DATA COLECTING TO VOLUME COMPUTING USING DIGITAL CLOSE RANGE PHOTOGRAMMETRY AND LASER TECHNICS

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INTRODUCTION

Cutting and filling volume calculation are important issues in many engineering and mining disciplines such as erosion studies, estimation of ore removed from a mine face and terrain assessment for construction.

The corrections of volume is direct proportional with the presentations of land surface in a best representation of land surface in best form is depend on the number of certain X,Y,Z coordinate points, point distributions and interpolation methods. Without doubt, in a convenient distributed and much more points provide better representation of land surface. However, much more points means much time and cost. Sometimes obtaining of geodetic points can be risky and also it can be impossible. For this reason, surface of land can not be represent correctly.

Geodetic surveying methods have been insufficient for the volume calculation of the objects need to calculation of volume in a short time or in a risky areas, or unreachable areas. In this case digital close range photogrammetry and Laser Scanning technology are alternative methods to volume calculation.

MATERIAL AND METHOD

Close Range Photogrammetry

Close range photogrammetry is a technique for accurately measuring objects directly from photographs or digital images captured with a camera at close range. Multiple, overlapping images taken from different perspectives, produces measurements that can be used to create accurate 3D models of objects. Knowing the position of camera is not necessary because the geometry of the object is established directly from the images.

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Photogrammetry techniques allow you to convert images of an object into a 3D model. Using a digital camera with known characteristic (lens focal length, imager size and number of pixels), it is need to a minimum of two pictures of an object. If it can be indicated the same three object points in the two images it can be determined other 3D points in the images.

The photogrammetric 3D coordinate determination is based on the co-linearity equation which simply states that object point, camera projective centre and image point lie on a straight line. The determination of the 3D coordinates from a definite point is achieved through the intersection of two or more straight lines. Therefore, each point of interest should appear in at least two photographs. Later, coordinates are measured from 3D model which is constituted by photogrammetric software.

Terrestrial Laser Scanning

Laser scanners are optical measuring systems based on the transmission of laser light. The environment is illuminated on a point by point basis and then the light reflected by an object is detected. A laser scanner consists of a one-dimensional measuring system in combination with a mechanical beam-deflection system for spatial survey of the surroundings.

The laser system measures range images which generates geometric dimensions of the environmental scenes whereas the reflectance image generates a photographic like impression of the scanned environment which can be used for feature extraction, visual inspection, object identification, surface classification and documentation purposes. At the moment, terrestrial laser scanners are used mainly in many engineering applications in order to digitize the 3D model of objects.

Surveying results must meet certain specifications in order to provide the necessary accuracy standards for a certain application. On the other hand, if instruments and methods are used which yield an accuracy far above the needed standard, this will result in unnecessary cost and expenditure. Therefore, any geometric surveying task comprises not only the derivation of the relative positions of points and objects but also an estimation of the accuracy of the results.

With laser scanners, a large number of 3D coordinates on an object's surface is measured in a very short time. Important object features, such as corner points or edges, are not directly recorded; instead they have to be modeled from the point clouds in a separate process. While it is possible to record the same object several times from different observation points, it is impossible to record the very same points in these repeated surveys.

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Therefore, deviations can only be noticed after objects have been extracted from the point clouds and modeled. If the geometric properties of the object are known, however, the deviation of single points from the object's surface may be an indication for the accuracy.

In the case of ranging scanners, range is computed using the time of flight or a phase comparison between the outgoing and the returning signal. Ranging scanners for distances up to 100 m show about the same range accuracy for any range. Triangulation scanners solve the range determination in a triangle formed by the instrument's laser signal deflector, the reflection point on the object's surface and the projection center of a camera, mounted at a certain distance from the deflector.

STUDY AREA

The study area is a sand heap (Figure 1). A truck was used to calculate volume of the sand. Because dimensions of the truck was be measured easily. The shape of the truck is rectangular prism. Width, length and height is sufficient to volume calculation. Volume of the truck body has been calculated as 17.44 m^3 sand excavated and loaded to the truck. 5 truck sand have been excavated. The compression ratio of the sand have been calculated as %10 . 78.47 m^3 sand have been excavated of the study area.

Figure 1, Study area

Volume Calculation by Close Range Photogrammetry

Control targets have been placed before the excavation of study area (Figure 1). Local 3 dimensional coordinates have been measured using a electronic reflectorless total station.

Photographs of the excavation area have been taken by Canon 7.1 mega pixel digital camera. Later, 5 truck body sand have been excavated and converged. Control targets have been placed again coordinates of the targets have been measured after the excavation.

Figure 2, Excavation Work

Control target coordinates and photographs have been transferred to the photomodeller software. Photogrammetric evaluations have been completed. Obtained coordinate values transferred to the surfer software. Volume of the excavation have been calculated from two surface difference as 74.97 $m^{3.}$ Photogrammetric evaluation was completed in 172 minute.

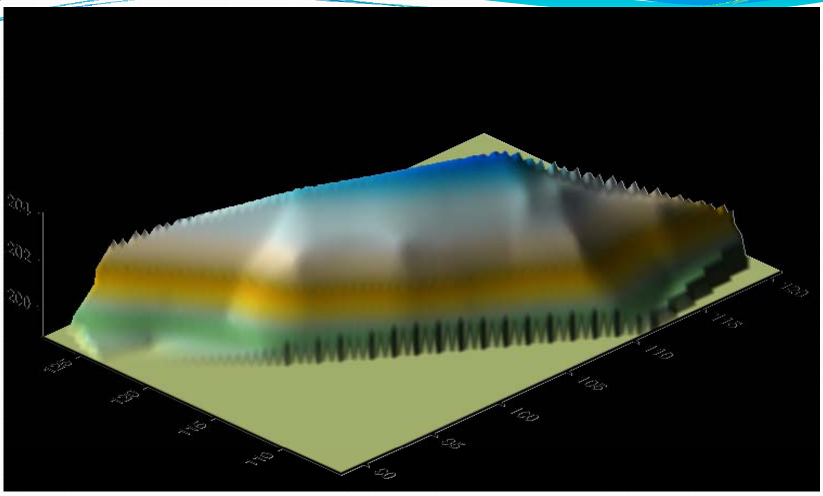

Figure 3, 3D model of object in pre-excavation

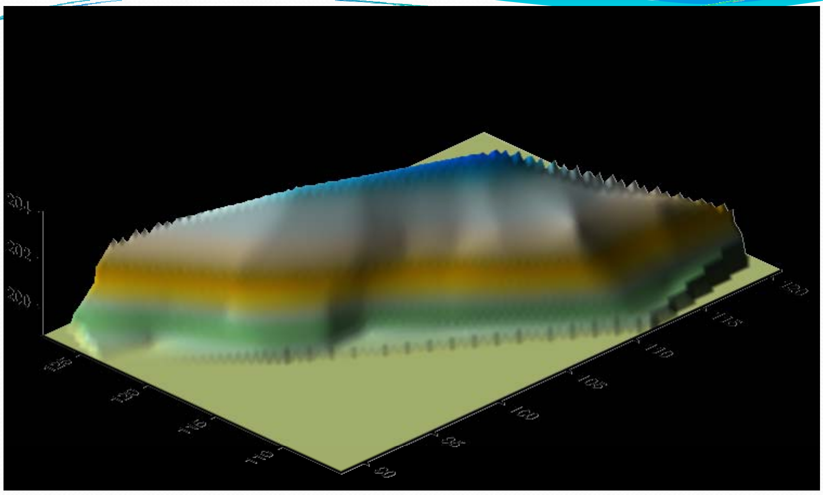

Figure 4, 3D model of object in post-excavation

Volume Calculation by Terrestrial Laser Scanning

In this study, Optech ILRIS-3D Intelligent Laser Ranging and Imaging Systems were used to scan mining area. ILRIS-3D is a compact, fully portable and highly integrated package with digital image capture and sophisticated software tools, ideal for the commercial survey, engineering, mining and industrial applications.

Main Features of Laser Scanner

-High resolution and high accuracy
-Highest dynamic range available on the market: from 3 m to beyond 1 km
-Class 1 laser rating: completely eyesafe
-On-board 6-megapixel digital camera and large-format LCD viewfinder
-Ruggedly designed for demanding field applications
-Battery operated
-No leveling, retro-reflectors, or mirrors required
Compact and easy to use
-Easily hand-carried and deployed by a single operator.

The field survey was carried out before excavation and after finishing excavation. The field survey was finished about ten minutes before and after excavation. Measurements were imported into the PolyWorks point cloud software. PolyWorks is a powerful point cloud software solution that processes data obtained from any 3D scanner. Originally developed to perform point-cloud-based inspection and reverse-engineering tasks for manufacturing applications.

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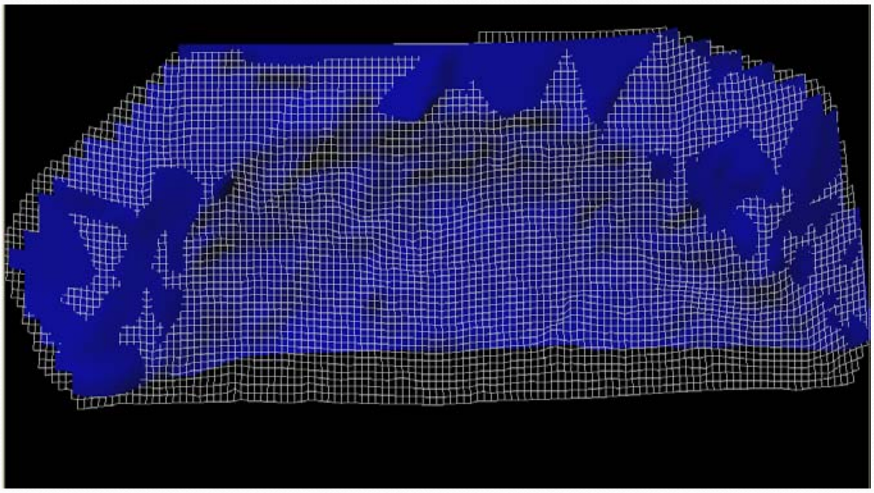

Figure 5, Cloud points

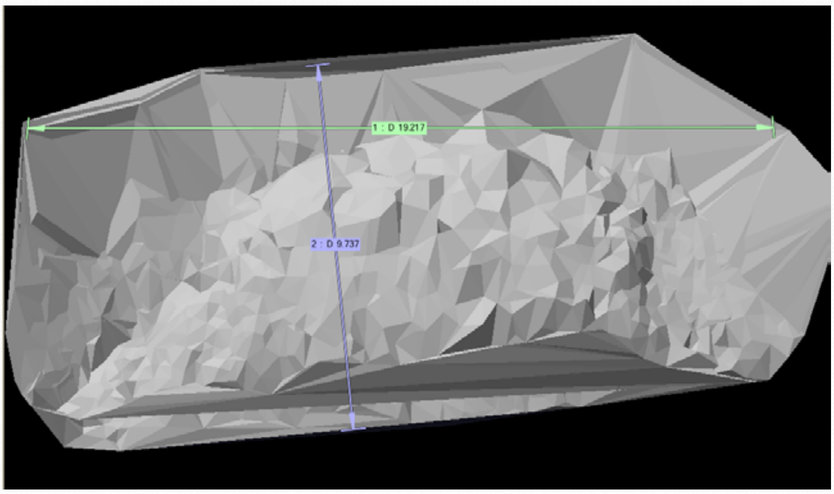

Figure 4, 3D model of object in pre-excavation

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Volume calculation can be calculated either between a scanned surface and a user-defined plane or between two scanned surfaces. The scanned surface can be represented either by a point cloud or by a triangular mesh. The final calculated results can also be exported automatically generated cross-sections at desired intervals. Volume of the excavation have been calculated from two surface difference with PolyWorks software as 77.85 m^3. Terrestrial laser scanning process was completed in 30 minute.

CONCLUSION

In this study, the utility of digital close-range photogrammetry and laser scanner have been investigated for volume computation. Photogrammetric processing itself can be done by one person. Only control points have to be measured on the terrain by classical methods. However, it requires fewer points compared to evaluation of all points or lines in a quarry or a mine.

Laser Scanners works similar to a total station; however, there are significant differences. With a laser scanner, only one man is enough to complete surveying. With 3D laser scanning volume calculations are possible in a matter of minutes, compared to several hours with photogrammetric method. Single point collection with a total station is labor intensive, costly, and most importantly, hazardous. Laser Scanning and photogrammetric methods eliminates these risks.

The end result with laser scanner is a more accurate, of volumes than photogrammetric methods. In addition, the amount of detail generated by thousands of points yields a more accurate representation of the real world surface. Data collection for current methods of mine volume calculations are long and often dangerous .

Terrestrial laser scanning is approximately rapid 4 times than close range photogrammetry. The cost of software and hardware in close range photogrammetry is approximately € 5.000. On the other hand, the cost of software and hardware in terrestrial laser scanning is €100.000. Terrestrial laser scanning is more expensive than close range photogrammetry.

THANK YOU FOR YOUR ATTENTIONS….