) OpenData Airborne LiDAR.

LiDAR Acquisitions

E-Cassini data includes LiDAR data acquired from different platforms. The density and accuracy of LiDAR data depends on the sensor-to-target distance and the sensor platform, which can be aerial or terrestrial.

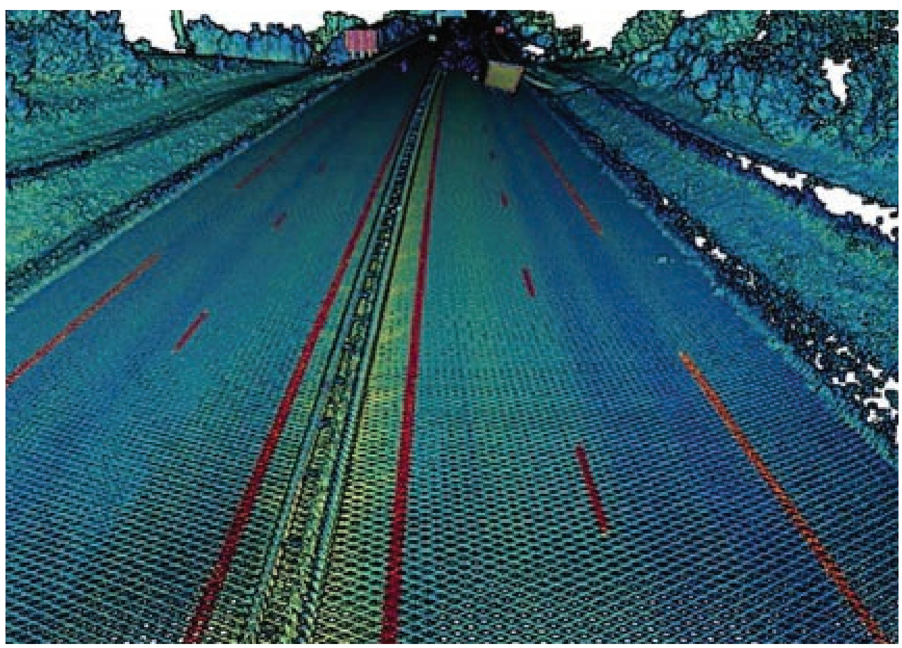
Airborne LiDAR

Airborne LiDAR involves sensors mounted on airplanes, helicopter, or drones, and is suitable for large area mapping. It can detect large objects such as buildings, trees, roads, and power poles. Objects that are below others will not be visible.

Low density urban airplane Lidar (left). High-density RGB urban mobile LiDAR on the same area (right).

Terrestrial Mobile LiDAR

Terrestrial mobile LiDAR systems are attached to vehicles like cars or trains and travel along a corridor. These systems focus on road, street, and railway objects; however, they may not capture objects outside the sensor's field of view.

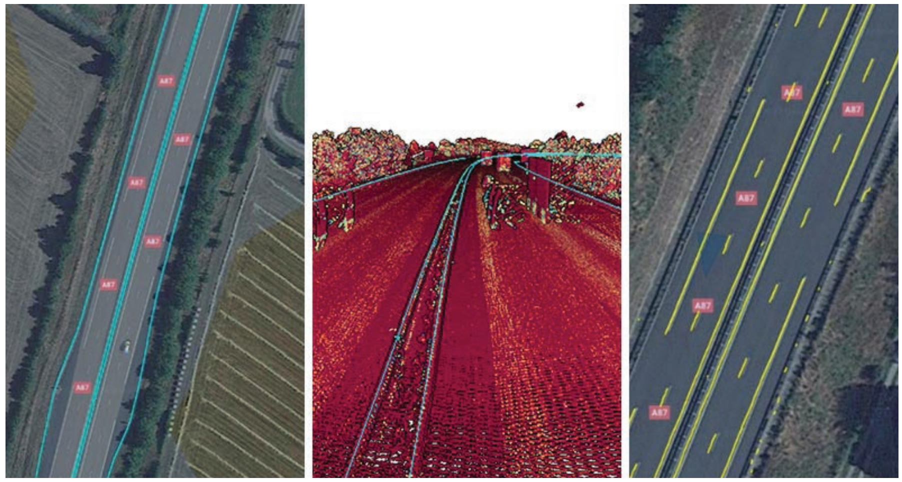


High-density highway mobile LiDAR displayed with intensity gradient colors.

Object and Shape Detection in LiDAR Point Clouds

E-Cassini's platform offers three categories of object extraction:

Safety Barriers
Safety barriers are linear objects located on the side or the middle of the highway and require high-density terrestrial LiDAR data for detection. The relative height of the barrier from the ground is provided in the output.



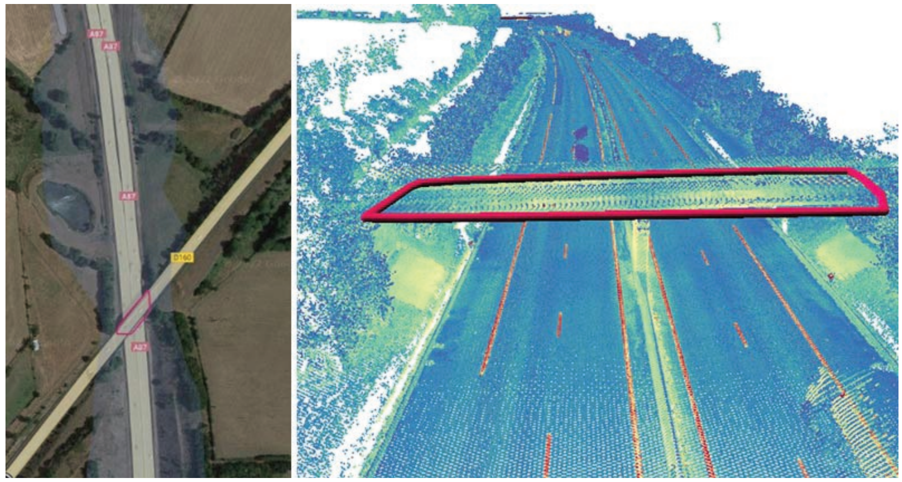
Detected highway barriers in 2D over Google imagery (left). Detected highway barriers in 3D over terrestrial LiDAR (middle). Detected highway road markings in 2D over Google imagery.

Highway Markings
Highway markings are flat objects of varying shapes that are detected by using high-density terrestrial LiDAR data. If available, the process can take the trajectory of the CSV file into account to increase the quality of the results.

Traffic Signs
Large and small highway traffic signs are detected using high-density terrestrial LiDAR data. If available, the process can take trajectory CSV file into account to increase the quality of the results.

Detected traffic signs in 3D over terrestrial LiDAR with intensity gradient colors.

Highway Bridges
Detecting highway bridges requires a high-density terrestrial LiDAR acquisition. If available, the process can take the trajectory of the CSV file into account to increase the quality of the results.



Detected highway bridges in 2D over Google imagery (left). Detected highway bridges in 3D over terrestrial LiDAR with intensity gradient colors (right).

Landscape Features

ENVI LiDAR classification analytics on E-Cassini's platform offer two processes for detecting trees and buildings. Both can be detected with either low-density airborne LiDAR or high-density mobile terrestrial LiDAR. Building roofs will be only partially detected since LiDAR sensors cannot detect hidden portions of roofs.

Trees
Trees can be detected using either airborne or terrestrial LiDAR data. The output includes the tree height and radius.

Detected trees in 2D over Google imagery.

Buildings

Buildings are detected using airborne or terrestrial LiDAR data. Outputs will include roof sections and building perimeters.

Detected buildings roofs in 2D over Google imagery (left). Detected buildings roofs in 3D over airborne LiDAR (right).

Building perimeter polygons are located at the bottom of the roofs.

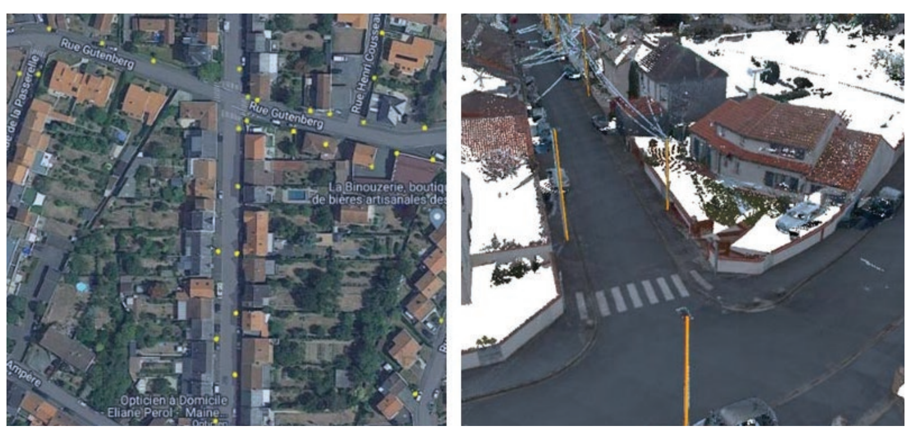
Detected building perimeters in 2D over Google imagery (left). Detected building's perimeters in 3D over airborne LiDAR (right).

Urban Elements

Urban elements include any type of object clearly visible in the point cloud. Detecting these types of objects requires high-density mobile terrestrial LiDAR.

Poles

Poles that can be detected include power poles, telephone poles, and streetlamps. Outputs includes 2D and 3D representations and pole height, which helps distinguish the type of pole.



Detected poles in 2D over Google imagery (left). Detected poles in 3D over high-density terrestrial LiDAR with RGB (right).

Deployment

Cloud-based processing services are initiated from E-Cassini's web platform, with dedicated virtual machines that handle the processing using the described analytics. Users can view results in 2D and 3D on E-Cassini's platform or download them for use in GIS software.

Future

NV5 Geospatial is in the process of developing new object detection capabilities including advanced pole classification using 3D Deep Learning.

Conclusion

The evolution of LiDAR technology has brought about significant advancements in 3D geospatial data acquisition and usage. This whitepaper has highlighted the transformative capabilities of GeoCassini, E-Cassini's cloud-based solution for sharing, updating, and managing data from various sources, including LiDAR sensors, drones, and videos. By leveraging NV5 Geospatial's renowned 3D extraction analytics, users can now leverage LiDAR data and apply sophisticated analysis benefiting various industries such as infrastructure planning, transportation, and urban development.

Furthermore, NV5 Geospatial's Custom Solutions Team possesses expertise in working with LiDAR and 3D data to deliver tailored results to customers with specific project requirements. As LiDAR technology continues to evolve, we can expect even more exciting applications and advancements in the future, further enhancing our understanding and utilization of 3D geospatial data.

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