Tools

LP360 Rail Extraction Tools

LP360, versions 2014.1 and above

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Revision 1.0

Overview

LP360 includes tools to automatically extract a rail alignment (centerline) vector as well as classify "top of rail" LIDAR points. This feature is implemented as a semi-automated Point Cloud Task (PCT) and is available in the Advanced version of both LP360 for ArcGIS® and LP360 for Windows® (the standalone version of LP360). We recommend using the ArcGIS version since we do not yet have vector editing tools in LP360 for Windows. We depict in Figure 1 a typical extraction of the alignment and top of rail. The alignment is collected as a set of 3 dimensional vectors in Shape file format. The top of rail points have their Classification Attribute set to the user's choice of class number being used for rail (10 is the industry standard).

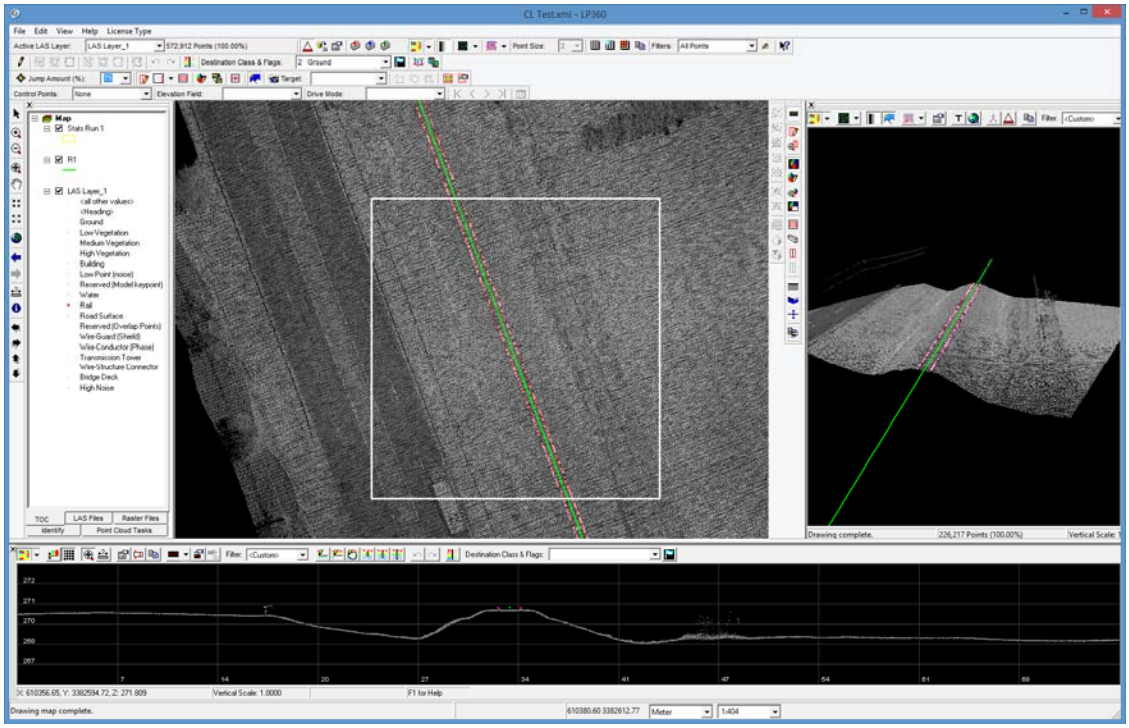

Figure 1: A typical Alignment (green line), top of rail (red points) extraction

Rail alignment/point extraction requires relatively high density LIDAR data. We have had some success at 40 points per meter^2 but recommend around 80 points/m^2. The examples we illustrate in this overview were collected via helicopter at about 100 points/m^2.

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We use a track definition to control the extraction algorithm. We include predefined descriptors for American Standard Gauge in both feet and meters. We also provide a dialog for defining other track gauges.

Using the Tools:

This is not meant to be a tutorial on the exact method of using the rail extraction tools but rather an overview to give you an idea of the process.

The first step is to set parameters for extraction such as whether or not you want the alignment vector, top of rail classified and so forth. These parameters can be saved as a customer Point Cloud Task, eliminating the need to set parameters each time you intend to use the tool.

Once parameters are set, the extraction process begins. There are two modes of semi-automated operation. In the first (and most common mode), the user draws a short, two point line extending in the track direction in which she would like to extract. The task then attempts to continue this line until it becomes "lost." As the extraction proceeds, the user is informed of progress in terms of units of length extracted. The interaction is depicted in Figure 2. Here the white line denotes the digitizing action by the user. The green arrow indicates the direction the user has digitized the white, two point line. The red arrows indicate that this seed line is placed approximately at the track alignment (centerline).

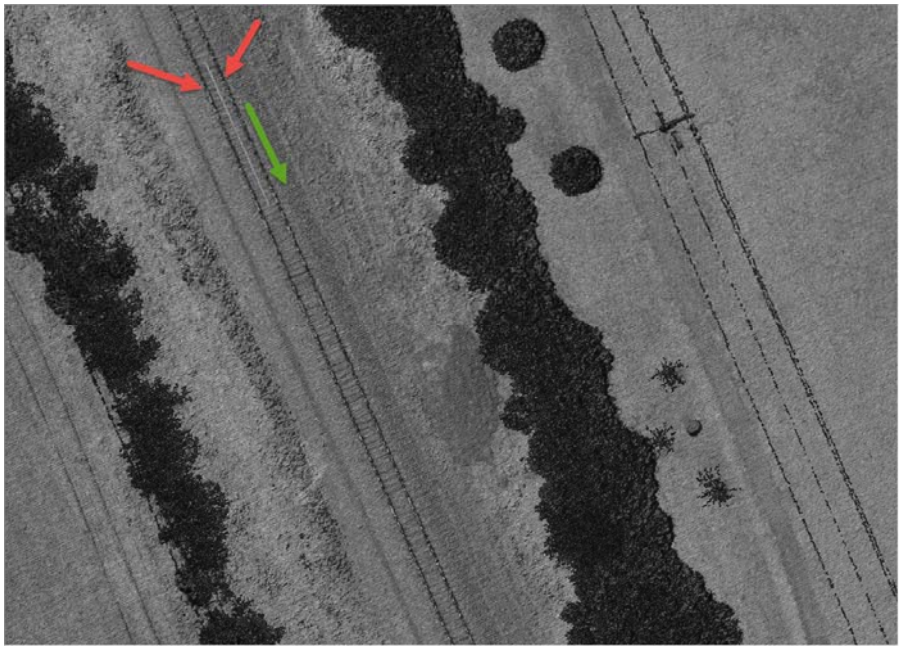

Figure 2: "Seeding" the alignment (red arrows denote the rails, green the "seek" direction

The algorithm will extract until it can no longer detect the rails. The result of the extraction of the seed placed in Figure 2 is denoted in Figure 3. Note the extracted green alignment vector that ended when it encountered an at grade intersection. Notice the classified top of rail shown as the red points in the profile segment at the bottom of Figure 3. The extraction ended when an at grade intersection was

encountered because the rails are below the street surface at this point. The user would start a new seed segment on the opposite side of the intersection and automatic extraction would proceed until the next obstacle were encountered.

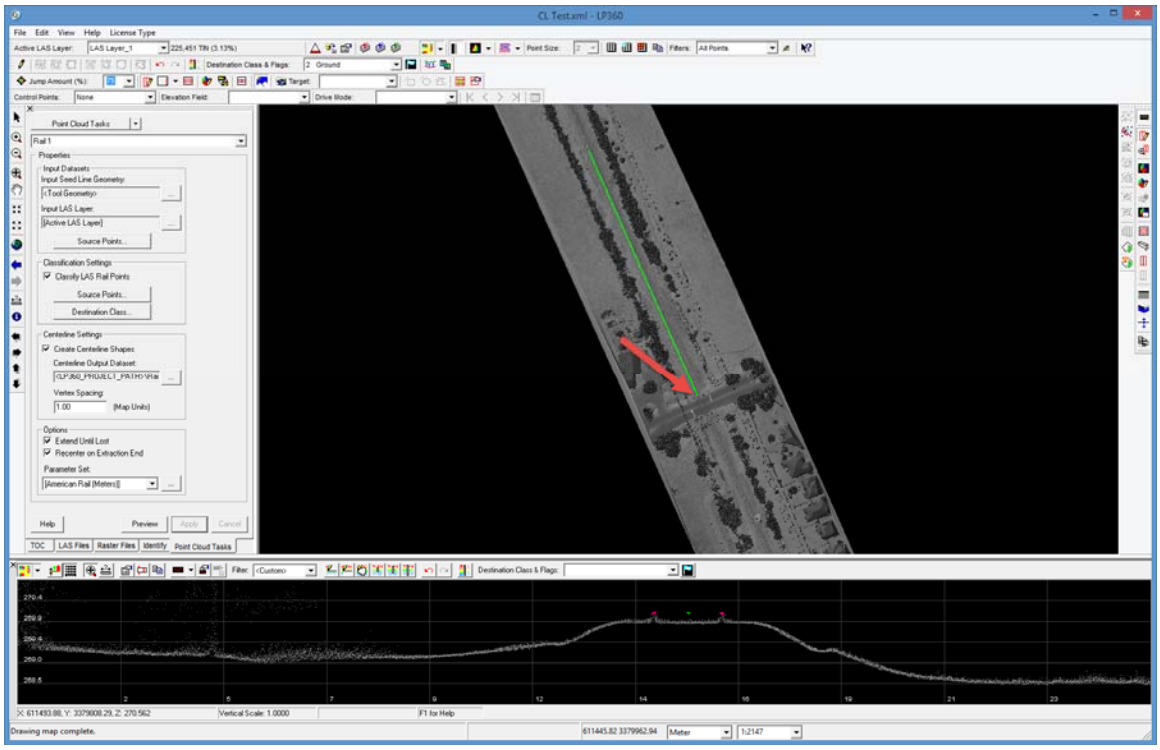

Figure 3: Result of extraction a segment (Map View) and classified rail (Profile View)

The second mode of operation is to use the first two points of a digitized seed line as the starting "hint" and the final point as the terminus (rather than the "extend until lost" option). This is used for digitizing specific segments.

When semi-automatic extraction is complete, it is necessary to correct any errors in the track alignment vectors. We recommend the vector editing tools in ArcGIS for this operation. This is quite efficient when using LP360 for ArcGIS since the LIDAR data simply appear as a layer in ArcGIS. This allows "heads up" digitizing for correcting alignments.

It may also be necessary to clean up some of the classified points for top of rail at locations where the automatic extraction became "confused." This is easily accomplished with LP360's interactive classification tools.

Discussion:

The key to a successful rail extraction project is adequate point densities. For this reason, most rail projects will require a data set collected from a helicopter or a mobile laser scanning (MLS) system. As discussed earlier in this paper, a density of about 80 pts/m^2 or greater (Nominal Point Spacing, NPS, of

around 10 cm or smaller) will provide good results. While we have had success with point densities as low as 40 pts/m^2 using very clean LIDAR data, this is not generally recommended.

The semi-automated algorithm will stop when certain issues are encountered:

- At grade intersections
- Elevated sections of track (trestles)
- Regions of low point density (discussed above)

The alignment vectors collected by the rail extraction algorithms are true three dimensional vectors. The vertex spacing is specified by the user (for example, every 1 meter). The elevation for the vertex (Vertex Z) is computed from the mean value of the elevation of the top of rail at a point perpendicular to the vertex. This is the required scheme for the United States Federal Rail Administration's Positive Train Control (PTC) system requirement.

As pointed out earlier, options exist to:

- Extract just the Alignment without classifying top of rail
- Classify top of rail without extracting the alignment

Conclusion:

The Rail Extraction tools in LP360 make short work of collecting track centerline (alignment) and of classifying top of rail. The tools for managing and displaying point cloud data allow very rapid movement through large datasets. Direct integration with ArcGIS provides a platform for complete editing and extraction.

For additional information, please contact:
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