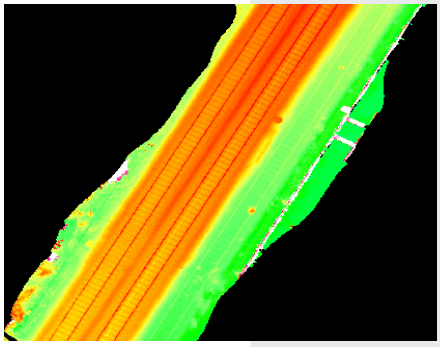
GmbH

TopoSys®

TopoSys
Corridor Mapping



White Paper
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Topographische Systemdaten

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Introduction

This white paper gives an overview about the technology, the deliverables and the customer specific usage and benefit by using airborne Lidar technology for corridor mapping. This white paper is based on ten years experience of TopoSys and a wide range of successful performed projects. The paper especially focuses on power lines, railways and motorways but the core results are also applicable for other corridor applications such as oil- or gas pipelines.

Survey

The survey is performed either by aircraft or by helicopter. The choice depends on several parameters like

- Shape of the corridor (e.g. segment length and number of segments)
- Size of the project area
- Location of the project area (flat area or mountainous area)
- Required point density
- Required metadata

The aircraft or helicopter will have the sensor system Falcon II installed which allows data acquisition of laser and image data in parallel during the same flight.

Typical mission parameters are

- Flight speed: 30 m/s (helicopter), 60 m/s (aircraft)
- Flight height 100 m up to 400 m
- Strip width 50 m to 200 m depending on customers needs (larger strip widths possible if requested)

A typical survey capacity is around 650 kilometres of corridor per day, assuming eight flight hours per day which usually refers to two missions with four hours each and a refuelling in between.

Deliverables

Core data which will be delivered are

- Lidar data point clouds of first and last echo
- Digital surface model (DSM) of first and last echo (grid width 0.10 m to 2.00 m)
- Digital terrain model (DTM) of last echo (grid width 0.10 m to 2.00 m)
- Intensity data
- Image data RGB and NIR (true-ortho images, resolution down to 0.20 m)

Accuracies

The range measurement accuracy of the Falcon II is 1.95 cm. Nevertheless, depending on the type of applications, sometimes better relative results can be achieved due to huge point densities as it is possible to use the overlapping measurements for statistical purposes.

Typically the relative horizontal and vertical accuracy inside the models is within a range of 5 cm to 7 cm, whereby errors introduced by the positioning and inertial system are taken into account. In most cases the mentioned relative accuracy is more important than the overall absolute accuracy. Due to the fiber based system concept, no other sensor system can achieve such a high relative accuracy with high reliability at the same time.

The absolute vertical accuracy compared to a local geoid is always better than 15 cm. This reflects GPS errors as well as errors introduced during the projection on the local geoid. The horizontal accuracy always depends on the calculated grid width and is usually given as half of the raster width. For corridor mapping applications flown at a low altitude with very high point densities, accuracies of better than 20 cm in position can be achieved. The accuracy can be improved significantly by the usage of ground reference control points.

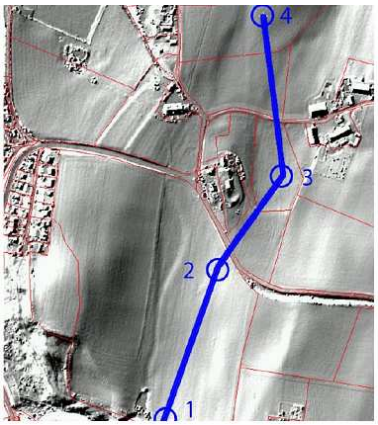
Metadata

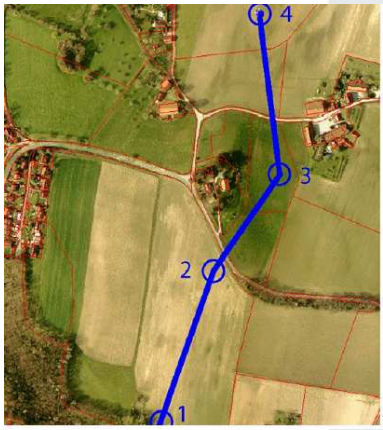
Within the final processing step of TopoSys data derived metadata as follows can be generated:

- Detailed and precise vectorized data of power lines, conductors and rails
- Cross and longitudinal sections based on raster datasets and high-density point clouds
- Details and 3D information of power lines such as sags, pylon centre lines, cable fixations and attachment points
- Determination of clearance distances for power lines, railways and motorways
- Vectorized data based on high resolution true-ortho images
- Metadata available in common file formats such as DXF-, DGN- and SHP-Files

Application: Planning

In general, TopoSys Lidar scanning can be used for pre-planning purposes as well as for monitoring application during the construction phase. By the usage of terrain models, the estimated corridor route can be pre-planned and profile across and along the corridor allow a pre-assessment of the planned route.

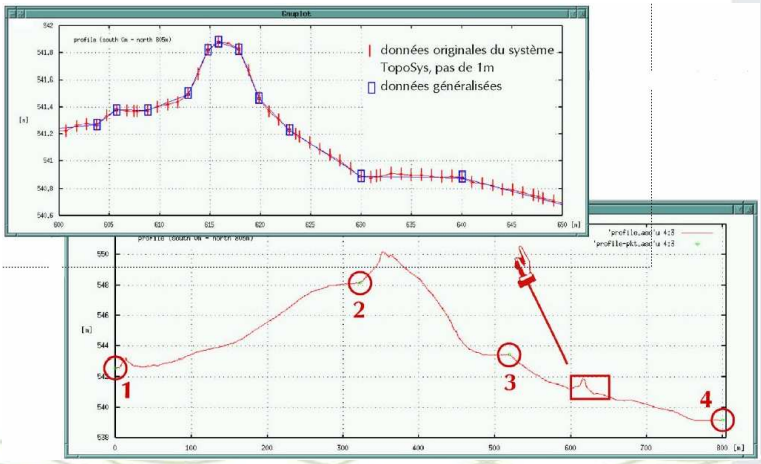




Due to the capability of the TopoSys Lidar to penetrate certain vegetation, it is possible, even in hardly accessible or inaccessible terrain, to generate a reliable terrain model which serves the needs for pre-planning.

The production of high precise cross and longitudinal profiles with different scales allow

- Determination of line of sight
- Determination of gradients of e.g. pipelines (water, gas, oil)
- Calculation of mass volume
- Determination of clearance to objects or vegetation
- Comparison with planned or mapped data

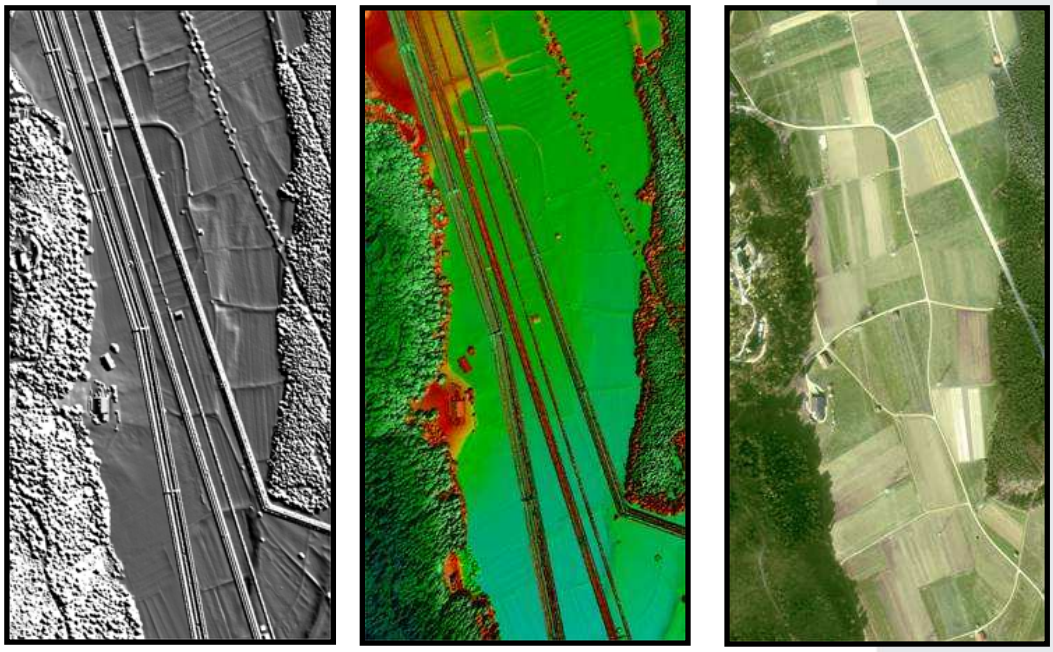


In later stages of the construction phases, Lidar scanning allows a very fast and cost efficient but also very reliable method to monitor the corridor against pre-planned parameters.

Generally speaking, TopoSys airborne Lidar scanning provides a very fast and cost effective solution to gather data required for pre-planning even under difficult terrain conditions. These data can be easily combined with existing data and can be stored in a GIS for multipurpose usage.

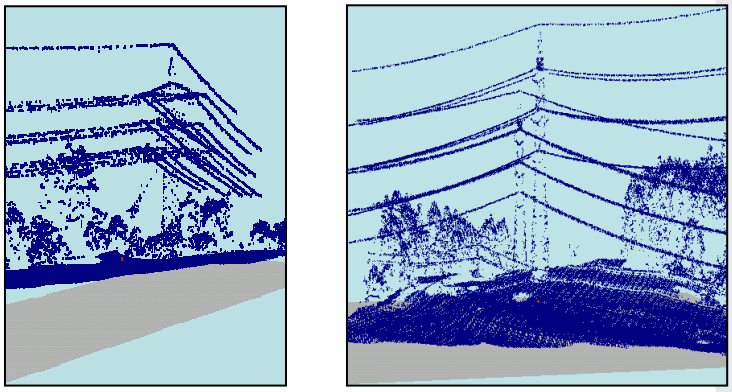
Application: Power Lines

Scanning of power lines provides actual, complete and high precision elevation and image data of the power line and the surrounding terrain and vegetation. Due to automated data processing the data are available quickly. A wide range of relevant data for planning and documentation, like clearances or infrastructural information can be extracted. Basic data can be easily updated with the same accuracy as known from common terrestrial methods.



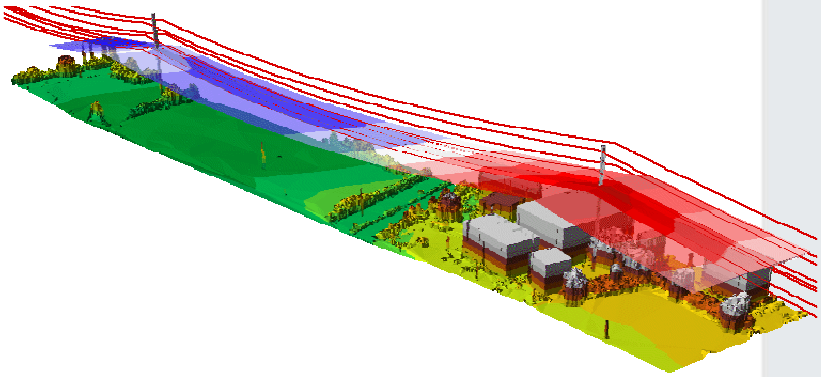
Relief image, colour-coded 3D view and RGB true-ortho image data of power lines

The TopoSys software package PowerLiner guarantees the extraction and vectorisation of single power lines. 3D coordinates such as pylon position, cable fixations, attachment points and other details can be easily determined. Results derived by the PowerLiner can be checked interactively and results can be corrected. Tools for 3D visualization are also integrated.



3D views of point clouds of power line raw laser data

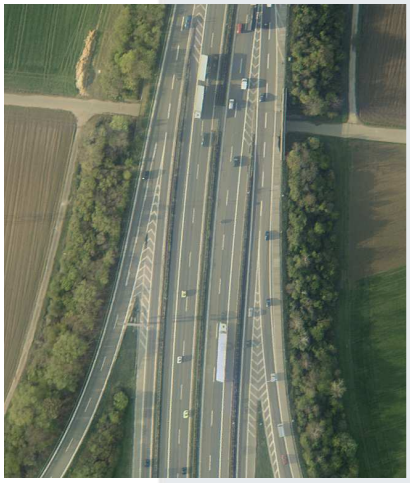
Metadata derived from PowerLiner data processing are also pylon centre lines, attachment points (intersections), lower edge of cross arm, power lines and lowest point per field/sag.



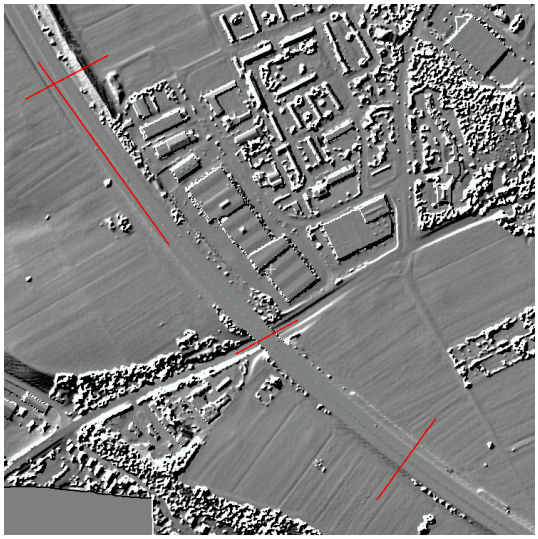
3D view of a vectorized power line (0.5 m DSM, line as vector Pylons as symbols)

Application: Motorways

Scanning of motorways by TopoSys allows monitoring the motorway itself as well as the surrounding environment.

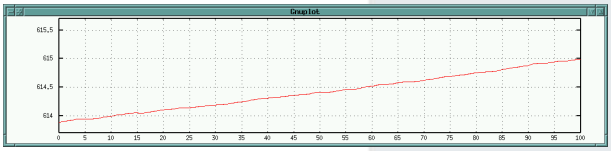


The image data allow to monitor the over all situation while the elevation data allow to assess the quality of the motorway by itself. Profiles across and along the motorway show important details of the motorway and allow planning reconstruction tasks.

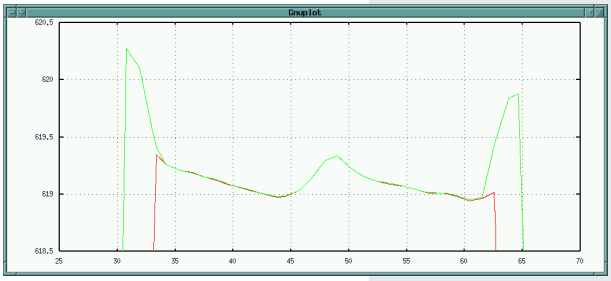


Motorway A7, Germany

Digital Surface Model (DSM)



Longitudinal section of the motorway



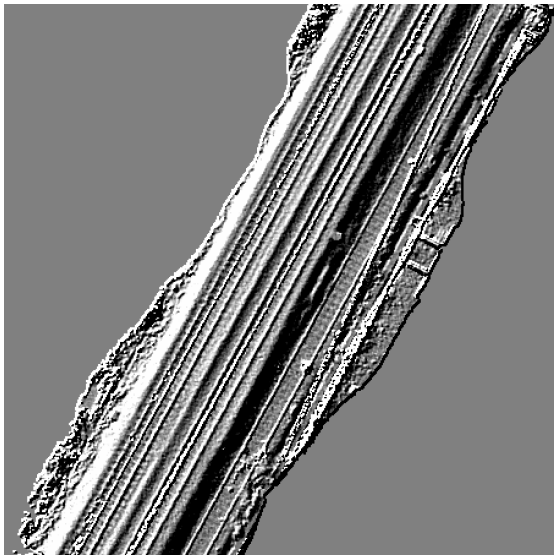
Cross section of the motorway

(including the shoulders)

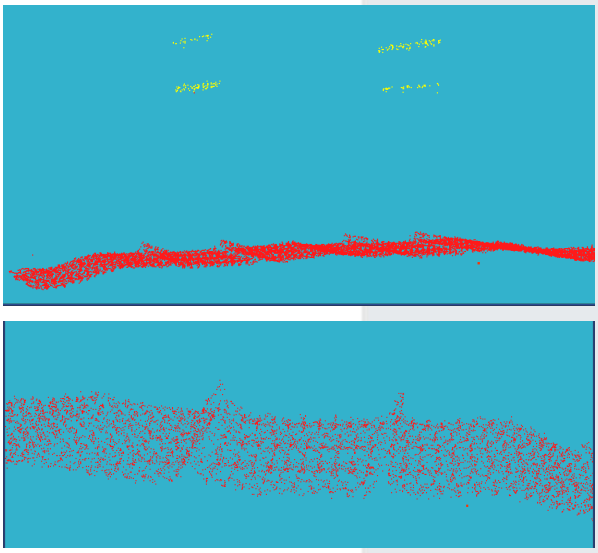
The core benefit of TopoSys airborne Lidar scanning is that data are collected very fast and cost effective in a quality which serves customers need. The data easily can be combined with other data and stored in a GIS for multipurpose usage.

Application: Railways

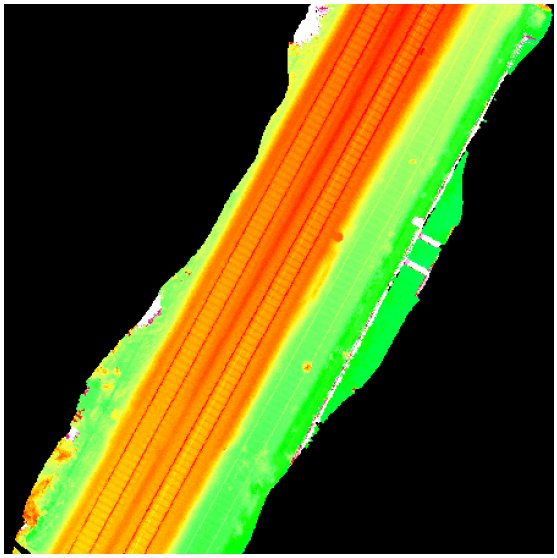
Scanning of railways by TopoSys allows monitoring the railway itself as well as the nearby environment in detail.



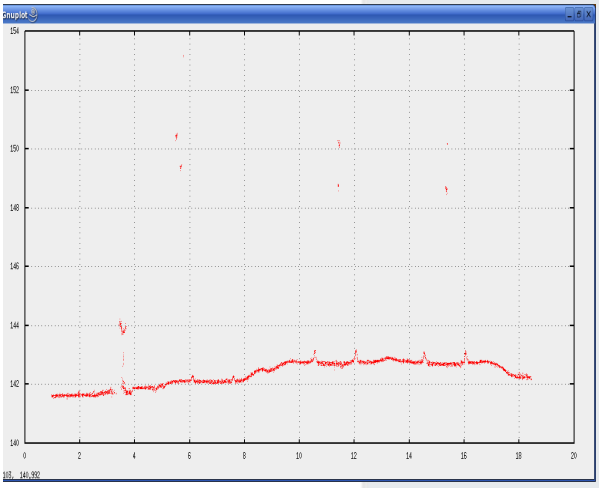
Relief image of First Echo DSM (including rails and conductors)



3D view of high density point cloud (conductors marked yellow)

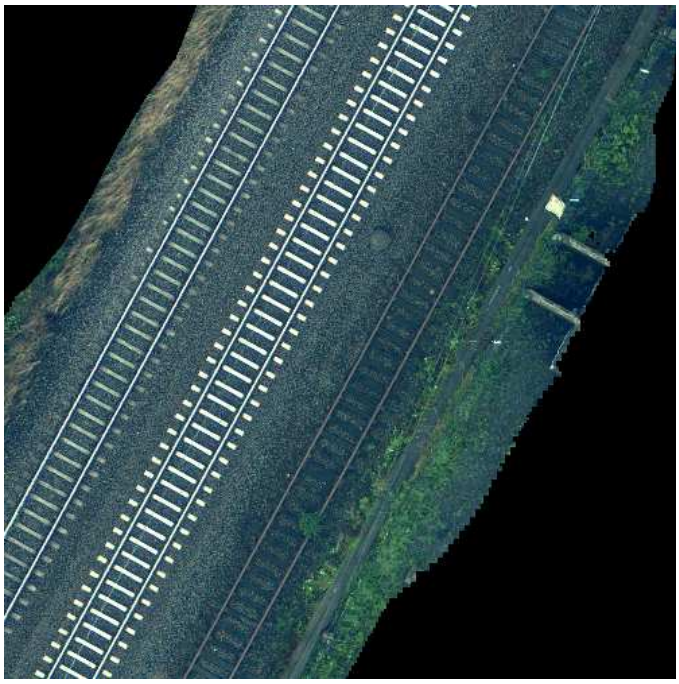


Colour coded elevation data of Last Echo DSM (only rails)



Cross section based on point cloud (rails and conductors displayed in detail)

The data can be used e.g. to derive safety margins between the railway and the surrounding environment (vegetation and manmade objects). Also the data can be used to derive metadata such as tracks, conductors or positions of pylons for further usage in GIS systems. With the support of high resolution images, the data also can be used for inventory purposes.



High resolution true-ortho image dataset

The core benefit of TopoSys airborne Lidar scanning is that data are collected fast and cost effective in a quality which serves customers need. The data easily can be combined with other data and stored in a GIS for flexible multi-usage.

TopoSys Specifics

The corridor mapping of TopoSys is very specific due to the unique sensor system Falcon II which is exclusively developed and operated by TopoSys:

- The sensor system Falcon II provides a constant high pulse rate of 83,000 pulses / s
- The achievable point density is between 10 points / sqm (aircraft) and 40 points / sqm (helicopter)
- The range measurement accuracy is 1.95 cm, the relative model accuracy about 5 cm to 7 cm
- Due to the fixed beam deflection of the fiber based scanner all mechanical errors introduced by mirror based scanner systems are avoided. This leads to the most precise scanner system world-wide
- The overlapping measurements and the specific scan pattern allow a very precise detection of objects and line objects like railways or power line cables or structures of polygons

- The small viewing angle results in an almost vertical "view" of all laser beams. This avoids shadowing effects and imprecise range measurements due to a flat reflection angle
- The echo separation between first and last echo is only 1.2 m compared to 3 m to 4 m of other scanner systems. This leads to a much better representation of small vertical objects. Also vertically stacked objects like individual power line cables are identified much more reliable and precise.
- The integrated line scanner allows to acquire image data in parallel to the Lidar data
- Forward or sideward looking mounting of the sensor allows to map structures like masts or pylons in detail