

Uncertainty in the spatial metadata of historical photographs – A geomatic and photogrammetric driven argumentation

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ABSTRACT

Current metadata concepts insufficiently represent geospatial information. This is an obstacle for retrieval techniques as well as for geospatial disciplines. Main point is, that established standards cannot handle uncertainty of geospatial information or are the source for uncertainty. We recommend a new concept to store and handle geo-information as metadata for historical photographs. The approach presented in this paper suggests how to source the necessary information and deal with uncertainty using Volunteered Geographic Information concepts.

CCS CONCEPTS

• **Software and its engineering** → Software organization and properties → Information systems → Data management systems → Information systems applications → Digital libraries and archives • **Applied computing** → Document management and text processing → Document management → Document metadata

KEYWORDS

Volunteered geographic information, geospatial information, georeferencing, metadata documentation, photogrammetry, crowdsourcing, historical photograph documentation.

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1 INTRODUCTION

Historical photographs are an important source of information for several disciplines. Some of these disciplines such as monument conservation, landscape planning, archeology or environmental modelling refer to the spatial aspect of images. The availability of images for projects depends strongly on the underlying meta documentation and methods to search and retrieve photographs.

While for a lot of disciplines space is an important dimension and classifier, we argue that current metadata standards fall short in providing a suitable structure to handle uncertainty as well as accuracy of geolocations. Providing only a point coordinate or geonames neglects the underlying perspective of photographs being a spatial and three-dimensional representation of data. Geomatics and photogrammetry provide concepts to handle inaccuracies as well as uncertainty and should be incorporated in metadata standards. We suggest to use extended metadata standards to better represent the spatial information. To collect spatial information, we test citizen science concepts that Goodchild referred as Volunteered Geographic Information (VGI) [8], to involve a (geographically) informed public. In this paper we derive the demand for such concepts from existing literature and present the theoretical foundations of spatial uncertainty and accuracy. We present the concept and first results of a Web-based citizen science platform which is currently under development.

2 CURRENT STATE AND THEORY

A lot of disciplines rely on spatial information and the spatial context that is incorporated in historical photographs. Architecture and monument conservation [14], archeology [2, 7], ecology and landscape planning [10, 12] are only some examples. Choi & Rasmussen showed that geographic names and geographical place are important search terms and recommend “to develop multiple access points to relevant images” also mentioning “geographical division” [3].

Crowd sourcing concepts based in social media platforms have been applied to involve a broader public in the interpretation and documentation of historic photographs. Dijck [4] and the Smithsonian Institute [11] both concentrated on publishing historical photographs on the photo sharing site Flickr and analyzed the public interaction with the archive data sets. They

pointed out that this practice can enhance the photo documentation and reveals our collective understanding of cultural heritage.

After a comprehensive research of the VGI phenomenon including quality and trustworthiness of user-generated content, Elwood, Goodchild, and Sui pointed out, that “VGI could serve as a potential data source to address research questions across geography” and “geographers no longer have exclusive claims on the production of either geographic information or geographic knowledge” [6].

Also Armitage & Enser [1] refer to the importance of geographic search, but only addresses geographic names of locations, which means text or key word based searching.

Current standards for historical photographs handle spatial information as a point coordinate or allow to handle geonames as keywords. Dublin Core defines DCMIPPOINT as a point coordinate. Getty Thesaurus of Geographic Names defines a thesaurus of geographic names of places. Also IPTC and EXIF, developed for the meta documentation of photographs do only refer to point coordinates (location of the photographer) and geonames as keywords or tags.

Photographs are three-dimensional spatial information. With regard to the geometric projection of a three-dimensional real world situation to a two-dimensional surface [9] it is also possible to reconstruct the underlying spatial information either through visual interpretation or by applying photogrammetric concepts.

Vietze et al. [13] tried to use historical images for the three-dimensional reconstruction of buildings. This example shows that current retrieval methods, using text based search to find images as spatial information, may lead to inadequate results. Keyword-based search provided a result set of 800 images based on geoname search in a national archive. The visual control of the images showed that only 44 out of 800 images could be used for the reconstruction. Two reasons lead to the discussed issue of inappropriate representation of spatial meta-information in current models: 1) Images not showing the object, but made in the neighborhood or surrounding and 2) Images with an insufficient level of detail due to a large distance between the photographer and the object.

But now it is necessary to distinguish between two different aspects of spatial meta-documentation: Exif and IPTC refer the point coordinates as geometric information about the photo (location of photographer and orientation). Geonames can either refer to the location where a photo was taken (also location of the photographer) as well as information about the content of the photo e.g. a building or named landscape element represented in the photograph. This makes the concept of spatial or geographic meta-documentation imprecise. In the following paper we will refer to “orientation metadata” and define it as the geometric information necessary or available to reconstruct the outer orientation of a photograph. For spatial information about objects depicted in a photograph we will use the term “object georeference”. Names of locations associated with a geometric element such as an area (e.g. polygon for administrative boundaries), linear structure (e.g. line or polyline for streets or

rivers) or a specific location (e.g. point for a small building, tree or crossing) will be referred to as “geonames”.

Applying the underlying concept of photographs as spatial projections of a three-dimensional space on a plane, we can define uncertainty as the inaccuracy of orientation metadata. The same concept can be also applied to georeferences. In this case the discrepancy due to a representation of an object with a spatial extent such as a building and its base-area through a single point needs to be discussed additionally with regard to scale issues. Geonames provide an uncertainty or inaccuracy with regard to space and time. First geonames of e.g. administrative areas can change over time. Second geonames can refer to spaces of undefined size and extend. They are only a weak spatial reference and do also provide only a restricted data to measure and quantify inaccuracy.

3 APPROACH

While digital photographs are stored with sufficient information about position of the photographer as well as azimuth, tilt and swing, this information is not available for historic photographs, but it could be reconstructed from other information. For this a Web portal will be built as the basis to collect spatial information about objects depicted in the photograph as well as a potential position of the photographer. The approach is based on the concept of VGI to collect spatial information from a regionally well informed community.

The Web-based portal as an open platform will present historical photographs to the broad public and will apply the concept of citizen science for object georeferencing:

- Features will allow to store all spatial information as accurately as possible (zooming and individual scale levels) by placing markers on objects in the image and related coordinates in a map view.
- Additional spatial information as geonames can be provided as tags.
- The Web interface will be designed user centric to increase the willingness to contribute.
- Information about outer orientation of the photograph will automatically be calculated from user contributions of depicted objects and photographer's location.

In the database we introduce a new archival data structure helping to improve the accessibility and introducing spatial search in archival data. We consider information about the photo (orientation) as well as information about the content of the photo with regard to spatial information (object-georeference). This requires new concepts to store information about the orientation of the camera as well as crowd sourced data about objects depicted in the photograph. As object georeferences we need additional point coordinates referring to the position of the object in the image and the real location in geo-coordinates.

Searching for spatial information will be implemented not only based on information about origin of the photograph (position of the photographer) and general location information

(geoname), but the location of objects such as buildings represented in the photograph.

While crowd sourcing can be also a source of inaccuracy or misinformation we suggest a quality control using quantity of contributions and quantification of errors and accuracy of individual contributions (e.g. mean square error).

4 FIRST RESULTS

The Web portal was developed during the past months and prototypically implements first functions and basic data structures to allow the collection of VGI as metadata for historical photographs. The portal consists of a Web interface showing photographs in a grid or a map view. First filters such as key word/tag based search, time slider and categories allow the user to orient and search in larger data sets (Fig. 1 to 3).

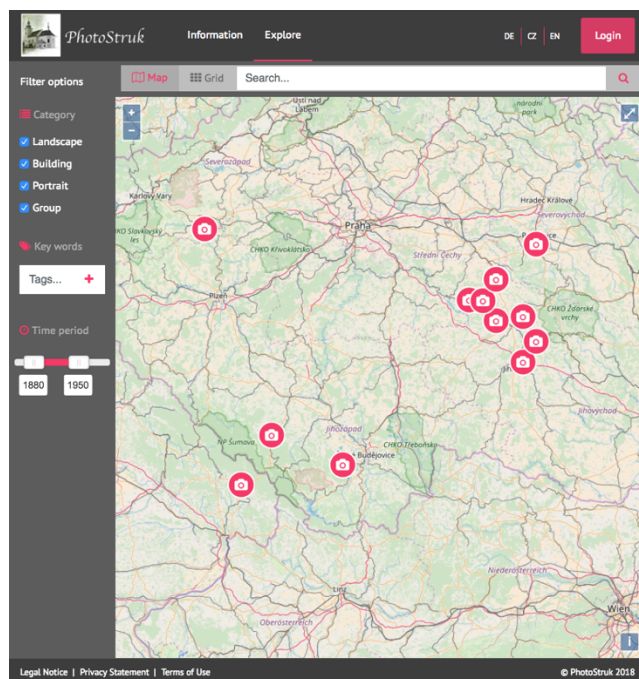


Figure 1. Map view of images in the geographic scope of the map with additional filters in the left menu

In the portal we follow the approach of spatial or map based search. The extent of the map defines the geographic scope of the search (Fig. 1). Each marker represents the object-georeferences and in future the orientation of a photograph will also be displayed (Fig. 2). Depending on the scale level object-georeferences are aggregated in one marker or are presented individually.

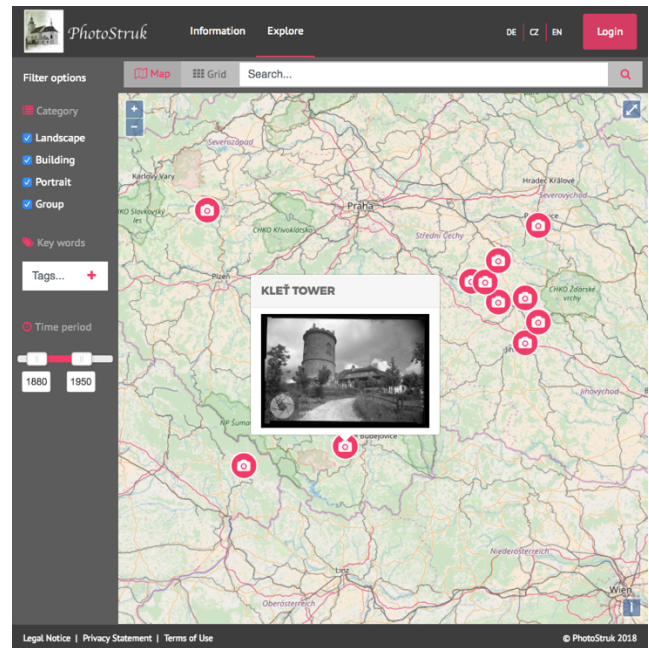


Figure 2. Preview of an image selected in the map

The left menu bar allows to use additional filter categories such as time of creation of the photograph, thematic classes and search inside the tags. Filter categories are stable between map view (Fig. 1 and 2) and grid view (Fig. 3).

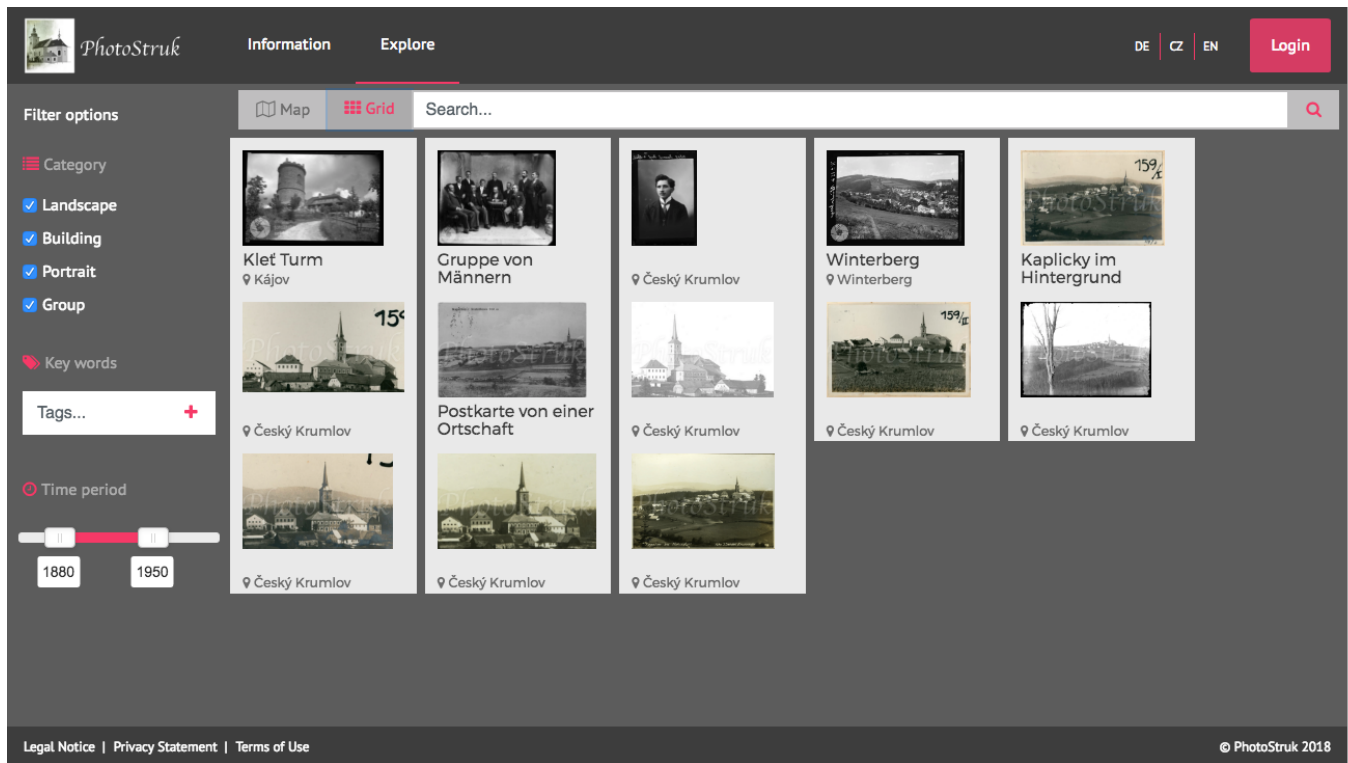


Figure 3. Grid view of images in the geographic scope of the map with additional filters in the left menu

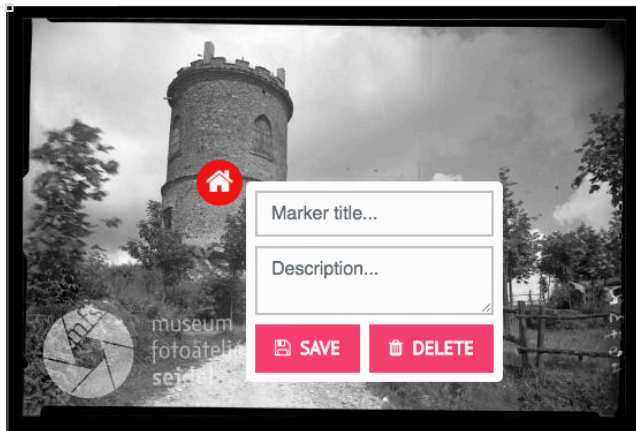


Figure 4. Marker for a building to indicate the spatial position in the image in addition with possibility to provide comments to prove the own knowledge about depicted objects

Most important are functionalities to allow the user to interact with the photograph by placing (drag and drop actions) markers for different types of objects on the photograph and indicate the

location of the object such as a building or a landscape element on the map (Fig. 4).

For each photograph an overview is available presenting classical archive documentation such as title and description (right part of the textual description below the map view) as well as crowd sourced information as markers, tags and comments (Fig. 5). Also the estimated location of the photographer can be indicated by users through a marker on the map (Fig. 5).

A first data set of 2,000 historic photographs stems from Atelier Seidel in Český Krumlov out of a total of 20,000 digitized photographs out of an archive of over 140,000 historic photographs from the 1880ies to 1954. This set was imported to the platform and provides the current basis for first tests. To validate the results of VGI also metadata for parts of the set are available as a test and validation data set. First internal usability tests were made to test the perception of the platform and were used to improve usability and the navigation. The platform will be made available to the broad public in October 2018.

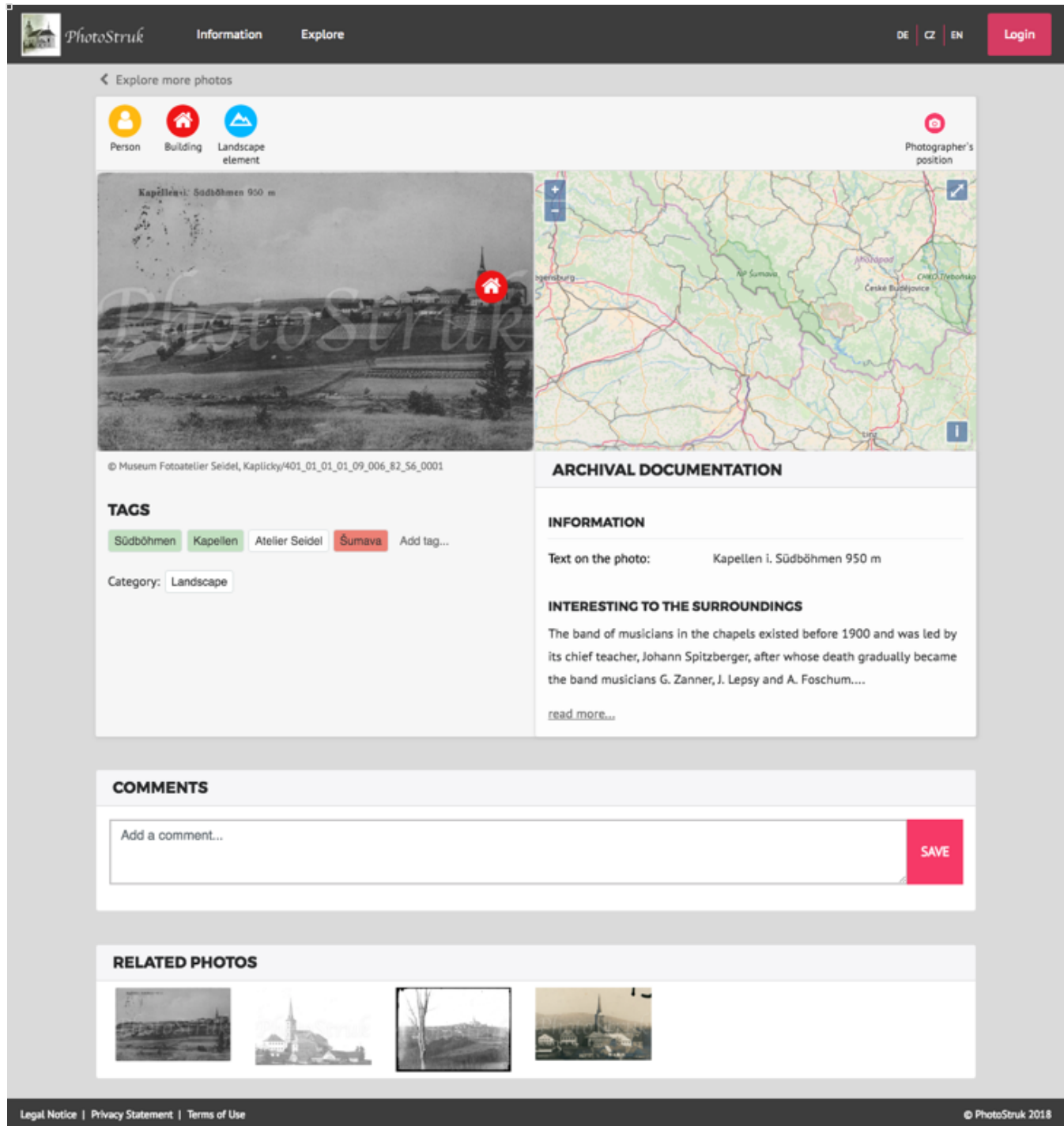


Figure 5. Detailed view of an image with markers for depicted objects to the top of the image, an interactive map to the right of the image with a marker to indicate the position of the photographer and below a text input field for user comments.

5 CONCLUSION & PERSPECTIVES

This paper is based on the assumption that current metadata standards fall short in providing a suitable structure to handle uncertainty as well as accuracy of spatial information provided in meta data of historic photographs and, hence, restrict spatial search and retrieval concepts. Uncertainty of the exact geometric conditions under which a photograph was taken as well as the uncertainty of the projection result from the lack of meta data standards to represent outer orientation of a photograph.

First results of the platform development already indicate the similar approaches to represent, retrieve or annotate photographs would not be possible, based on classical metadata structures. By analyzing the relevant concepts of photography and photogrammetry as well as geospatial search concepts we presented that a better representation of the spatial character of a photograph is technically possible. Uncertainty can be quantified by geometric metrics e.g. accuracy of orientation. Relevant data structures can be derived from geoinformatic and photogrammetric concepts and can be extended by new concepts also incorporating VGI.

To collect spatial information, we suggest citizen science in addition to classical archival documentation processes, to use concepts from VGI. Collecting in a step by step process the geographical details about a photograph, may help to reduce uncertainty or, as suggested, improve accuracy. VGI approaches need to be tested not only with regard to acceptance of the service, but also to the accuracy of contributions. This requires new metadata fields to store information about the outer orientation of an image as well as the data for georeferenced objects depicted in the photograph.

For this we are developing the Web-based platform PhotoStruk (www.photostruk.de) to test VGI and map based georeferencing concepts. Concepts will be tested on data from Museum Fotoatelier Seidel in the South Bohemian district. Results of this case study will be used by archeologists to reconstruct destroyed villages and buildings in the former Sudetenland, combining archeological findings with data from photographs [5].

As a consequence, an extension of metadata standards could contribute to help different disciplines to better find historical photographs using spatial and map based search concepts. Further development of the Web portal and testing of the platform will show usability and accuracy of the new standard, storing volunteered geographic information of historic photographs.

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