



The ClearView viewing tool in the EdgeWise software displays the laser scan point cloud, showing the density of MEP features in the North Carolina chemical plant.

Advanced Extraction Algorithms Reduce False Pipe Identification in Laser Scan Point Cloud

Meridian 3D Converts to Automated Workflow

Meridian 3D Inc. had tested automated extraction software to model the piping in laser scan point clouds of industrial plants in the past, but found the technology was generating too

many false positives, especially when highly reflective stainless steel pipes were involved. A recent trial project at a chemical plant, however, convinced the firm's scanning experts that extraction algorithms have finally advanced enough to meet the demands of their typical modeling projects.

"Automated extraction of dense piping [from a point cloud] normally resulted in 10 to 15 percent false positives," said Rick Artiga, Director of Operations for Meridian 3D, a high-definition measurement and scanning firm in Greensboro, N.C. "That took too much time to clean up in the QA/QC phase."

BY KEVIN P. CORBLEY

The extra clean-up work exceeded the time saved using the automated technology, according to Artiga. “False positives” refers to those instances when the extraction algorithm incorrectly identifies a non-pipe feature as a pipe. Curved surfaces in densely packed plants are often to blame, but Artiga added that stainless steel piping often multiplies this issue due to their highly reflective surfaces which create noise in the point cloud. Noise makes extraction challenging whether it’s manual or automated.

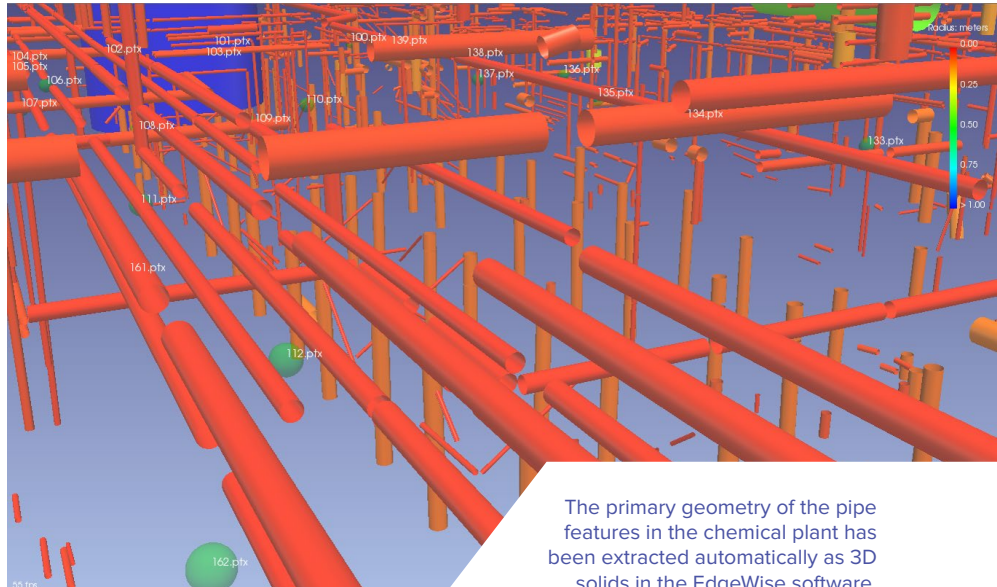
The false positives issue was particularly acute for Meridian 3D because it performs numerous laser scanning and modeling projects each year in clean-room chemical facilities jam-packed with stainless steel piping.

Far from turning its back on automated technology, the Greensboro firm has worked as a regular beta tester of advanced extraction and modeling software developed by ClearEdge3D, a pioneer in this arena. When ClearEdge3D felt it had made a major breakthrough in eliminating false positives in its EdgeWise 5.0 release, Meridian 3D was high on its list of beta testers.

“Getting the thumbs up from Rick [Artiga] and his team validated our success due to the rigorous demands of their projects,” said ClearEdge3D CTO and Founder Kevin Williams. “Meridian 3D scored false positives at less than three percent the first time they tried our new release.”

The Science behind Automated Extraction

ClearEdge3D’s Williams first started working on automated feature extraction and object recognition more than



The primary geometry of the pipe features in the chemical plant has been extracted automatically as 3D solids in the EdgeWise software.

a decade ago at a large U.S. defense contractor. The challenge then was to develop non-manual methods of finding specific features such as buildings, roadways and vehicles in point clouds collected by airborne LiDAR systems. Once he saw terrestrial laser scanners coming onto the market, he recognized that they too would require automated feature extraction technology to truly reach their full potential, and he launched ClearEdge3D to address this problem.

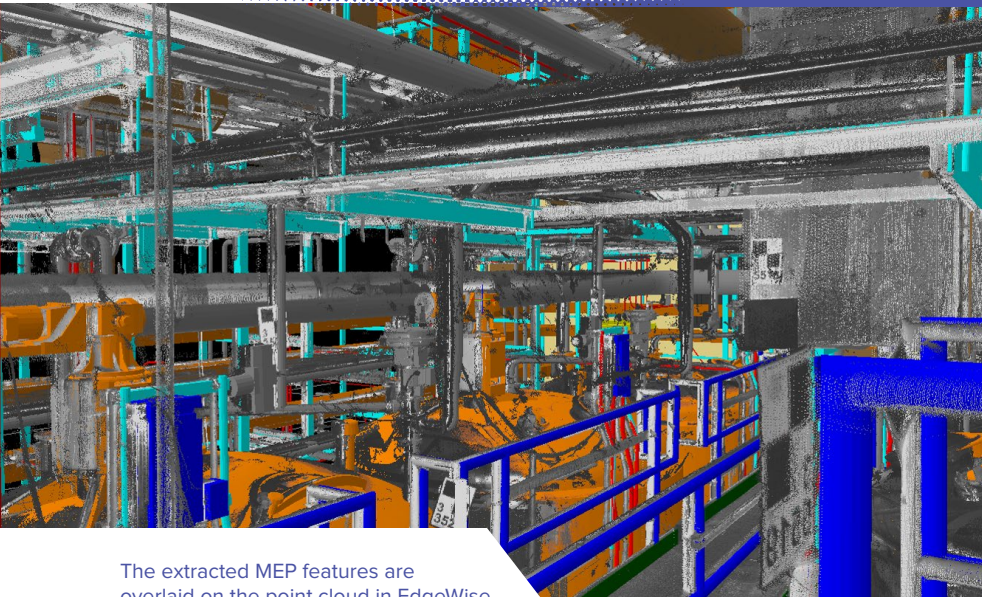
“At first, ClearEdge3D focused on automated modeling of building facades from laser scans, but there wasn’t much of a market there,” said Williams. “We quickly realized the demand was in modeling industrial plants and facilities that are crowded with mechanical, electrical and pipe [MEP] elements that are a nightmare to model manually.”

Williams explained the key to writing automated extraction code is describing the shape and size of features using

mathematical equations. The planar features in building facades are relatively straight-forward to describe mathematically with planar equations, which can be easily fit to a point cloud using the well-known least-squares equation. However, the cylindrical surfaces of pipes are slightly more complex in that they do not have a closed-form solution to the least squares fitting equations and instead require an iterative fitting process.

When the Virginia software firm introduced EdgeWise MEP for automated extraction and modeling of features in densely packed plants and HVAC rooms, the software reduced staff hours by up to 70 percent on many projects. Until then, modeling from the laser point cloud was performed manually in design software such as Autodesk Revit, which was not built for that purpose.

“Incorrect identification of pipes in the MEP environment has been a problem because other surfaces can



The extracted MEP features are overlaid on the point cloud in EdgeWise.

resemble cylinders,” said Williams. “Corrugated metal, which is everywhere in an industrial plant, and rounded or beveled corners on concrete columns are the two most common features mistaken for pipes by the software.”

To reduce false positives in the newest version of the software, Williams’ team wrote algorithms that mathematically distinguished the corrugated surfaces and rounded corners and then filtered them from the objects identified as pipes. As was found in the Meridian 3D trial, the occurrence of false positives was cut from an average of 15 percent to between one and three percent, which saves significant time during the manual editing phase of final modeling.

Extracting Pipes More Accurately

Meridian 3D put the new software to the test in a chemical plant room with a confusing maze of MEP components where most of the piping was stainless steel. The two-person scanning team

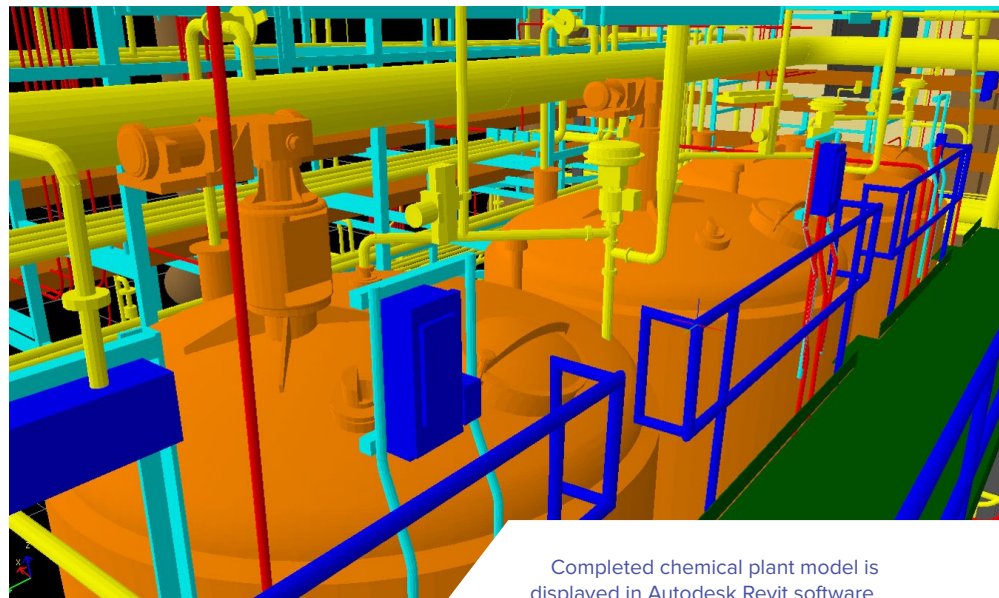
was prepared to deal with the stainless steel pipes, having encountered them many times in the past.

“The key to reducing noise when scanning stainless steel environments is controlling the power of the laser scanner,” said Artiga. “For the chemical plant,

we chose to use our ZF 5006 scanner because it has adjustable power.”

From experience, Meridian 3D has learned the best point cloud results come from setting the scanner to low intensity and short range. While this requires the team to acquire a greater number of scans in the field, the payoff comes from the clean point cloud. In the 14,000-square-foot chemical plant room, which had 37-foot high ceilings, the team captured 70 scans, all of which were fully targeted.

Back in its Greensboro headquarters, Meridian 3D first ran the point cloud through its traditional manual extraction workflow built around the LFM Server software environment. Although time-consuming, the three-person process accurately identifies and extracts nearly all of the stainless pipes in the plant room. The technicians used the bubble view in LFM to ‘walk through’ the point cloud during QA/QC to find pipes and other features missed during the first extraction pass.



Completed chemical plant model is displayed in Autodesk Revit software.

“For this project, the manual workflow took 200 man hours followed by 40 hours of QA/QC for the three person team,” said Artiga.

With those results in hand, Meridian 3D then performed the extraction again, this time with the EdgeWise software suite. The extraction time was cut to 150 man hours and required two technicians instead of three. Although there were some false positives in the extraction, which increased QA time to 50 hours, the overall net time savings using the automated software was 40 man hours, or about 15 percent.

“The big difference for us was that the automated workflow freed up one person to work on modeling,” said Artiga. “We got more work done in a given period of time.”

For the team, the time savings spilled over into the extraction of structural features in the point cloud, such as support columns and steel beams. The automated extraction suite was also able to extract those features along with the MEP. In addition, the software offered its own ‘walk through’ function, called ClearView, where the QA examinations were performed. From EdgeWise, the technicians exported the extracted 3D solids directly into Revit for final modeling of the as-built plant environment.

“False positives have been reduced to a reasonable level...and we’ve converted to the automated workflow,” said Artiga. “This has enabled us to leverage our staff resources more effectively.” ■

Kevin Corbley is the president of Corbley Communications Inc., a Denver-based business development firm that has specialized in the geospatial industry since 1993. Corbley holds a B.S. in Earth Science with a concentration in Remote Sensing.

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ESRI 3D MAPPING FORUM www.esri.com/3Dforum	7
EXELIS www.exelisvis.com	54
FARO www.faro.com	21
GEOCUE www.geocue.com	3
HARRIS www.harris.com	59
INTERGEO www.intergeo.com	61
LEICA GEOSYSTEMS hds.leica-geosystems.com	5
LIDARUSA www.lidarusa.com	11
MANDLI www.mandli.com/maverick	51
MAPTEK www.maptek.com	15
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