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Toward A Location Based Service for Assessing and Recommending Landscape Views

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Abstract

The rationale and initial design considerations are presented for a location based service (LBS) that will offer people personalized recommendations for aesthetically desirable places. This will be based on people's personal characteristics and environmental factors known to affect landscape perception. A prototype user-interface has been designed for eliciting users' perceptions of landscape elements and colors they perceive from photographs of landscape views. In the long-term, a VGI repository database will be maintained to make personalized location specific recommendations about suitable landscape views for user-specified locations. A prototype fuzzy logic recommendation system comprising 72 rules has also been designed to model how personal factors (gender, age, health status) and perceived colors likely determine the aesthetic suitability of landscape views. An initial trial revealed some limitations and stressed the need for further testing of the feasibility of fuzzy logic as the reasoning framework for this LBS for recommending suitable landscape views.

1. Introduction

As urbanity imposes psychological demands that become excessive, people seek stress-reducing (especially natural) environments where they can recreate and relax. The investigation of the ecological and visual aspects of physical landscapes is critical for understanding and addressing many of the psychosomatic disorders of urban dwellers. In this paper, we focus on visual perception of people's everyday environments. Human-beings engage in a wide variety of important decisions in their everyday lives, based on visual properties of the geographic environment and their geographical knowledge. Examples include coping with environmental visual pollution, finding one's way in spatially extended areas, and finding a landscape view appropriate to one's emotional status. Color, shape, composition, and configuration of objects are important components of visual stimuli that should be studied to understand our perceptions of and reactions to physical landscapes in urban environments.

In this short paper, we present the rationale and initial design considerations for a prototype Location Based Service (LBS) for landscape view assessment. This LBS will ultimately offer people personalized recommendations for places (near their chosen location(s)) that are most likely to appeal to them aesthetically. The LBS is designed to make such personalized recommendations based on available knowledge of how people's personal characteristics affects landscape perception. A prototype user-interface has been designed for eliciting users' perceptions about the types of landscape elements and the colors they perceive in images showing landscape views. An important goal of this project is to maintain a large database of people's perception of landscape views, based on volunteered geographic information (VGI) generated from people tagging images uploaded by them and/or others.

Another important component of this LBS is a fuzzy logic decision system which implements rules reflecting knowledge from research on how personal characteristics (gender, age, health status) and environmental variables together affect the aesthetic and emotional appeal of landscape views. Currently, the dominant color of landscape views is the only environmental variable being used in the fuzzy logic rule-base for this exploratory stage of the project. Color perception and how it varies with age, gender and health condition is heavily researched in multiple fields, which gave us confidence in developing our first set of rules based on color perception alone. Over time, the rule base will be refined and greatly extended to reason with multiple environmental factors that affect people's perception and emotional response to landscape views. Despite the additional effort needed, the fuzzy logic system offers scope for more nuanced reasoning, compared to conventional Boolean logic reasoning.

2. Overview of LBS System Design

The theoretical concepts and system design decisions for the LBS prototype (currently implemented in a Visual Basic programming environment) is summarized in this section. This is a refinement and development from earlier work completed for the first author's Master's thesis project (Soleimani 2015).

The user-interface for eliciting VGI allows users to both upload and interactively create descriptive tags images of landscape views. Multiple images for different directional views of a location are encouraged to be input (see Figure 1). The image tagging process is currently set up to avoid free-form descriptions; instead, users choose from a pre-defined list of landscape elements and colors to describe the salient elements and their characteristic colors (Le Yaouanc *et al.* 2010; O'Connor and Kroefges 2008). They also estimate distances to landscape elements from the photograph's vantage point (but this information is not being used by the system currently). A grid of cells (see Figure 1) is also displayed to help users count the number of cells each specified landscape element is covered by in the image—this allows the system to calculate the proportion of all identified colors in the image and assign a dominant color for every image. Additionally, based on research on the impact of colors on people's emotions, the LBS system categorizes colors as follows: *very warm* (yellow and orange), *warm* (brown and red), *cold* (green, blue, and magenta) and *neutral* (grey, black, and white) (Chappel et al. 2014).

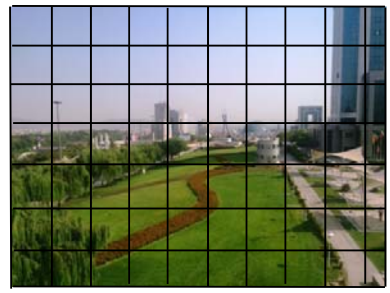
The fuzzy logic decision system was implemented in MATLAB software and comprises 72 independent if-then combinatory rules based on all possible combinations of 4 input linguistic variables (gender, age, health condition, and dominant color category)—the desired consequent for each rule maybe one of four suitability values (good, fair, acceptable, bad) (see Table 1 for examples). The specific methods for deriving fuzzy sets and membership functions for the linguistic variables are based on our interpretation of research findings from color perception studies (Kaya and Epps 2004; Chappel et al. 2014; Sokolova and Fernández-Caballero 2015).

3. Experimental Validation

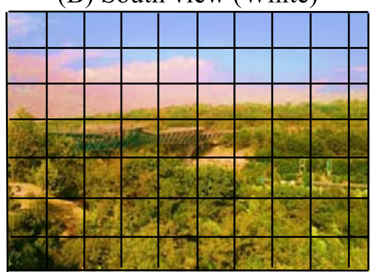
Experimental testing and VGI collection is yet to begin because system design issues are still being resolved. The authors have been using only themselves as test subjects, but an informal validation trial was conducted with a 35-year female cancer patient known to the first author. She chose to upload four images of the Fire-and-Water-Park of Tehran (Figure 1). It took her the longest to process her first image, but it got progressively faster. Her color tags for landscape elements were surprising and revealed that her judgment was based not just on colors apparent in the uploaded images, but also (and probably more so) by her memory of prior *in situ* observations in the park. Based on her personal profile (female, middle-aged, cancer afflicted), Table 1 shows the four possible rules that are available for this user in the current system. Based on the dominant colors for views in Figure 1, cold color dominant views are found towards the north and east. Hence, given the rules, the system should yield relatively higher suitability membership values (good, fair) for the north and east view photos and lower membership values for the others.

(A) Location of Fire-and-Water Park, in Tehran, Iran

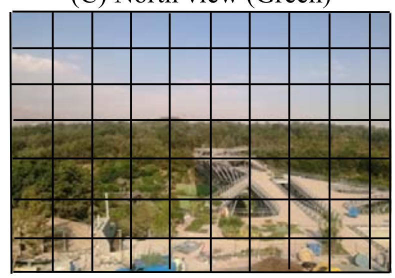
(B) South view (White)



(C) North view (Green)



(D) East view (Yellow)



(E) West view (Gray)

Figure 1. Fire-and-Water-Park of Tehran, Iran as visible in satellite imagery view (A) and four different directional views (B – E) and dominant color tagged by a user.

Table 1. Four possible rules for a female, middle-aged user suffering from cancer

if	Gender	Age	Disease	Dominating Color of View	then	(Desired) View Suitability
R_1	Female/ Male	Young/Middle-aged/ Elderly	Cancer/Neurological/ Vision	Cold/ Neutral/ Warm/Very warm		**Good**
R_2	Female/ Male	Young/Middle-aged/ Elderly	Cancer/Neurological/ Vision	Cold/ Neutral/ Warm/Very warm		**Fair**
R_3	Female/ Male	Young/Middle-aged/ Elderly	Cancer/Neurological/ Vision	Cold/ Neutral/ Warm/Very warm		**Acceptable**
R_4	Female/ Male	Young/Middle-aged/ Elderly	Cancer/Neurological/ Vision	Cold/ Neutral/ Warm/Very warm		**Bad**

The final step of defuzzification in any fuzzy logic system is necessary to convert a fuzzy set output to a crisp number could then allow choice of the appropriate linguistic label to describe the obtained output. For this experiment, the recommended suitability scores from five available defuzzification methods in MATLAB confirmed that the suitability assessment for a view may depend strongly on the defuzzification method. As can be inferred from the suitability scores tabulated in Table 2, the bisector, centroid and MOM methods yield such similar scores for all views images that it is not possible to distinguish between them; the LOM method would recommend the neutral colored south and west views (suitability scores of 0.66 vs. 0.41 for north and east views); only the SOM defuzzification method would lead to the desired recommendation of the north and east cold views (suitability scores .41 compared to 0.16 for the south and west views) as being more suitable than the other two views. This clearly suggests that the fuzzy logic fuzzification and defuzzification methods need to be explored more thoroughly for this prototype LBS system.

Table 2. Defuzzification results

Method	North View	South View	West View	East View
Bisector	0.43	0.41	0.41	0.41
Centroid	0.45	0.41	0.41	0.41
Smallest of maximum (SOM)	0.41	0.16	0.16	0.41
Largest of maximum (LOM)	0.41	0.66	0.66	0.41
Mean of maximum (MOM)	0.41	0.41	0.41	0.41

4. Conclusion

The LBS prototype system design and even the underlying rationale will continue to evolve and be refined, since these rules are based on a much-simplified model and may be modified and refined based on more in-depth review of literature, recommendations from experts, and future human-subject validation trials. In the next iteration, the fuzzy rule base should be updated to decide the color category based not on the dominant color in a landscape view but the proportions of all colors tagged by users. Other factors (e.g., configuration, texture, elements) that affect landscape perception must eventually be incorporated into the fuzzy logic system. Experimental validation suggested the need for an improved user-interface, and reducing users' cognitive load while processing images; the prototype must also be migrated to a web-based development environment for collecting sufficient VGI. Finally, the VGI elicitation process can yield not just a database of landscape view descriptions, but can also be designed to capture users' assessments of the suitability of those views. This component of the VGI database will be most critical for validating and improve the rule-base that is supposed to capture how people vary in how they perceive different views of landscapes.

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