Geophysical Research Abstracts
Vol. 16, EGU2014-6900, 2014
EGU General Assembly 2014

Combining Multiple Surveying Techniques to Accelerate Surveys of Open Pit Mines

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Terrestrial Lidar Scanning (TLS) is well-accepted as the most precise tool for surveying open pit mines, collecting ultra-dense measurements drastically faster than traditional land surveying with a GNSS receiver. However, while a TLS can capture the most important parts of a mine in only a few surveys, the remaining occluded areas of the mine require several additional surveys, extending the survey time.
To drastically reduce the time required for a TLS survey while still providing good quality data, we have adopted an approach that augments TLS data with UAV-based aerial triangulation.

First, we identify a handful of positions from which the TLS can survey the vast majority of the mine, paying particular attention to the most important areas of the mine and the areas that an airborne scanner would have difficult accessing, such as the walls. We then survey the mine with a UAV-mounted camera and collect several ground control points (GCPs) in areas spread across the mine.

During post-processing, we use aerial triangulation to derive a point cloud from the overlapping images captured by the UAV and matched the TLS and UAV data with the GCPs. Generally, the aerial-triangulation data is less dense and precise than the TLS data so we only used it to fill in areas we did not cover with the TLS. To minimize the impact of any loss of detail, we plan surveys so that the TLS covers the most important parts of the mine and so the UAV data is only needed for less important areas. The result is a georeferenced topographic map of the entire mine with high-quality data in the most important areas, all collected within hours rather than days.

As proof of this concept, geo-konzept surveyed a mid-sized German open pit mine with a goal of spending only half a day surveying on-site. With an Optech ILRIS TLS and a geo-konzept Geo-Copter X-8000 UAS, we met this goal by surveying the entire 500-m$\times$500-m mine in only 3 hours. Post-processing and georeferencing only required another 4 hours, meaning the entire survey could be done in a single day of work. We conclude that this multi-instrument approach greatly accelerates the rate at which surveyors can scan open-pit mines while still collecting dense and precise data.