G.2 Novel Approaches to research and discover Urban History[1]

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1 Introduction

Imagine you're exploring the historic center of a city with its impressive town houses, churches and monuments. What if you could just use your mobile to find out about the historic buildings around you, with detailed visual information about how they were built and the story behind them, making history come alive before your eyes? Photographs and plans are an essential source for historical research (Münster, Kamposiori, Friedrichs, & Kröber, 2018) and key objects in Digital Humanities (Kwastek, 2014). Numerous digital image archives, containing vast numbers of photographs, have been set up in the context of digitization projects. These extensive repositories of image media are still difficult to search. It is not easy to identify sources relevant for research, analyze and contextualize them, or compare them with the historical original. The eHumanities research group HistStadt4D, funded by the German Federal Ministry of Education and Research (BMBF) until July 2020 consists of 14 people – including 4 post-doctoral and 5 PhD researchers. Since a focal interest is to comprehensively investigate how to enhance accessibility of large scale image repositories, researchers and research approaches originate from the humanities, geo- and information technologies as well as from educational and information studies. In contrast to adjacent projects dealing primarily with large scale linked text data as the Venice Time Machine project ("The Venice Time Machine," 2017), sources addressed by the junior group are primarily historical photographs and plans. Historical media and their contextual information are being transferred into a 4D – 3D spatial and temporal scaled - model to support research and education on urban history. Content will be made accessible in two ways; via a 4D browser and a location-dependent augmented-reality representation. The prototype database consists of about 200,000 digitized historical photographs and plans of Dresden from the Deutsche Fotothek ("Deutsche Fotothek,").

1 Originally published in (Münster et al., 2017).

2 Key Aspects

Usage scenarios and research values

Digital image repositories meet a wide range of needs, from research in humanities and information technologies, through museum contexts and library studies to tourist applications (Münster, 2011). Architectural historians have developed various methods of analyzing both, preserved and never-built or destroyed structures in chronology and context (Brassat & Kohle, 2003). Style analysis, iconographic approaches, and art sociological methods all address structural historical questions. The technological possibilities of digital image repositories allow architecture historians to draw on a much larger stock of material, and to process and evaluate this from new perspectives. In addition, innovative software tools can be used to locate sources temporally and spatially, or to support dating, stylistic criticism, authorizations or archaeological investigations (Verstegen, 2007). Depending on the user group, a number of specific requirements must be met. Historical researchers, for example, need to be able to compare and contextualize sources (Brandt, 2012; Münster, Jahn, & Wacker, 2015; Wohlfeil, 1986), and to trace the relationship between source and representation (Favro, 2006; Niccolucci & Hermon, 2006). This includes identifying formal patterns, singularities, and discontinuities in architecture and cityscape. This raises a host of questions: How do buildings and cities change over time? In which contexts, such as political or formal developments, does a historical cityscape evolve? What similarities can be found between objects in terms of construction standards and requirements, building codes, regional, temporal or personal tastes and styles? The research group will address these and many more questions in a specific project on the interdependence between urban development and urban photography.

Creating targeted tools for working with image repositories

An adjacent task will be to perform a systematic survey of the needs of users of image repositories, whose findings will be used to conceptualize technological support options. As historic images, objects and information are increasingly being digitized on a massive scale, more content becomes available for investigation; more cross-analyses are possible; more knowledge is collected, structured and shared (Schuller, 2009). The new scale of research and information retrieval creates many new challenges. Many scholars note that online searching for images and information is “counter-productive” due to the amount of irrelevant data retrieved or their limited technical abilities (Beaudoin & Brady, 2011). Access and efficient data retrieval is inhibited for variety of reasons. The degree of search expertise is as important as the functionalities and usability of the platform (Kemman, Kleppe, & Scagliola, 2014). A lot of the existing tools of research programs and applications stem from computer science and do not necessarily meet the needs of humanities scholars (Dudek,

Blaise, De Luca, Bergerot, & Renaudin, 2015). Users need efficient search and filter functions, an intuitive software interface and navigation (Barreau, Gaugne, Bernard, Le Cloirec, & Gouranton, 2014). Appropriate documentation through metadata plays an important role in ensuring sustainability (Bentkowska-Kafel, Denard, & Baker, 2012; Maina & Suleman, 2015). In contrast, users expect an intuitive and feasible introduction to the topic and data (Maina & Suleman, 2015) with options to find out more as required. The simplest way to link and contextualize visual information is to use highlighted keywords as hyperlinks in texts and captions. Data interaction and processing tools are also essential for research (Hecht, Meinel, & Buchroithner, 2015; Webb & O'Carroll, 2013).

Photogrammetric methods of visual knowledge generation

A possible technological basis for creating access to large scale image repositories is the spatial and temporal aggregation of data, in this case historical photographs in a 4D model. The potential of photographic images ranges from pure documentation in archaeology and monument preservation, through image interpretation, for example for damage documentation, to the production of complex 3D models for archaeological investigations (Bührer, Grün, Zhang, Fraser, & Rüther, 2001). Geometrical reconstruction from historical photographs is based on photogrammetry. Information from multiple 2D images is used to acquire 2D and 3D object geometries and have frequently been applied on historical and measurement images in other German cities like Jena, Potsdam and Berlin and even in Baalkbek, Libanon (cf. Bräuer-Burchardt & Voss, 2001; Henze, Lehmann, & Bruschke, 2009; Siedler, Sacher, & Vetter, 2011; Wiedemann, Hemmleb, & Albertz, 2000). Since some decades, traditional analytical photogrammetry has increasingly been complemented by digital image processing and analysis. The elaborate process of manual image analysis can be largely automated, resulting in large image collections from which geometric information can be generated automatically (Pomaska, 2011). A common method to create 3D models is e.g. Structure-from-Motion (SfM) (Lowe, 2004). To date, automated photogrammetric methods are generally used primarily to evaluate current, mostly digital images. So far, this has rarely been done for historical images, as it involves specific challenges. Scanned analogue records usually have unknown camera metrics, missing or minimal object information and low radiometric and geometric resolution. Our aim is to develop application-oriented tools and adapt existing methods for photogrammetric analysis of historical photographs, to integrate them into the process of historical image analysis (Fig 1), and to create a spatial relationship to today's situation.

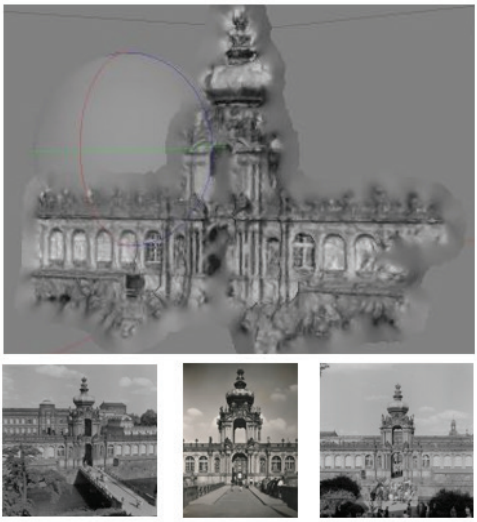

Fig. 1: 3D model based on current photographs and historical photographs (proof-of-concept)

Augmented reality

The prototype 4D model, and the 4D historical photographs, drawings, plans, and information within it, will be made accessible via a location or context related information access as augmented reality. This technology has gained importance in the last few years and undergone extensive testing (Chang, Hou, Pan, Sung, & Chang, 2015; Chung, Han, & Joun, 2015; Livingston, Bimber, & Saito, 2008; Walczak, Cellary, & Prinke, 2011; Zöllner, Becker, & Keil, 2010). Augmented reality describes the enrichment of the real world through virtual data, which can include 3D models, texts, pictures, films or audio data.

Fig. 2: Augmented-reality representation of a cityscape (mockup)

Enriching the reality or replacing parts of reality can help to bridge the cognitive gap between our daily life experience of a cityscape and its depiction in historical photographs (Niebling, Griesser, & Woessner, 2008). In the historical context, the viewer is able to interactively capture visual and textual information about objects in their historical spatial reference system (Ridel et al., 2014). Our investigation will focus on the accessibility of historical data: How can interaction with virtual buildings be designed? Which metaphors can be used? How can augmented reality support educational and research settings?

4D browser

As an alternative way, the 4D model will also be accessible via a 4D browser interface for spatially and temporally located searches in media repositories. An basing application prototype of a research platform for 3D reconstruction projects is in development was developed during a master thesis (Bruschke, 2015), employing approaches, such as semantic data linking and visualization of temporally and spatially arranged information (Gouveia, Branco, Rodrigues, & Correia, 2015). Since the prototype has focused on individual building complexes, the 4D browser application has to visualize an entire city model, which also changes constantly over time. Moreover, a visual interface is proposed to make additional information accessible, such as the current and original location of the depicted object. Further features intended to support scholarly users of the prospected platform are image rectification tools and overlays combining several pictures from different periods which can shed light on changes in a building. Statistical analyses of photographed objects over time may provide information on a building's significance. Last but not least, the application should be intuitive to operate for a heterogeneous user group (Warwick, 2012).

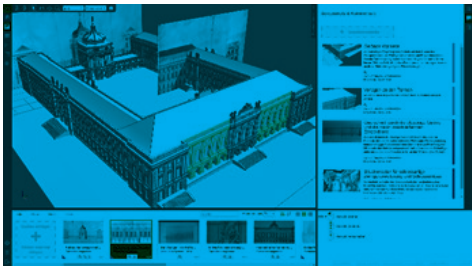

Fig. 3: 4D-Browser (prototype)

3 Summary and Contribution

As a result of huge and concerted digitization efforts, extensive digital repositories of historical photographs have been created in the past few decades. This volume of data presents a major challenge to support search, access and information enrichment for users. In August 2016, the research group started examining scientific methodological requirements and intuitive user interfaces for dealing with massive media repositories from a multidisciplinary perspective. After two years of research the previously described activities led to various conceptual, empirical and technological outcomes and application prototypes have been created (Niebling, Münster, Bruschke, Henze, & Maiwald, in print).

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