

Terrestrial Laser Scanning - New Perspectives in 3D-Surveying

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Abstract

Laser scanners are used more and more as surveying instruments for both, terrestrial and airborne applications. Such systems are designed to digitise the geometry of real environments with a high precision and high accuracy. In contrast to known techniques for surveying tasks, laser scanners enable measurements of millions of single points (point cloud) in expanded areas in a very short time which opens a new perspective in 3D surveying. Different laser scanners are designed by the industry based on triangulation, pulse and phase-shift measurements.

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. The laser scanners thus provide an active illumination, non-contact measurement of the environment. This is advantageous in many situations, where operator access is limited or poor ambient lighting exists. In combination with passive CCD cameras colour information is mapped onto the geometry, leading to virtual reality.

At the moment terrestrial laser scanners are used mainly in industrial applications in order to digitise the 3D environment of plants and machines for as build documentation as well as simulation and optimisation tasks. The automotive industry has already adopted laser scanners, providing accurate and precise measurements of their environments in a very short time, even without shut down of the production lines. Beside this industrial sector, laser scanners are used in many applications, for documentation of plants (chemical etc.), for construction business, architecture in general, as well as for documentation tasks in cultural heritage. Terrestrial laser scanners are used within the research project *Natscan* for documentation of forests in order to provide information about the growth and quality of trees in forests. Both, airborne and terrestrial laser scanners are combined the first time for Forest and Landscape Assessment within *Natscan*.

In this paper different physical technologies for 3D measurements are introduced and for each technology industrial available laser scanners are presented. The laser scanners are discussed based on its principle technology, its performance and the main application area. Furthermore, based on this introduction, the paper reports the approach from physical measurement to "as built" models in the end. It presents applications from industrial and cultural landscape conservation projects of different laser scanners. The paper summarises the actual status of terrestrial 3D laser scanning in real environments and concludes with an outlook to new technologies for 3D measurements.