Getting Context on the Go – Mobile Urban Exploration with Ambient Tag Clouds

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ABSTRACT
Tag clouds are a well-established concept for organizing and visualizing large amounts of user-generated content annotated with keywords. Applied on mobile devices, so-called 'ambient tag clouds' which are based on surrounding georeferenced and tagged resources may act as compact location descriptors. This paper presents our on-going work towards more expressive ambient tag clouds. By analyzing locative textual Web content, such representations summarizing available background information can be generated without explicitly assigned tags. Thus, these ambient tag clouds enable the mobile exploration of a place's semantic beyond visible objects and common points-of-interest.

Categories and Subject Descriptors
H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval - *Information filtering*; H.5.2. [**Information Interfaces and Presentation**]: User Interfaces – *GUI*

General Terms
Algorithms, Design, Human Factors

Keywords
Location-based Service, Tag Cloud, User-generated Content

1. INTRODUCTION
The phenomenon of user-driven content generation has produced a vast amount of georeferenced digital information over the last few years. Today, well-known Web sites such as Wikipedia or Flickr offer thousands of articles and photos annotated with corresponding geographical identifiers. An established technique to organize and compactly visualize these extensive, yet unstructured datasets is the tag cloud concept: keywords (tags) that can be freely chosen by users to describe the digital resources are summarized in weighted lists where a single keyword's frequency is represented by its font size.

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Tag clouds based on georeferenced resources are increasingly investigated and enhanced by researchers. E.g. 'tag maps' augmenting 2D maps with overlaid tags were presented in [3]. Filtering map content via a corresponding tag cloud is introduced in [6]. Based on formerly assigned tags in a specific area, mobile users can be provided with tagging suggestions [8]. Due to a tag cloud's support for searching, browsing and overviewing tasks [4], so-called 'ambient tag clouds' were recently proposed as aspatial location descriptors for use on mobile devices [2]. In contrast to spatial-centric map representations, ambient tag clouds enable a content-driven exploration of a mobile user's current surroundings.

In this paper, we describe our on-going work towards more meaningful and context-aware ambient tag clouds. Following an information extraction approach, we resolve the former requirement of an underlying tagged and georeferenced dataset. Instead, we exploit unstructured textual Web content bound to real world coordinates as locative data sources for ambient tag clouds. Thus, the resulting visualizations reveal compact background information and support a user in exploring the semantics of her current whereabout.

2. PROTOTYPE ARCHITECTURE
Our present prototype architecture consists of a mobile application communicating with a HTTP service hosted on a remote server.

The mobile application is implemented on an *Android*-powered device and invokes the HTTP service passing the device's current location which is determined via a built-in GPS receiver. Following a two-stage process, the involved service is responsible for determining and preprocessing available locative information as well as generating and formalizing the corresponding cloud representation. Given a user's whereabout, our service performs a location-based search for georeferenced (in our current prototype German) Wikipedia articles using the appropriate Web service from *Geonames*, a publicly accessible geographic database. Invoking the resulting Wikipedia URLs, the corresponding HTML pages are fetched. Therein, special comments (e.g. *<!-- start content -->*) denote the actual article text. To retrieve the plaintexts required for the tag cloud generation, page parts outside these markers are discarded and HTML tags inside the article are removed. Each article plaintext together with its corresponding URL and real-world coordinates is then fed into the cloud generator which returns a corresponding cloud representation described in XML (see Section 3).

The mobile application parses the service's response to visualize the tag cloud (Figure 1). The user may interact with the cloud by touching tags of interest: selecting a tag switches to a common map representation revealing the underlying georeferenced articles (Figure 2). Now, the user may decide to flick through an article's abstract or to read it in full length.

Figure 1. Ambient tag cloud generated at Michaelerplatz in Vienna's first district.

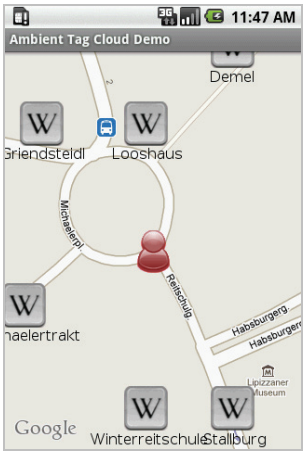

Figure 2. A map view reveals the underlying georeferenced content for a selected tag.

3. TAG CLOUD GENERATION

The tags are extracted from the Wikipedia article plaintexts by applying the *Term Frequency-Inverse Document Frequency* (TF-IDF) algorithm [5]. This algorithm represents a simple method for identifying salient terms in one document out of a collection of documents [7]. The key assumption is that if a term appears frequently in one document, but not in the overall collection, it is reasonable to consider it particularly descriptive for this document. For the ambient tag cloud, we thus expect that such salient terms likely represent descriptive tags for the user's current environment.

Our implementation first tokenizes the articles into individual terms of one, two and three words length. Commonly used words are removed using a language dependent stop-word list. For each term in the resulting set, the number of appearances in the set is recorded (*term frequency TF*). For the second computation step, an index of reference documents is required. Because it is impractical to compute TF-IDF against the entire collection of existing Wikipedia articles, the reference index was instead built from a general-purpose text corpus compiled from newspaper texts. (This measure also ensures that the implementation remains flexible and applicable across different topical domains.) The reference index is queried with each term; and the number of documents in which the term occurs is recorded as the *document frequency* (*DF*). The TF-IDF score is finally computed according to the following formula, where *N* denotes the size of the set of terms (i.e. total number of terms extracted from Wikipedia articles), and *D* denotes the size of the index (i.e. total number of documents indexed):

$$TFIDF = \frac{TF}{N} \cdot \log\left(\frac{D}{1+DF}\right)$$

The n highest scoring terms are transformed into an XML representation. The XML lists each term, the term's score, and references to the original geo-tagged source article(s) the term was obtained from. Each reference is thereby expressed through the HTTP URL of the original source article, and the geo-coordinate the article was tagged with. (Since terms frequently appear in more than one Wikipedia article retrieved for a location, there are usually several such references for each term in the XML.)

4. CONCLUSIONS AND OUTLOOK

This paper describes our first steps towards an automatic creation of ambient tag clouds by mining georeferenced textual information in form of locative Wikipedia articles. The application of such ambient tag clouds on mobile devices supports a user in the content-driven in-depth exploration of her location.

In future work, we plan to explore alternative sources for analyzable content to further increase the expressiveness of ambient tag clouds. One possible approach is the integration of location-based Web search queries (cf. [1]). Further novel data sources include social media sites and micro-blogging platforms which extend ambient tag clouds by a temporal dimension and thus, could express a place's semantic changes over time. The combination of data from several sources is supposed to result in the most complete summary of a location but poses new challenges such as the design of appropriate weighting algorithms.

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