Landscape Photo Classification Mechanism for Context-Aware Photography Support System

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***Abstract*—This paper presents landscape photo classification mechanisms to enhance our proposed photography support system named *Phorec*. The system utilizes big data in social photo stock services and online historical weather database to recommend relevant photos based on user's natural contexts, including location, time, and weather condition. In order to help user take better photos, important information, such as camera setting, time, and location, is displayed with the photo selected by the user. Since the aim of *Phorec* is to support not only photographers but also general users as a travel assistant, we mainly focus on the landscape photos. From the huge collected data, landscape photos classification is required to extract the landscape photos from the uncategorized photos. In this paper, some possible landscape classification techniques are investigated and evaluated with our collected dataset. In addition to the straightforward tag analysis and Exif analysis method, we propose a unique method that utilizes a common face recognition technique for excluding non-landscape photos. Experimental results show that our proposed people-exclusion method works well for excluding non-landscape photos from the collected various photo.**

I. Introduction

In the age of modern digital camera, Digital Single Lens Reflect (DSLR) and Mirrorless camera are the most common camera offering high quality photos. The camera itself provides a number of automatic functions that make photography easier than before. For example, auto focus system promises that the collaboration of camera and lens will point the focus on the object accurately. However, controlling camera manually awards you charming photos, for example photos of soft and smooth water current can be taken with longer shutter speed. On the other hand, the uncontrollable natural contexts, including location, time, season, and weather condition, known as natural keys of landscape photography, certainly affect the light condition. Because direction of sunlight results in the different light density and shadow, it gives us various qualities of photo as well. Consequently, the camera controlling skills, composition arranging, and the major contexts are important factors that experienced photographers always consider.

To support photographers while taking photo, meaningful data from photographer's social network are widely used for analysis and development of several support systems. [1] introduces a photo recommender, directional assistance, and framing assistance based on user's contexts regardless weather condition and quality of photos. Optimal composition and camera settings corresponding to user's contexts for a camera on mobile phone was proposed in [2]. As a new aspect of support systems, we proposed a context-aware photography support system called *Phorec* in our poster manuscript [3]. The system suggests special settings for taking beautiful photos in certain contexts through example photos.

Phorec works well in the aspect of a recommendation system but still leaves some issues. The most important issue resulting in the quality of the system is the category of photos. Our system focuses on recommending landscape photo so that the system can be widely used among photographers and general users. However the photos in Flickr[1], online photo database which we use, are uncategorized. Accordingly, some landscape photo classification mechanisms are needed to identify landscape photos in the system.

Photo classification is one of the challenging topics of image research fields. Several approaches have been proposed based on various features. In the field of indoor and outdoor image classification, [4] used low-level image features, including histograms in the Ohta color space and texture, to classify indoor and outdoor scenes. Edge analysis technique was proposed in [5]. The result showed that this technique outperforms other low-level feature analysis. [6] used SIFT visual descriptor [7] and enhanced SPM method [8] by partitioning images into several resolutions and using the horizontal and vertical modalities to classify photos into several scenes. To classify landscape photos, [9] classified landscape and city photos by using low-level features, including color, edge, and texture. However, classification of landscape and non-landscape photo still remains unexplored.

This paper proposes an enhancement of the *Phorec* system by performing a landscape photo classification. As the system mainly focuses on landscape photos due to the aim of supporting not only photographers but also general users as a travel assistant, we investigated several methods for distinguishing landscape photos from the uncategorized photos. The remaining parts of this paper are organized as follows. Section II briefly describes our developed support system overview. Section III introduces the landscape photo classification method. Section IV reports the experiment. Finally, the conclusion and future works are summarized in the section V.

II. Our developed system

We assume that relevant photos according to a user's camera settings and context information can give various information such as good location, time, appropriate camera settings and the photo they may take. This assumption does not encourage

[1] www.flickr.com

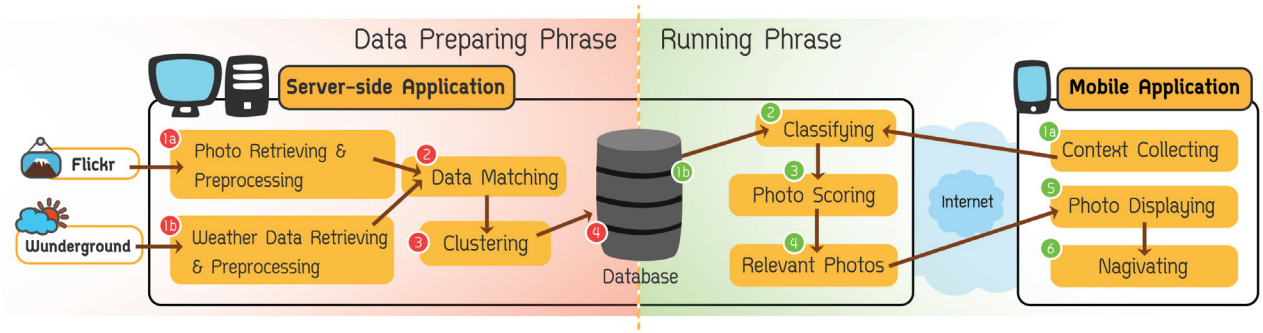

Fig. 1. System architecture of Phorec

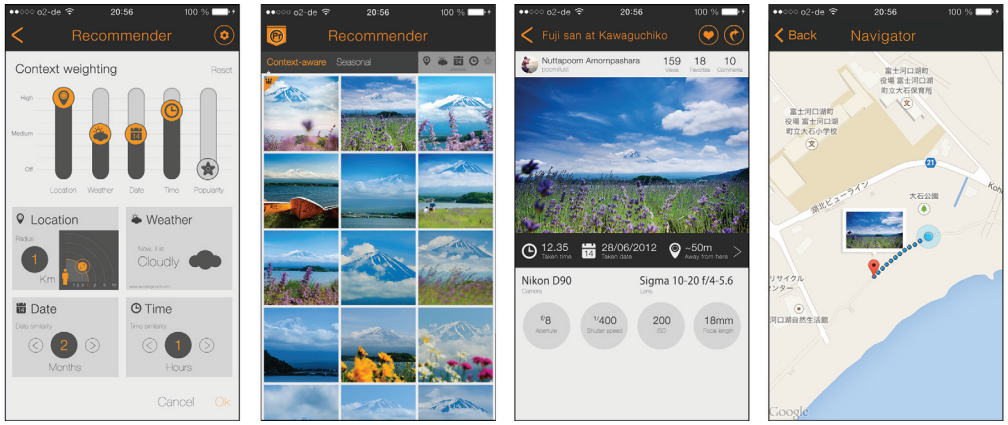

Fig. 2. User interfaces of Phorec mobile application

users to take photo in the same way as someone has already done, but we expect users to learn, adapt, and find their own way to improve photography skill from example photos.

The system takes context information, context weights, and user's profile from a user as inputs. The contexts information of prior-collected photos in database and user's collected are compared, filtered, and scored with the context weights. The sophisticated user interfaces then show the relevant photos with camera settings, contexts information, and navigation as the outputs of the system. As shown in Fig. 1, *Phorec* can be divided into two parts, *Phorec server* and *Phorec mobile application*. The two parts are communicate via the Internet through a web service provided by the Phorec server.

A. Phorec server

The responsibility of Phorec server is to collect, preprocess, score photos and weather information, and provide a web service for Phorec mobile application. Thanks to the Flickr API provided by Flickr, we can retrieve photos' context information, Exif metadata, GPS coordinate, and social feedback in terms of numbers of view, like, favorite, and comment, from the given GPS coordinates. We have collected more than 140,000 geo-tagged photos taken around famous places in Osaka, Nara and Kyoto in Japan. Preprocessing is done to modify collected data into a consistence format. From the uncategorized photos from Flickr, a landscape photo classification is used to eliminate non-landscape photos from the system. The information of classified photo is matched with weather condition collected from Weather Underground[2]. During running phase, Phorec server receives a request from a user with user's context information and context weights. Scores of each photo, composed of location, date, time, weather condition are calculated based on similarity of each context. Then the popularity score is calculated from the social feedback and the number of view in the system.

B. Phorec mobile application

We developed an iPhone application to collect user's contexts information and exhibit a set of relevant photos through sophisticated user interfaces. The application is composed of two sub-systems, *Recommender* and *Photo Explorer*. The Recommender system is designed for the scenario that user is at the place. Contexts information is automatically collected from user's surroundings. Only brief configurations of some contexts parameters and context weights can be set by the user. On the other hand, every parameter can be configured in the Photo Explorer system which is designed to be used when user is planning a trip. As shown in Fig. 2, Phorec mobile application is composed of Context Configuration, Photo List, Photo Viewer, and Navigator. The Context Configuration allows user to set contexts by context weights panel and context

[2]www.wunderground.com

Fig. 3. Accurate face detection on non-landscape photo

configuration fields. The Photo List exhibits the corresponding photos in grid view. The Photo Viewer shows the selected photo in larger size with photo's contexts information and camera settings. The Navigator displays an optimal path to the selected photo's taken location.

III. Landscape Photo Classification

As *Phorec* is designed for not only photographers but also general users to use this system as a travel assistant, landscape is the photo category that can be commonly used for both classes of users. From the collected huge data in *Phorec*, a landscape photo classification is needed to distinguish landscape photos from the uncategorized photos. In addition to a straightforward tag analysis method and popular Exif analysis, we employ a unique method utilizing common face detection technique called "people-exclusion" technique.

A. Tag analysis

As the simplest method, we first investigate a tag-based classification. Several tag analysis approaches in [10], [11], and [12] reflect that textual-based analysis is one of the meaningful methods in online photo sharing sites and has an advantage in a calculation speed compared to other image analysis. Based on this information, we assumed that tags in the photos collected in our system have some clues to identify the landscape and non-landscape photos. We expected that landscape photos may contain the terms related to the word "landscape." On the other hand, non-landscape may contain other unrelated terms, such as "food," "party," and "flower."

B. Exif analysis

For more effective method, we focus on Exif-based classification. Exchangeable image file format or Exif is the standard that specifies formats and content of images. Containing camera settings, such as aperture, exposure time, ISO, date and time, geo-coordinates and other meaningful data, Exif is the feature that is widely used in image classification, for example in [13]. From our experience in photography, we expect that good landscape photos are usually taken with special settings.

TABLE I
Frequency distribution of tags in landscape and non-landscape photos

	Landscape		Non-landscape	
No.	Tag	Frequency (%)	Tag	Frequency (%)
1.	japan	41.60	japan	35.05
2.	kyoto	22.80	osaka	14.71
3.	日本	14.80	kyoto	14.01
4.	osaka	12.60	日本	13.22
5.	kansai	10.40	osaka	8.53

TABLE II
Landscape photo classification using different algorithms

Algorithm	Accuracy (%)	Landscape		Non-landscape	
		Precision	Recall	Precision	Recall
NaiveBays	68.56	0.00	0.00	0.69	1.00
Decision tree (J48)	68.56	0.00	0.00	0.69	1.00
Multilayer Perceptron	67.33	0.39	0.07	0.69	0.95

TABLE III
Face detection on landscape and non-landscape photos

Category	Face detected photos	No face detected photos
Landscape	36	464
Non-landscape	217	1061

For instance, aperture value of panoramic view or wide view photo should be high (f/8, f/11). Combining with the exposure value (EV), which indicates the brightness of the scene, that landscape photo is likely to have the higher EV than non-landscape photo under the same condition. Saying that, at the same time of the day and weather condition, landscape photo should be taken with the brighter EV than non-landscape photo. The EV of a photo $EV(P_i)$ can be calculated by

$$EV(P_i) = log_2 \frac{aperture^2(P_i)}{shutterspeed(P_i)} + log_2 \frac{iso(P_i)}{100} \quad (1)$$

C. People-exclusion method based on face detection

Although image analyses have already been proposed for classifying several scenes, there are no state-of-the-art for distinguishing a landscape photo. Face detection techniques have been developed for some purposes. Currently, it promises a high detection accuracy and calculation speed. From our assumption, non-landscape photos, such as portrait, party, and activity photos, are likely to have some people in the scene. As a basic and straight-forward approach, we tried to use the face detection technique to mark a photo containing human faces as a main object as a non-landscape photo.

IV. Experiment on Landscape Photo Classification

From the collected photos and historical weather conditions, we created a training set for the classification by randomly se-

lecting the photos from our database and asking photographers, who have experienced more than three years in photography, to decide which photos are landscape photos. From the total 1,778 classified photos, the number of landscape photos and non-landscape photo are 500 and 1,278 photos, respectively. We perform an experiment on landscape photo classification through three approaches, including tag analysis, Exif analysis, and face detection. The experimental results show that face detection technique works well as an initial step to exclude non-landscape photos. But the tag and Exif analysis result in very low accuracy.

First, we tried to analyze tags and find relationships between each tag and category of the photos. From the training set, frequency distributions of distinct tags are calculated. The result on Table I shows that the top-5 most frequently used tags are common terms, for example "japan", "osaka." Moreover, the term "landscape" occurred in only 0.6% of total landscape photos. This result infers that the tag analysis is not suitable for landscape photo classification in this system.

In the second approach, we performed the Exif and EV analysis by following the assumption that EV of a landscape photo should be higher than the EV of non-landscape photo given the same time and weather condition. From the training set, we initially calculated the EV of each photo by using Equation 1. As the brightness relies on the time and season, we estimated the period of a day, e.g. early morning, noon, and night, by calculating sunrise and sunset time of each day from latitude, longitude and date using the Sunrise equation in [14]. For the photos taken in the night time, we cannot use this approach because light condition of landscape and other scene are likely to be the same. From this information, we created a dataset containing EV, period of a day, and weather condition for the classification. Several classification algorithms have been used. As shown in Table II, NaiveBayes and Decision tree (J48) give the precision and recall zero for the class of landscape photo. This result shows that these classifications do not work well on this dataset. We conclude that this dataset has no prominent relationships of features in both landscape and non-landscape photo classes.

Finally, we performed the face detection approach by using Haar cascade face detection. In some case, faces exist in a photo but not as a main object, so we calculate the size and number of the detected face in the photo. Some example of accurate face detection in non-landscape photos are shown in Fig. 3. Table III shows that 16.98% of non-landscape can be removed from the initially-collected data. However the remaining number of non-landscape photo is still large because there are some photos that do not contain human face, for example, photos of flower, foods, and so on.

V. Conclusion and future works

We have proposed landscape photo classification mechanisms to enhance the context-aware landscape photography support system aiming to help users improve their photography skills through example of good photos and important photography settings. The support system provides a set of good landscape photos corresponding to user's contexts with settings information and navigation system. To achieve our intention to support photographers and general users at the same time, the landscape photo classification is quite important function to utilize a huge amount of photo on Flickr efficiently. Our experimental result shows that the number of non-landscape photo can be reduced by using face detection technique but tag and Exif analysis does not work well in our testing data.

Although we could exclude non-landscape photos containing human faces from the uncategeorized photos, there are a number of non-landscape photos which do not contain any human face. So we have an attempt to improve the landscape classification by using some visual descriptor techniques and analyzing low-level features of photos towards color histogram, pattern, and edge.

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