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Field Notes

ILRIS-3D—One Tool, Multiple Uses: Mine Safety, Volume Calculation, Change Detection

Mining operations around the world have adopted advances in technology to improve safety, streamline efficiency and increase profitability. Since the early 1990s mines have harnessed lidar (light detection and ranging) technology as a tool for gathering spatial data. Advances in lidar have enabled miners to quickly and accurately acquire 3D digital spatial measurement data.

ILRIS-3D (Intelligent Laser Ranging and Imaging System), a tripod-mounted terrestrial laser scanner, is becoming the instrument of choice for many mines because it integrates the capabilities of multiple tools within one wireless platform and it is easily deployed and operated by one person. This Field Note looks at three critical areas where ILRIS-3D has demonstrated its unique flexibility:

- Mine Safety
- Volume Calculation
- Change Detection

Mine Safety Wall Monitoring

Figure 1: Crusher building (foreground), rock retaining wall (background).

Barrick Goldstrike Mine, Elko, Nevada. A large retaining wall abuts the rear of a crusher building (Figure 1). The retaining wall supports massive weight and volume as large mining vehicles deposit rocks into the crusher. The concern was that the continuous transit of massive volumes of rock, together with the vibration from the crusher and the heavy duty vehicles, could exert a potentially destructive pressure upon the wall. A collapse in the wall could expose mining personnel to serious injury as well as damage the crusher building.

The ILRIS-3D was deployed to scan and measure the wall behind the crusher building. Permanent fixtures were placed around the crusher site and scanning targets were mounted on the retaining wall. The targets and the wall were scanned for a total of 1 hour from two different vantage points. More then 7 million X, Y, Z range data points were acquired at a resolution of 15 mm.

These range measurements now provide baseline data for future surveys. The point cloud derived from the ILRIS-3D survey was imported into a commercially available graphic visualization software package where it was processed, analyzed, manipulated and output in graphic format. In this case, InnovMetric's PolyWorks IMAlign/IMInspect was used to process the point cloud data and output the images (Figure 2).

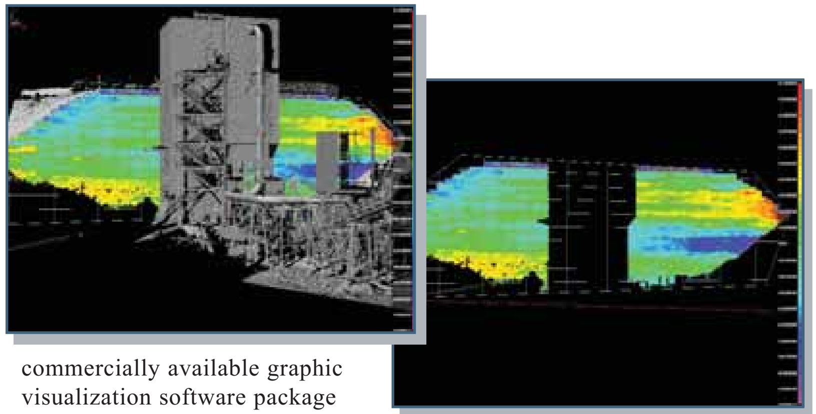

Figure 2: Crusher building with wall behind (left); crusher digitally removed from point cloud data (right).

In Figure 2 a mesh was digitally superimposed on the wall to show deviation. Color coding was assigned to indicate ranges of movement. Red/yellow = movement away from the reference plane (≤10 cm); blue = movement toward the reference plane (≤10 cm); green/turquoise = no movement.

Volume Calculation

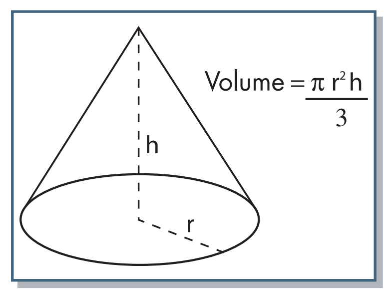

Figure 3: Cone volume formula based on GPS-measured points taken from base and top of pile.

When the volume of a pile of stock material has to be calculated, a common method is to have an individual with a GPS unit walk around the perimeter of the pile to establish GPS ground reference points for calculating the base area. Then the GPS operator has to climb the pile in order to get height reference points. This approach, however, has several risks. First, it is potentially hazardous as it exposes workers to injuries caused by falling debris, or collapsing into unstable material. Second, it is time consuming, and third, it is often inaccurate.

Figure 3 shows how the surface area of a cone-shaped stockpile is estimated based on three GPS points at the base of the pile and one at the top. Using the equation above the volume can be estimated based on the cone's geometry.

A safer, faster and more accurate method of estimating stockpile volume is to use PolyWorks software to process and merge two data sets; georeferenced GPS points and ILRIS-3D range data.

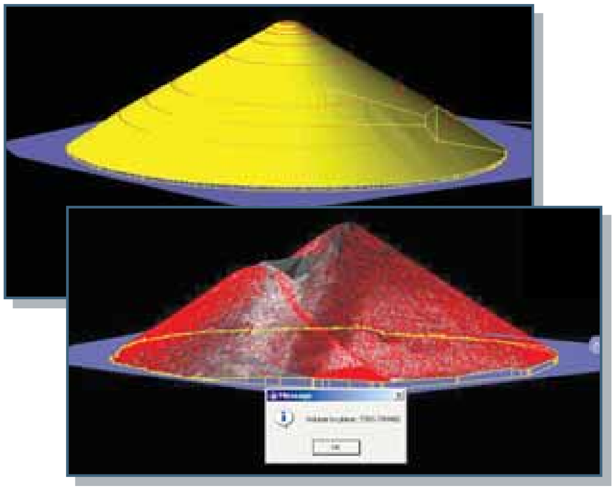

Figure 4: Volume estimate of 6802.98 cubic meters based on GPS-derived cone only (above); volume calculation of 7393.75 cubic meters based on ILRIS-3D and GPS-derived plane (below).

First, a plane is created in the software by selecting the lidar data points representing the base of the stock pile. The plane is used to cap the cone so that PolyWorks has an end reference point to perform its volume calculation. Next, a polygonal model is created from the ILRIS-3D point cloud data. The same GPS-based plane is used so that reference points are consistent. Then PolyWorks combines the metrics from the ILRIS-derived polygon and the GPS plane to calculate a more accurate volume estimate.

One reason the PolyWorks volume calculation is much more accurate is that it is based on a polygonal model derived from ILRIS-3D range data, as opposed to a purely geometric cone shape. The ILRIS-3D measures irregularities and asymmetries in the stockpile, revealing shape and volume characteristics that the geometric formula ignores.

In this example, the GPS-only method estimated a stockpile volume of 6802.98 cubic meters. The combined ILRIS-3D/GPS/PolyWorks method estimated a volume of 7393.75 cubic meters. The difference between the two methods, 590.77 cubic meters, represents 8% of the estimated volume. Such a difference can be expected to be even greater when a stockpile is more irregularly shaped (i.e., not like a cone).

Change Detection

Anglo American Copper Mine, El Soldado, Chile. A quick and accurate means of detecting surface change is necessary in many mine operations, especially in open pit mining where environmental forces such as wind, flooding, temperature extremes and erosion can combine with the constant stresses of heavy equipment to destabilize rock faces.

ILRIS-3D has provided mine operators with an easily implemented method for monitoring surface movement and detecting change. Advantages to this method of slope or error mapping are that the system is easily deployed by one individual, and can be operated remotely via a wireless connection. Ease of set-up and operation means that an area of interest can be repeatedly surveyed. Repeatability enables mine operators to build a database of accurate measurements that can reveal the rate and extent of surface position change over time. Because the range measurement data is digital it can be imported into a variety of 3D modeling software packages for output as a slope or error map.

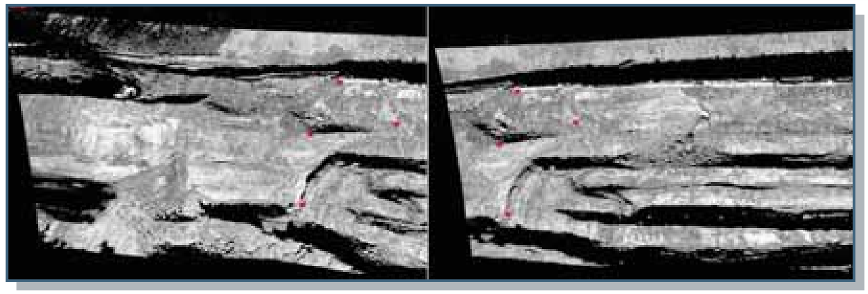

Figure 5: Red dots indicate common features selected for alignment.

In this instance, a number of common features were selected in order to align a number of pre-scans (Figure 5). Then these pre-scans were aligned.

The selection of common features was repeated to align a number of post-scans. As with the pre-scans, the post-scans were then aligned.

Then, both the pre-aligned and post-aligned scans were imported into PolyWorks IMInspect, where they were placed within the same workspace, allowing an error map to be readily generated (Figure 6).

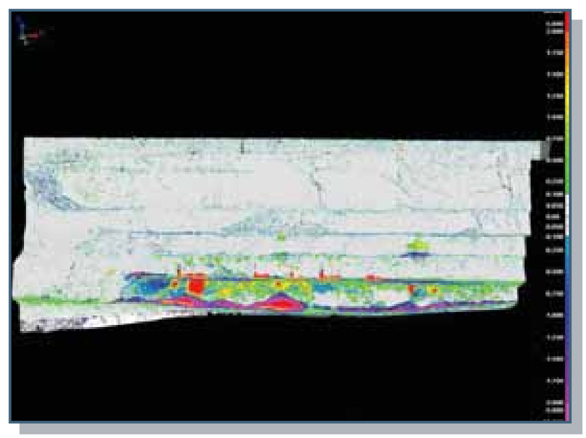

Figure 6: Color-coded error map showing change in rock face.

Conclusion

The ILRIS-3D, along with InnovMetric's PolyWorks software solutions, have proven to be invaluable tools in at least three essential mining areas: safety, volume calculation and change detection with proven increased accuracies.

Ease of set-up and operation (one-person, remote wireless), long-range capability (1500 m), eye-safe operation (Class 1, IEC 60825-1 / US FDA 21 CFR 1040), portability and direct-to-digital output add up to make the ILRIS-3D unrivaled. ILRIS-3D's proven track record to perform multiple tasks has also shown it to provide an exceptional return on investment (ROI).

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