

3D documentation and virtual reconstruction of the castle of Waldstein

The combination of low-cost photogrammetry and a geodetic survey

Peter BAUER, Institute of Engineering Geodesy and Measurement Systems, Graz University of Technology, Austria

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Introduction

The majority of historical castles in Austria are abandoned, exposed to wind and weather and slow decay. Because of their high importance as landmarks which have shaped the history of their nearby area for centuries, they deserve a detailed 3D documentation for the people and future scientists.

Terrestrial laser scanning and UAV imagery have become state of the art methods for documentation in cultural heritage. However due to the high costs of a terrestrial laser scanning session and due to legal restrictions of drone surveys, these techniques are only applied to a selected number of historical sites of major public relevance.

The progress in photogrammetry has produced affordable software solutions which enable amateur users to simply derive 3D models with a handheld camera and a ruler. Although these models cannot compete with the accuracy of a professional survey, they offer an immense opportunity for gathering fast semantic and topological information of these structures for everyone.



Fig. 1. Group of volunteers at the first survey campaign (© Peter Bauer).

The Castle of Waldstein

Robert Baravalle (1961) writes in his book about Styrian castles, that Waldstein was founded at the end of the 11th century by Waldo of Ruen and has changed the ownership several times. Today's appearance of the main castle dates back to the 14th century and was extended with barbicans and two gatehouses in the 15th and 16th century. Because of the newly built residence in the valley, the castle was abandoned and left to decay at the beginning of the 17th century. Although it was open to the public till the end of the 20th century it is now closed to the public due to the danger of falling stones.

Survey Method

The aim of the survey was to update the hand drawn maps with modern total station measurements and to document the stonework of the inner castle and the remains of a Romanesque chapel in 3D. For the 3D documentation a photogrammetric approach has been chosen. Therefore, the site has been photographed with SLR cameras by a group of volunteers under technical supervision. The focus of this first campaign was on a time and cost-efficient workflow. The images have been matched with low-cost software and the resulting point clouds have been scaled with photo scales, which have been placed into the scenes. Hereby the most significant remains of the castle have been documented in a single day of fieldwork.

Afterwards the scaled point clouds have been geo-referenced with airborne images and LiDAR data, which are accessible to the public by the open GIS of the Austrian government. The horizontal coordinates of corners and edges of the 3D point clouds have been extracted from the rectified and georeferenced airborne images. The national digital terrain model (DGM) has been used to give the local point clouds an approximate height. This workflow has provided an adequate three-dimensional representation of the castle complex with minor accuracy demands, which served as a data foundation for further detailed investigations.

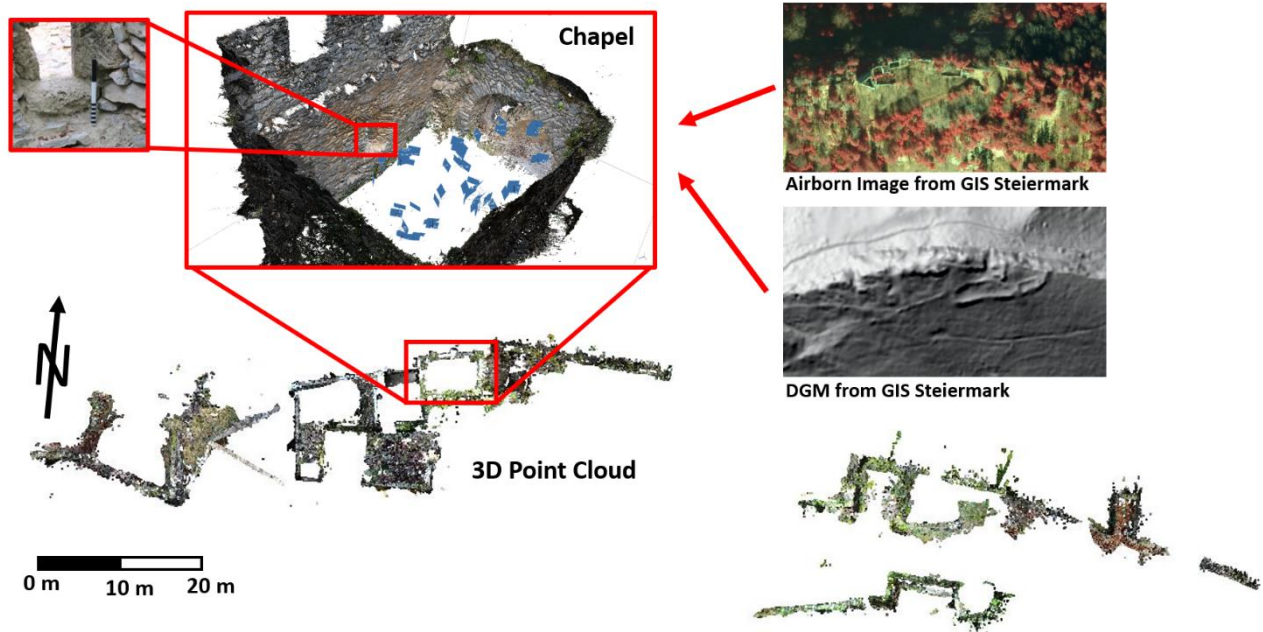


Fig. 2. 3D point cloud produced with low cost photogrammetry and open government data (© Peter Bauer).

In a second campaign, measurements with a total station and a geodetic GNSS device have been carried out to produce a highly accurate 3D model of the former castle Waldstein. In addition to the location of the barbicans, also key features in the High castle have been measured, which were visible in the amateur images of the first campaign. These keypoints and the technical supervision of the first campaign made it possible to process the amateur images with professional software. This improved 3D point cloud and the total station measurements have been the basis for a detailed 3D reconstruction.

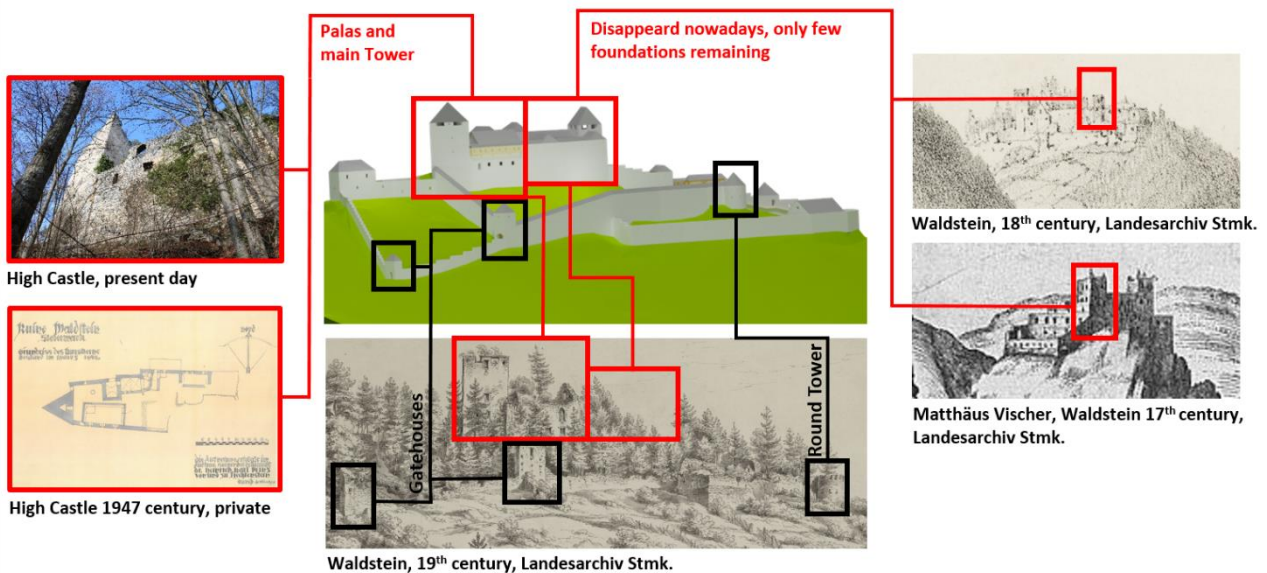


Fig. 3. 3D reconstruction of the castle Waldstein ¹.(© Peter Bauer).

¹<http://igms.3dworld.tugraz.at/HomepageWaldstein.html>

The appearance of the castle has been modelled according to old plans provided by the castle owner and according to historic drawings from the Landesarchiv Steiermark. During the modelling process valuable inspiration has been found in Otto Pipers books (1902) and (1912).

Conclusion

Introducing citizens into the basics of photogrammetry raises the public interest for historic structures. Motivating them in capturing and sharing photogrammetry-ready images can lead to a larger coverage and better temporal resolution of historic spatial data. Although low cost photogrammetric point clouds can have absolute deviations of a few decimetres (in this case verified with total station measurements) the relative accuracy is sufficient for the adequate representation of the used stonework and construction phases, if these historic sites disappear before a professional documentation could have taken place. The largest benefit for the investigation of these sites, can be seen in the combination of this amateur photogrammetry and professional terrestrial surveys with total stations or laser scanners (TLS). The gathered photogrammetric raw data can be taken into account any time in the future, as long as some key features of the structure survive over time to create ground control points.

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