Velodyne HDL-64 mounted on a collection vehicle.

GHOST IN THE MACHINE

Automating Methodologies for Advanced Asset Management

A major goal in the management of a LiDAR workflow is to minimize the touches, the number of "mouse clicks" needed to reduce raw collection data into functional information. The best way to achieve this is through the automation of as many of the redundant tasks as possible. In the quest to develop a fully automated data reduction system, we currently find ourselves hovering somewhere in between the act of heavy lifting and nirvana.

One valuable tool is a technique that we will refer to as "ghosting". It is based on the comparison of two or more cycles of LiDAR data that have been collected at separate points in time. The efficiency in this technique comes from taking the asset metadata that has been carefully extracted from one point cloud and placing it into a second point cloud to look for changes such as new or removed items. The advantage of using this concept comes from the fact that you only have to identify a majority of the assets once. Subsequent asset inventories become less expensive and time consuming to perform.

To make the act of ghosting effective, it is very important that the point cloud data that is chosen to be overlaid has been collected using the best methodologies and practices available. The success of this technique relies heavily on the quality of the geospatial information that is collected along with the LiDAR data. That means that you have to have a high quality GPS and inertial instrument in your sensor package.

In doing the comparison, one cycle of LiDAR data is chosen as the baseline spatial representation of the assets. It is in this dataset that all of the heavy lifting takes place. Although many parts of the data reduction process can be

BY RAY **MANDLI**

automated, here is where there will be a large dose of manual interaction. Analysts and raters will be involved in identifying and labeling the assets. In many cases they will be verifying the results of the automated processes, but they are also looking for the missed assets and adding other identifying features to the database. The work can include the drawing of the borders of a sign's surface, correcting the placement of a point for an object, the vector line tracing of the tops of walls and guardrails and verifying horizontal and vertical clearances. These assets are fully attributed with all of the information that the customer wants to know as well as standard metadata such as collection date and time, route, milepost, length, width, height, and distance from the road surface.

Dual HDL-32 configuration.

Now that the hard work has been completed in cycle 1, it's time to take a look at cycle 2. Once the second cycle of a project has been loaded, the software is setup to look into the asset database of the previous cycle of metadata. Each of the assets from the baseline file will be displayed in the current cycle's LiDAR point cloud as a "ghost asset". This allows the raters to evaluate each asset for any differences between the current 'snapshot' of the environment and the previous one. If the asset is sufficiently similar in shape and location, the rater will accept the ghost asset into the current cycle and it will be displayed the same as if it were a new asset. This saves the rater's time in defining brand new geometries and filling out all of the attributes again. Accepted assets can also be moved in mass by the rater if they need minor adjustment to fit the current point cloud.

> "In time, as the process gains expertise and experience, it will become more and more automated."

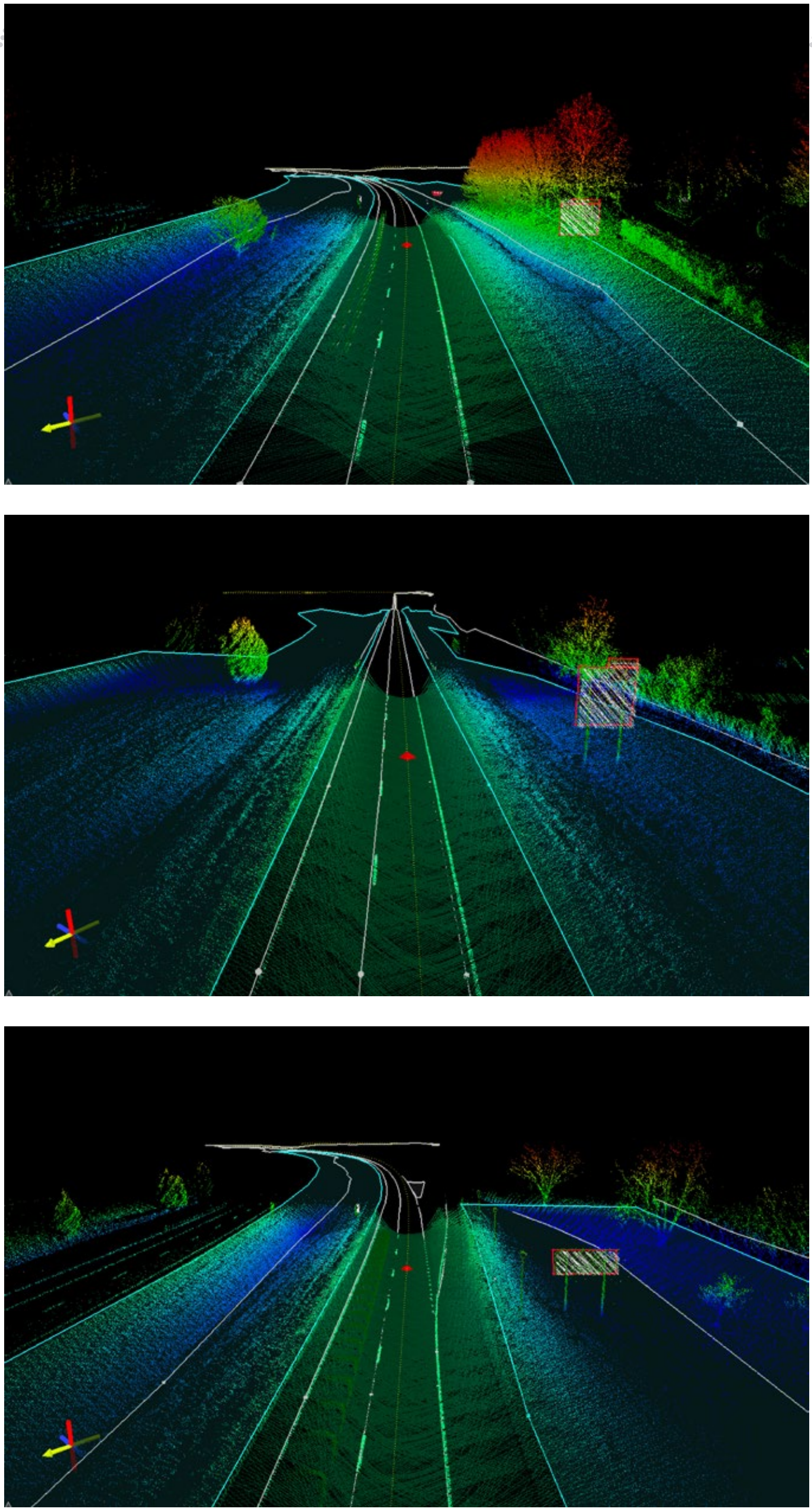
All asset objects created in the software carry a universally unique identifier. This allows a variety of reports to be created regarding the lifetime of an asset and the state of the project from year to year. The software also keeps a list of each ghost asset that is accepted and each that is removed. From this data, a cycle-to-cycle change list is generated to describe what is new, what has changed, and what is no longer there. Users could view, for example, the condition history of a sign or find the year that an end treatment on a barrier was changed. In time, as the process gains expertise and experience, it will become more and more automated.

What follows is a set of examples taken from two cycles of LiDAR data. The original point cloud was produced using a single Velodyne HDL-64 on a section of Interstate 24, which is operated by the Tennessee Department of Transportation, in July of 2011 in Montgomery County near Clarksville, TN. The second cycle of the same stretch of road was captured in January of 2013 with a dual configuration of the HDL-32.

Even though the two cycles were created using different sensor configurations, the metadata from cycle 1 matched very well with cycle 2. There were several occurrences of registration error that caused some assets to be off by several feet but the software allowed for correction of those inconsistencies by bringing everything into a sub foot alignment. With better methodologies and practices, that error could be reduced down to an inch.

In each of the examples, the graphical line data from cycle 1 is superimposed onto the point cloud of cycle 2. The red rectangles represent the manually measured surface area of the signs. The vector graphics show the centerline, edge of pavement, the GPS trace, and mowable areas along the road.

Work is underway to automate a large piece of this process. The LiDAR sensors are becoming more capable and new software is being developed to take advantage of the potential. This year will see the implementation of full feature automatic extraction of roadside assets like signs, guardrails, pavement distress and line striping. These advancements will make the collection of datasets that meet the requirements of the new surface transportation programs under MAP-21, economically feasible. To take on the large projects that encompass the road networks of entire states, efficiencies have to be developed and LiDAR technologies will play a major role in that effort.



Surface area of sign identified in LiDAR data between two cycles.

Raymond Mandli founded Mandli Communications, Inc. in 1983, and since then his company has grown to be one of the most innovative technology integrators in the transportation industry. During this time Mandli Communications has developed advanced mobile data collection systems that include imaging, positional, pavement, and LiDAR technology.