

Title: Integrative 3D Recording Methods of Historic Architecture—Burg Hohenecken from Southwest Germany

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This study explores the integration of various methods including photogrammetry, laser-scanning, GIS, and textual analysis in order to create a more holistic understanding of a castle ruin. The case study is the medieval castle *Burg Hohenecken* in the city of *Kaiserslautern* in southwest Germany. The project is divided into two main components: the visual and the textual components. The objectives of the visual component are to merge a laser-scan and a photogrammetric model, thus combining the measuring strength of laser-scanning with the visual aesthetics of photogrammetry. Once digitized as a merged 3D-model, the castle can be virtually controlled and examined, providing an opportunity to potentially reconstruct the castle (using *Autodesk 3DsMax*). Hypothetical reconstructions from the various construction and expansion periods will assist in studying the castle's function throughout time. The textual component, consisting of 70 letters (1212-1560 A.D.), provides historical context concerning the castle, its inhabitants, and correspondence.

Laser-scanning and 3D photogrammetric technologies have been in rapid advancement for over 20 years beginning in the disciplines of geography and mathematics (Kersten et al., 2004); specifically in photogrammetry and geodesy (Vosselmann and Maas, 2010). Academics have developed a variety of techniques and devices in order to adapt the technologies for archaeological purposes (Remondino, 2014). The intricacies of archaeological sites have pushed the devices to their limits, allowing for the production of newer devices more suited for rough terrain and countless blind spots due to walls, vegetation, and elevations. The location of the castle atop a mountain adds to the difficulty of acquiring photos encompassing the entire castle in one take (Gonzo et al., 2004). As a result of these challenges, a terrestrial laser-scanner, an aerial drone with a mirror-less camera, and a terrestrial DSLR camera, were used.

The visual component consists of two parts: the laser-scanning and the photogrammetry. The Riegl VZ-400 laser-scanner (with an attached DSLR camera) was provided by the Institute of Geography at Heidelberg University. We conducted 22 scans, manually linked via tie-points (placed within overlapping areas) in the proprietary software, *RiSCAN PRO*. This model was meshed in *Meshlab* using the *Ball-Pivot* method.

The photogrammetric data was collected using a Sony NEX-7 camera attached to an aerial drone built by the IWR (Interdisciplinary Center for Scientific Computing) at Heidelberg University, and a hand-held Nikon D3300 SLR camera (provided by the University of Nebraska-Lincoln). The eight rotor drone took 385 photos up to 100 meters above the castle in a predetermined course, capturing views not completely collected by the laser-scans. The remaining 1,351 photos were done terrestrially with the Nikon D3300 SLR camera. *Agisoft Photoscan Pro* was used to align the 1,736 photos, generate the dense cloud, the mesh, and the texture.

The textual component regards the information extracted from the letters, including names and inheritances of the *Hohenecken* lineage, physical locations within the surrounding environment,

and construction details of the castle. This data builds a network of communication within a past landscape and pre-existing structures of the castle. The locations in the letters will be geo-referenced in GIS allowing the landscape to be visualized rather than imagined, thus reconstructing the environment of the past utilizing primary and secondary sources.

This project is a work in progress, with an anticipated completion by May 2016. An updated status can be viewed online (<http://www.jamescoltrain.com/970.Aaron/>) in which the letters and models have been uploaded. A virtual tour (using *Unity*) of the reconstructed 3D-model, based upon textual evidence will allow users to “walk” through and explore the castle. The purpose is to analyze the historic functions of the castle and its significance in the regional landscape, contributing to its preservation and enhancing the knowledge of the regional architecture.

## References

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