

3D Laser Scan Technology

Recently, laser scanning technology has become a frequent subject of foreign and domestic forums. Interest is not without a cause, as this revolutionary new survey solution has had a huge impact on geodesy, photogrammetry, and cartography, an impact perhaps only comparable to the application of GPS. Laser scanning has become an integral part of the fields mentioned, but has also led to spectacular results in other spheres of activity, such as mining, the construction industry, preservation of monuments, archeology, facility technology, etc.

piLINE Számítástechnikai Kft. has been developing a technical spatial IT system with national coverage for more than a decade. Amongst other things, our activities cover the development and operation of large enterprise Web technology based applications, as well as the implementation of technical state monitoring systems. Based on the profile, it was obvious that the application of laser scanning technology is capable of providing a leap in quality regarding the products and services developed. In addition, it also offers a wide range of information technology opportunities as a radically new, precision data source. Based on all this, piLINE Kft. has committed itself to laser scanning technologies, and is currently providing a high number of related services in this area. The following contains a short overview of these through the example of a few specific fields of application.

LMS-Z420i – operating principle and specification

Scanning is done using the newest equipment developed by the Austrian company RIEGL, the LMS-Z420i 3D laser scanner. This mobile instrument makes high resolution, wide range scanning possible is a reliable and swift manner even underneath the "most problematic" industrial or field conditions.



The positioning electronics (1) are optimized for high speed scanning and data entry. Vertical offset ("line scan") of the laser beam (2) is ensured by a multi-mirror polygon (3). Horizontal control of the laser beam ("frame scan") is carried out by the horizontal rotation of the optical head (4). Management and control of the scanning task is supervised by software – RiSCAN PRO (7) – installed on a standard notebook. The information recorded (scanning range, angle, intensity) is transmitted to the computer via a LAN or Wireless adapter (5) and is archived in the form of a 3D point distribution cloud model.

The following technical data provides some insight into the features of the scanner:

- Measurement distance: min. 2 m, max. 800 m
- Measurement accuracy: ± 5 mm
- Data recording: 12000 points/mp
- Laser beam: close infrared range
- Vertical angle: 0° 80° , min. step 0.008°
- Horizontal angle: 0° 360°, min. step 0.01°



One feature of LMS-Z420i is that the scanner is equipped with a professional, high resolution, replaceable camera, so that digital snapshots are created of the object simultaneously with laser scanning. Color information from the digital shots can be projected on the point distribution cloud. As a result, in addition to providing accurate 3D depiction, the model also has a photorealistic effect, which may provide essential information during further analysis or processing of the model.



Fields of application

Depending on customer requirements, processing may be carried out in several phases. Once the point distribution cloud is surveyed, CAD models, relief models, true orthophotos, and even a compete database background may be created. Completed files can be displayed using desktop applications as well as a Web interface.

The following is a list of a few examples of fields of application, complemented by the our work.

Construction industry and facility technology

- Creation of 3D overview images
 - The technology makes the external and internal model of buildings possible. These may be displayed is a single 3D walkthrough model. Pictures taken during measurement makes photorealistic rendition possible. The models created in this way can provide services to your enterprise as the basis of decisions, as well as presentation materials.
- Facade survey
 - The 3D point distribution cloud and the photographs can be used to create so-called true orthophotos of a better quality that orthophotos created using traditional photogrammetry. The true orthophoto is capable of overcoming problems resulting from building visibility, and therefore problems caused by redundant mapping and parts covered by facade elements that are jutting out can be easily overcome. All this in a shorter time than required for creating a traditional orthophoto, and with a more cost efficient process.



National Institute for the Blind - Facade survey from a single position

- Deformation inspection
 - This survey method makes the comparison of measurement results yielded at different points in time possible. It becomes possible to display any sinkage of the building or deformations that have occurred during time. The extent of deviations can be displayed using colorful, graphical diagrams. Experts can draw conclusions from deviations regarding the causes behind the problem, such as increased groundwater levels, faulty foundations, etc.



- Modification and supplementing of documents required during construction
 - Creation and modification of implementation plans
 - Creation of repair and refurbishment plans
 - State recording
 - Etc.
- Creation of 3D records
 - This technology is used to graphically display objects at their actual location, in actual size. Using this tool, it becomes easy to for example decide where to place a machine within the building, whether modifications need to be performed on the building or the object to be moved, so that they are placed at the appropriate location. Objects can also be mapped to a database, making it possible to store other descriptive data and display it at the press of a button.
- Facility monitoring
 - The process of operation or construction can be monitored and documented as a result of measurements carried out at various point in time. Based on this,



conclusions can be drawn regarding both the schedule of construction and the quality of the work performed.

- Map and relief survey
 - Due to the precision and short timeframe of measurement, the smallest unevenness of the area can be surveyed from a single point in a range with a radius of approximately 800 meters, even making it possible to create map contour lines on the field.
 - Specification of groundwork volumes
 - Measurements carried out at different point in time can be applied to accurately define the quantity of soil moved. Due to a high level of precision, significant cost savings can be achieved when compared to traditional geodesic measurements, as the uncertainty of measurement is significantly lower.

Mining application

- Modeling of surface mining and underground cavities
 - **3**D models may be used to create graphical and useful presentations, providing visual support for meetings and demonstrations. Furthermore, these models may be used to for example examine how to approach a given area, etc. The location and selection of further production sites may also be greatly influenced by a graphical, spatial walkthrough model, which is also metric.
 - The model created based on color photograph and the intensity of the laser beam reflected from the surface of the object can provide data regarding the type and quality of materials.
- Specification of production capacity
 - Measurements may be used to monitor the location and the schedule of production. These may be the basis of simpler regrouping of resources, the machines to be used, transportation, etc., which may result in higher efficiency.





Archeology

The scanning of monuments, statues, archeological findings, and dig sites makes it possible to store their current state. The laser scanner makes it possible to graphically store the location and situation of findings.







Line facilities

The geodesic and state survey of paths, nodes, equipment, and the environment of highways, railroads, telecommunication, hydrocarbons, and product transmission networks is made possible within a short timeframe and a cost efficient manner.

Processing phases of gas delivery station



Creation of CAD model based on the point Complete model details distribution cloud





Database connection setup

Identification of objects

- When an electric public utility network is surveyed, high voltage lines need not be approached closely. Required accuracy can be guaranteed without the danger of accidents.
- In high cost investments, such as the construction of highways or railroads, the amount of groundwork to be done can be specified quickly and with a high level of accuracy. In case of tasks such as this, most of the costs are represented by groundwork. As a result, significant costs can be saved with accurate measurements. Another advantage is that these do not take up as much time as traditional geodesic measurements.
- Machine industry
 - Reverse Engineering
 - Reverse Engineering means that an object already exists, but a digital based blueprint or model is not available. In this case, the survey can be used to create the design afterwards, which may be the basis of later mass production. The best example for this comes from the automobile industry. In one case, car chassis were first created out of clay. This is a graphical, easily shapeable model, which can be used for example to test aerodynamics. Once the final shape had taken form, the model was digitized. This was the basis of controlling the production lines.









- Quality assurance
 - Quality control of the finished products is possible within the accuracy parameters of the instrument. If a reference model is available, which may be a digital model of a planned or former model, a comparison with the object to be examined may lead to the definition of the location and size of differences from the reference. Information acquired from these differences may indicate a fault in the production line. If deformation occurs during the use of the product, forces acting behind this can be calculated based on information related to its location and extent.
- Security
 - Scanning makes quick recording of the environment possible during on-the-spot investigations, where not only the location, but the position of the subject of the investigation can be recorded spatially. Together with photographs, these models can provide data of decisive importance.
- Urban development

The laser scanner can be used to create a digital cityscape model more quickly than using photogrammetric methods. If the model of planned buildings is inserted into this model, the cityscape to be implemented can be previewed. This model can serve as the basis of decision for approving planned investments. It is furthermore possible to examine how the building planned influences the view from the windows of neighboring buildings. The model makes it possible to develop a more uniform and better looking cityscape.







