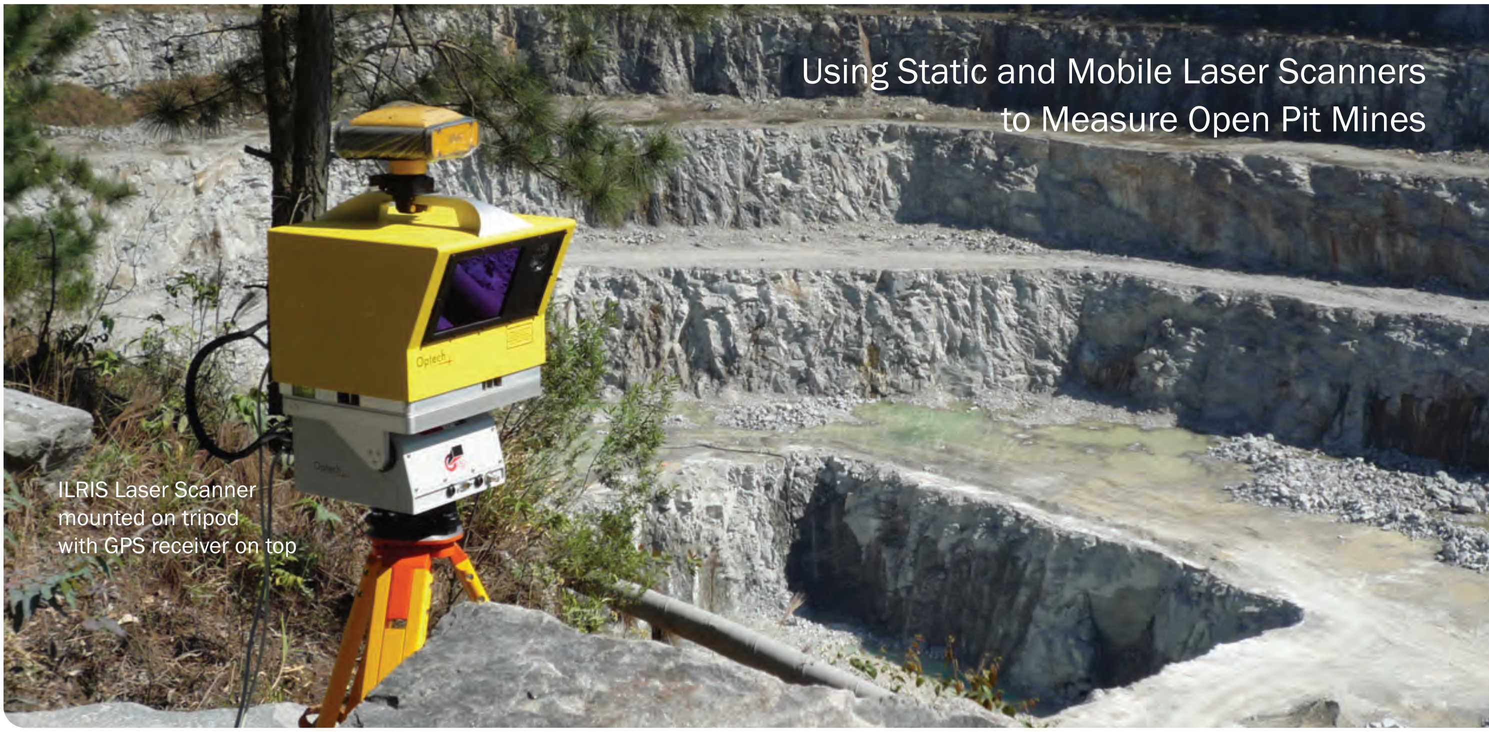
Optech

Open Pit Mine Surveying

ILRIS Application Note: IL-004 Rev A



ILRIS Laser Scanner mounted on tripod with GPS receiver on top

Terrestrial laser scanning (TLS) enables a surveyor to acquire massive amounts of georeferenced spatial data in a fraction of the time traditional methods require. Depending on the application, the surveyor has a choice of two TLS methods: static or mobile.

To gauge the efficacy of TLS in “real-world” mining applications, both static and mobile TLS methods were tested. Both instruments—the ILRIS Laser Scanner and the Lynx Mobile Mapper™—are manufactured by Optech, and were selected to obtain the highest accuracy and the best possible coverage of inaccessible areas.

The ILRIS (Intelligent Laser Ranging and Imaging System) is a fully portable, tripod-mounted, laser-based imaging and digitizing system. About the size of a motorized total station, with an on-board high-resolution digital camera and large-format LCD viewfinder, the ILRIS has a visual interface similar to that of a digital camera. With a 10-kHz data acquisition rate and a range of over 1.5 km, the ILRIS proved highly suitable for these mine environments where robust field performance and portability are critical.

The Lynx Mobile Mapper is a mobile scanning solution—a lidar scanner that surveys the areas surrounding a roadway as the survey vehicle drives along. In field tests, it was discovered that mobile mapping is also suitable for a new application in mining environments.

The Lynx Mobile Mapper is installed on a platform that mounts onto a vehicle such as a van, boat or high-rail vehicle. With its own on-board GPS receiver and inertial navigation system (INS), the Lynx Mobile Mapper is equipped to collect spatial data in a dynamic mode, allowing the survey vehicle to drive close to the area of interest while simultaneously collecting millions of data points.

The Lynx Mobile Mapper is equipped with two lidar sensors, each collecting data at rates of up to 200 kHz (i.e., 400,000 points per second when using both sensors). At 200+ meters, the sensor range obviously influences the surveying technique: driving close to the area of interest produces the densest data collections.

Static Laser Scanner in Open Pit Mine Applications

One of the crucial ILRIS mine applications is where the survey area is very wide and accurate ranges are essential. The field tests were carried out during two mine surveys: a gold mine in Brazil, and a coal mine in Indonesia.

The survey of the gold mine aimed to analyze a landslide that had occurred a few months earlier, and to calculate the volume of material involved in the slide. To capture the entire extension−1.5 km by 1 km, with a depth of about 700 m−the mine was scanned from 6 positions, the coordinates of which were determined with a GPS receiver mounted on top of the scanner. The 1.5-km range of the ILRIS enabled the acquisition of detailed scans of each mine face from its opposite side. The scan duration was 10 minutes per location and produced 5 million points per scan, covering the rock face with surface details at the centimeter level. The field survey was completed in 1 day, whereas traditional methods would have required 2 weeks.

In processing, the six scans were aligned to a single point cloud and converted to a single mesh. Next, a digital terrain model (DTM) was generated, which allowed the lidar ground data to be classified by removing all points above or below a designated surface. The entire mesh was then automatically georeferenced based on the six GPS positions. A virtual reference plane, necessary to calculate volume, was established by importing a georeferenced polyline obtained from a previous survey that used traditional methods. The volume comparison identified a loss of material of about 8,350 m^3 in the upper part of the rock face due to the landslide.

Highlighted area shows landslide in gold mine

Static Laser Scanner in Coal Mine Survey

The survey of a coal mine in Indonesia had two objectives: 1) to image the general morphology of the mine, and 2) to determine the volume of coal extraction over a one-year period, October 2008 to October 2009. To capture the very long extension—1.5 km by 10 km, with a depth of 1000 m—40 scans were required for the October 2008 survey, resulting in 200 million points. The field survey was completed in 2 days, whereas traditional methods would have required 5 weeks. The October 2009 survey was limited to the area where coal had been extracted, and for which volume calculation was needed.

Both surveys were georeferenced using a total station and provided detailed models of the surfaces before and after the coal extraction. Contour lines were extracted and imported into AutoCAD for comparison and analysis.

Lynx Mobile Mapper mounted on survey vehicle at an open pit mine

Mobile Laser Scanner in Canyon Survey

In North America, a second coal mine survey was conducted to calculate volume in certain areas, and to provide deliverables in the form of a DTM plus contour lines. The selected mine covers a canyon with a width of about 300-400 m. The Lynx Mobile Mapper surveyed 5 kilometers while the vehicle drove at a speed of 20 km/h, collecting 200 million points in about 2 hours; previous measurements with traditional methods required about 3 weeks.

A GPS base station, set up near the mine's office building, collected data at a frequency of 1 Hz. The data was combined with the GPS and INS data collected on-board to calculate a Smoothed Best Estimate Trajectory (SBET) using commercial software. The SBET was then merged with the laser ranges, angles and intensity data to generate the final georeferenced point cloud. This stage required 4 hours in the office. A commercial software package created the DTM and the contour lines, and calculated the volume.

Conclusion

The surveys demonstrate that terrestrial laser scanning, when compared to conventional methods, can be up to 15 times faster.

The three mines all benefitted from importing a final mesh into their own software for calculating volumes and other uses. All surveys resulted in the generation of a detailed DTM of the entire area irrespective of terrain and access limitations. Moreover, the dense point clouds facilitated geological analysis such as rock face stability assessments. The resulting accurate and extensive digital database gives mine engineers access to a wealth of information for supporting future operational decisions.

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