What is 3D Laser scanning?

3-D laser scanning is a relatively new, but already revolutionary and very successful surveying technique. The two techniques mostly used in terrestrial surveying are the time-based and the phase-based techniques. They both yield a digital data set, which is essentially a dense “point cloud”, where each point is represented by a coordinate in 3-D space (X, Y and Z, relative to the scanner’s position). With this data, the 3-D shape of any object or geometry of a scene can be quickly determined. The most important advantage of the laser scanning method is that a very high point density can be achieved, depending of the laser scanner type and distance to the object. In any case, the shape of the surveyed object or scene can in principle be measured in three dimensions at a very high level of detail and accuracy.

Time-based laser scanners

Today, the most popular measurement system for laser scanners is based on the time-of-flight principle, which will be referred to as time-based scanner. This technique allows measurements of distances up to several hundreds of meters in ideal conditions. The accuracy and precision of the measured distances is in the order of 1 cm or better, depending on the distance to the target. The time-based scanners, sometimes called "ranging" scanners - have a laser diode that sends a pulsed laser beam to the scanned object. The pulsed laser beam moves through a rapidly changing zenith and azimuth angle in response to the motion of a mirror inside the instrument. The pulse is diffusely reflected by the surface of the scene or object and part of the light returns to the receiver. The time that light needs to travel from the laser diode to the object surface and back is precisely measured. Knowing the speed of light, the distance from the scanner to the object and the azimuth and zenith angle of the beam, the position of each point where the beam is reflected can be calculated to three-dimensional Cartesian space. In addition to the range and angular measurements, which are translated on-the-fly into the X, Y, Z coordinates, the amplitude of the returned signal is also recorded which is often referred to as intensity.

Phase-based laser scanners

The other laser scanner type, namely phase or modulated-based system, works in a different manner. Instead of having the light source pulsing on and off they run it constantly. The light source is modulated with a sine wave, causing the amount of light that the laser emits to vary accordingly. In similar fashion to the time-of-flight method, the signal is transmitted from the laser and reflected from the object. To determine the length to the target, the phase differences between transmitted signal and reflected signal are compared. The range is restricted to a maximum of seventy to one hundred meters. Accuracy and precision of the measured distances are in the order of several mm I In this respect Phase-based laser scanners are superior to the range-finding or time-based laser scanner. The acquisition speed is also much higher, up to 100 times faster than time-of=flight laser

scanners. This allows the phase-based type of laser scanner to be used on mobile platforms for rapid surveying, for example mounted on a railway carriage inside a tunnel.

Applications of 3D Laser scanning

Rapid face mapping and documentation

Rapid face mapping for geological and geotechnical applications

Documentation of slope current stata

Geometric analyses of slopes and earth bodies

Volume calculations

Monitoring of movement / slope instability/rock fall detection

Underground (tunnel) survey

Survey of underground space geometry

Detection of discontinuities, loose blocks in wall and roof

Measurement of orientations in exposed rock faces

Surface reconstruction approach

Point cloud segmentation approach

Deriving joint set spacing

Measurement of discontinuity roughness

Small-scale roughness

Large-scale roughness

Open pit mining

3D modeling

Real-time volume monitoring