



Using viewsheds, GIS, and a landscape classification to tag landscape photographs

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A B S T R A C T

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Landscape scenery is inherently difficult to conceptualize because of its perceptual nature. Yet landscapes are an extremely important resource for tourism and quality of life so there is a need to classify and manage landscapes. This paper shows how viewshed analysis based on the known location and direction of a photo can be used to tag a photo and this provides a method for assessing the New Zealand Landscape Classification. GIS visibility and overlay functions are combined with digital elevation data and a landscape classification to produce the tagged photos. This tool links an oblique view with multiple distance perspectives to a GIS dataset. There are complexities associated with distance perspectives and the appropriate balance of foreground and distant landscape. This paper argues that the benefits of automated tagging of landscape photos are threefold. The process of modelling landscape tags forces researchers to confront the complexity of landscape character classification. This in turn leads to improved methods for representing and classifying landscape character. Secondly, once tagging methods have been developed then people may choose to use these tools rather than to manually tag photos. Thirdly, such a tool provides the opportunity to utilize the increasingly important volunteered geographic information on the Internet for understanding landscape categories. Landscape photographs and associated tags on the Internet provide insight about landscape categories employed by the public. This could lead to the development of what is labelled “tag clouds” and a landscape “folksonomy”.

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Introduction

Search engines on the Internet are still largely based on text. Thus searches for images on the web are limited by the availability of textual annotations of the images, or by association of text with images by proximity in documents. With the almost exponential growth of the numbers of images in photo-sharing sites such as Flickr, Picasa, and Panoramio, there is growing need for automated methods for the annotation or ‘tagging’ of photographs with text and other metadata, regarding both location and semantics of the content of the photograph. In October 2009, Flickr passed the 4 billion mark in photographs uploaded (Wikipedia, 2010a)! More than three million of these Flickr photos have been geotagged or placed on maps by their users. While 3 million is a large number, this means that fewer than 0.1 percent of Flickr images are geolocated. Panoramio, which is linked to Google Earth, has far fewer photographs in total, just exceeding 5 million photographs in October 2009, but about 80 percent of their photographs are

geolocated (Wikipedia, 2010b; Manchón, 2007). Many people are willing to upload their digital photographs to the Internet and make them publicly available, but do not have the right combination of time, knowledge, and interest to provide annotations of their content or of their locations. Tools that link landscape photographs to GIS databases through viewsheds will therefore provide a valuable service.

Landscape photographs can be used verify existing landscape GIS databases. If the landscape photograph has been manually tagged, then this can be compared to an automated tag to check that the GIS database contains appropriate spatial and conceptual information. Tools for tagging photographs can provide valuable enhancement of information content in both directions: from GIS to photo tags and from photo tags to improved conceptualization of landscape. Landscape management is improved by the use of a landscape classification so that there is a frame of reference for communication. The perceptual nature of landscape makes it difficult to classify landscapes and in particular determine and define appropriate classes. Yet how landscapes are conceptualise ultimately impacts on landscape inventory and the identification of rare and distinctive landscapes. A contemporary source of information on how people conceptualise landscapes is the tagging of photographs on the internet.

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This research was initially motivated by the need to verify the New Zealand Landscape Classification (Brabyn, 2009) using photos taken in the field. The automated tagging of these photos using GIS and the landscape database allowed the content of the photo to be compared easily with the content of the landscape classification. With the growth in geo tagged photos on the internet, the use of tools that link photo content to landscape GIS databases has considerable benefit for research on landscape conceptualisation. In this paper we argue that photo tagging could be used to generate a landscape “Folksonomy”. Common language associated with landscape photo tags provides a strong theoretical foundation for a landscape classification. Tools for linking common language to a landscape classification are therefore useful. We demonstrate a simple approach that can assign tags to photographs of landscapes. This can be used to compare with existing manual tags or check against the content of the visual scene. Given the location and orientation of the photographer, we can generate the semantic content of the photograph by combining a landscape character classification with viewsheds and distance buffers in a GIS. This can be done to add content tags to actual landscape photographs. It can also be done to attach content tags of landscape scenes to places where photographs have not been taken, to characterize, for example, the character of what would be seen while hiking along a track or stopping at a scenic view point.

Landscape and landscape categories

We adopt the position that “landscape” is simply the appearance of the land and water from a distance. This definition is consistent with Appleton’s (1980) definition; “the environment perceived, especially visually perceived” (p. 14), and Palka’s (1995) definition; “the assemblage of human and natural phenomena contained within one’s field of view out-of-doors” (p. 71). Landscape as a visual experience holds considerable value in society, is often the main attraction for tourism industries, and can add significantly to the quality of life of residents. It is important that the values associated with landscape are represented and robust systems are established for conceptualising landscape.

Language provides an important insight into how the general public conceptualise landscape, and is the basis for a branch of landscape research known as cognitive categorization. Tversky and Hemenway (1983) published an early paper on the content of outdoor scenes. Mark, Smith, and Tversky (1999) and Smith and Mark (2001) summarised this research and also conducted experiments for identifying category norms for landform, landcover, water, human settlements and human made infrastructure. It is clear that basic common language terms, such as hills, mountains, lakes and ocean, are the categories that normal people are using for conceptualising many different landscape components.

Photographs are often used to illicit landscape preferences and categories used by different ethnic groups. For example, Kaplan, Kaplan, and Brown (1989) showed landscape photographs to participants and asked them to express landscape preferences. These preferences were then compared to objective characteristics of the scenes. Mark, Turk, and Stea (2007) have shown local and regional landscape photographs to Yindjibarndi speakers in northwestern Australia, and have asked them to talk about the content of the photographs. There is a considerable body of literature on the semantic content of landscape photographs.

As described in the introduction, an increasingly important source of landscape photographs is the internet. Many of these photos are tagged, and this provides an important source of information for landscape category research.

New Zealand landscape character classification

The availability of a landscape character classification implemented in a GIS is an essential requirement for our approach to tagging landscape photos. Such a landscape character classification has been developed for New Zealand, and Brabyn (1996, 2009) discusses in detail the process and theory behind this classification. The fundamental rationale for having a landscape classification is to provide a frame of reference for communication about landscapes, and this research demonstrates the opportunities that arise once such classification is developed.

The NZ Landscape Classification is based on the unique combination of four landscape component layers; three physical environment layers- landform, water, and landcover, and one human modification layer (infrastructure and urban areas). These individual component layers were built from a range of GIS datasets, and it is the composition of these component layers that form the landscape classes. The classification is based on the general public’s perception of landscape and the classes used in everyday language.

Tags and folksonomies

“Tags” are essential to content-based image retrieval. “In online computer systems terminology, a tag is a non-hierarchical keyword or term assigned to a piece of information (such as an internet bookmark, digital image, or computer file)” (Wikipedia, 2010c). The process of tagging is also called annotation, and provides metadata for an image. Manual photo annotation, or tagging of photographs, is viewed as the “gold standard” for tag quality (Tuffield et al., 2006), but is recognized as labour intensive. Thus there have been efforts to develop semi-automated (Tuffield et al., 2006) and fully automated (Li & Wang, 2006; Mörzinger, Sorschag, Thallinger, & Lindstaedt, 2008) annotation procedures. However, none of these efforts has used an independent source of image content information and transferred it to the photos using viewsheds. Luis von Ahn developed an image-tagging game called the “ESP Game”, in which players earned points if they agreed on tags for photographs (von Ahn & Dabbish, 2004). This game has been used by Google to improve semantic image retrieval in Google Images.

Related to tagging is the formation of folksonomies. “A folksonomy is a system of classification derived from the practice and method of collaboratively creating and managing tags to annotate and categorize content” (Wikipedia, 2010d). Typically, texts and tags on the internet form the foundation of different folksonomies, and provide an alternative to more institutionally supported taxonomies or “controlled vocabularies” (Guszlev and Lukács, 2007, p. 194). Although internet tagging will produce variation in the use of semantic categories, the share volume of tagging submitted on the internet over a period of time results in the formation of “tag clouds”. Each tag cloud will have a central core of common meaning but also contain peripheral meanings that are less common. Folksonomy is an emerging label that refers to a “bottom-up categorical structure development” (Guszlev and Lukács, 2007, p. 194). Landscape folksonomies could play an important role in making links between tags and landscape image content (Vander Wal, 2007; Veres, 2006), and ultimately assist in identifying landscape categories that are meaningful to the general public, and cultural sub groups.

Given the socially constructed nature of landscapes categories and that language provides a useful insight into what categories are used, a landscape folksonomy and associated tag clouds may prove to be useful for developing more formal landscape classifications. Indeed, it could be argued that a landscape classification should be a folksonomy. Tools are therefore needed that can link formal classifications such as the NZ Landscape classification, with landscape photos on the internet. By automatically tagging photos on

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