Photo Management Solution

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Abstract

This paper is intended to introduce a photo management function for effective filing and browsing of a large number of photos. Specifically, it describes the functions including 1) a similarity search function for sorting photos based on their visual features such as the color, composition or texture, 2) an event grouping function for grouping photos according to their recording time and 3) a redundant photo detection / hierarchical presentation function for browsing efficiently by evaluating mutual visual similarities between photos. The experimental results using actual photos are given at the end of the paper.

Keywords

photo management, album management, browsing, similarity search, grouping, visual features, image analysis, digital camera

1. Introduction

The popularity of digital cameras and cellular phones has made it possible for anyone to shoot photos at anytime, causing an explosive increase in the number of photos recorded by individuals. However, due to the labor and time taken for filing the photos, it often happens that the recorded photos are left unarranged and as the result these photos are rarely accessed. The functions for photo filing management are getting more important than ever. These include the search function that searches photos based on various keys input by the user, the classification function that groups similar photos according to purpose, and the presentation function that supports the browser in searching for candidate images.

NEC has been conducting R&D into multimedia indexing technology aiming at effective storage and utilization of images and have recently developed a photo management system for general users covering 1) a similarity search function for searching out similar photos based on visual features; 2) an event grouping function that groups photos automatically according to their in recorded time; 3) a hierarchical display function for browsing photos efficiently by detecting redundant photos based on the mutual visual similarities.

2. Summary of Photo Management Functions

Fig. 1 summarizes the flow of the photo management system.

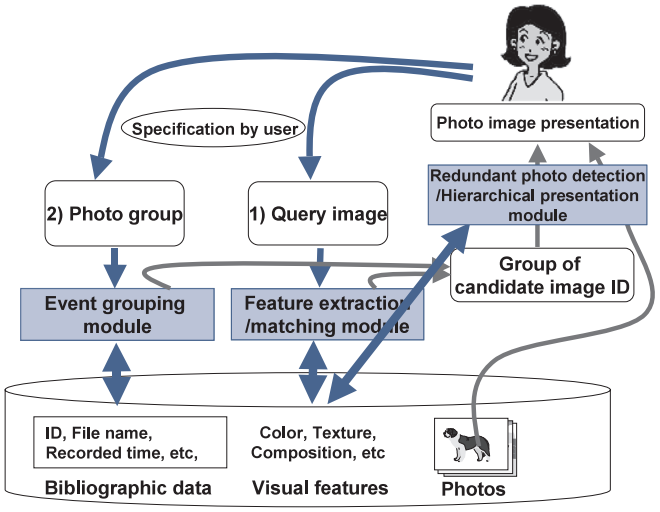

Fig. 1 Photo management function summary.

The newly developed modules consist of the following:

1) Feature extraction/matching module.
2) Event grouping module.
3) Redundant photo detection / hierarchical presentation module.

When a new photo is registered, the photo management system assigns an ID, extracts bibliographic data such as the recorded time, and stores it in a table. At the same time, feature extraction/matching module extracts the visual features such as the color, texture and composition automatically and stores them.

In searching or browsing photos, a user performs either of

the following operations:

1) Specifying the query image.

2) Specifying the photo group to be browsed.

When the user specifies the query image, the feature extraction/matching module evaluates the similarity between the query image and photos stored in the system based on their visual features. Then, it outputs the candidate photos in order of similarity. When the user specifies the photo group to be browsed, the event grouping module analyzes the recorded time of the photos in the specified group and outputs event-wise grouping information of the photos.

The redundant photo detection / hierarchical presentation module evaluates the similarity between the images in the output groups, detects the photos that were taken in the same composition, and presents them to the users hierarchically.

By using these three modules, the user can search and browse photos effectively.

3. Operations of Modules

3.1 Feature Extraction / Matching Module

This module searches the photos that are visually similar to the specified photo to enable browsing based on the photo contents.**Fig. 2**(a) shows the feature extraction and matching procedure.

When a new photo is registered in the system, this module extracts the visual features such as color, composition, texture, etc. (step A). The extracted features are transformed into lower dimension based on the principal components acquired in advance using training data (step B). When the query image is input by the user for similarity search, feature extraction / matching module extract the visual features from the query image and perform principal component analysis as well (steps (1) and (2)), and outputs the candidate images by executing matching between them. Since these compressed low dimensional features are used in matching process, the module can search candidate photos with high speed and low memory consumption.

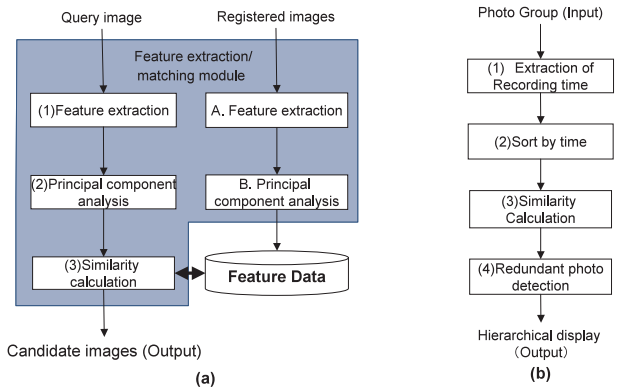

Fig. 2 Procedure of feature extraction and matching.

3.2 Event Grouping Module

This module groups the photos per event using the recording time, when the group of photos are specified. Users can browse photos efficiently with the users' memory about event. Users can also easily extract photos related to an event to be shared and browse in per-topic slideshows, etc.

Fig. 3 shows the flow of event grouping processing.

When a photo group is input, this module acquires the recording time from Exif (Exchangeable image file format) (step (1)). It then obtains the density distribution by summing up the pre-defined window function values on the time axis with reference to the recording time of each photo (step (2)). Finally, the module obtains the local minimum points of the density distribution and outputs the time of each local minimum point as an event boundary (step (3)).

The window function is defined considering the effect of each photo in the event.

The granularity/properties of an event can be managed by adjusting the shape, width and size of the window function. With this module, the user can adjust the granularity of the output events by specifying the size of the window function.

3.3 Redundant Photo Detection / Hierarchical Presentation Module

Fig. 2(b) shows the flow of redundant photo detection / hierarchical display processing. This module first extracts the recording time information, when a photo group is input (step

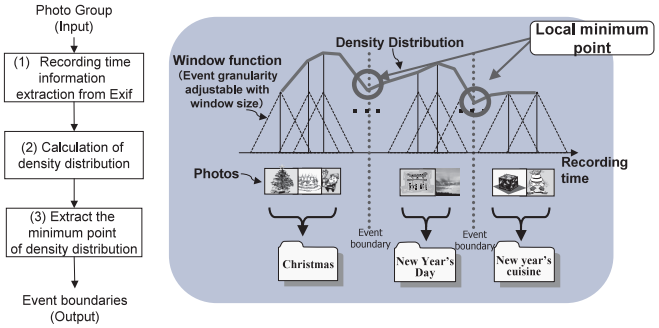

Fig. 3 Event grouping based on recording time analysis.

(1)). It then sorts the photos in the time axis (step (2)), calculates the similarity between the adjacent photos in order of recording time (step (3)), and detects them as redundant photos when the visual similarity between two time-adjacent photos is high (step (4)). The module displays the obtained redundant photos in piles hierarchically. Users can easily browse photos since the number of photos that a user must view in order to select a photo is decreased.

4. Application Examples

This section discusses the results of the application of the modules described in Section 3 above to actual private photos. For these evaluations, we focused on several users, each of whom prepared about 3,000 photos that had been recorded on various occasions including at parties, travel and hobbies, etc.

Fig. 4 shows the results of a similarity search when a user specifies photos showing cuisine. It shows that the system is capable of accurately capturing the visual features common to "cuisine" photos and finding them precisely as the candidate images. The similarity search is especially effective for listing the photos which has an inherent composition for each target type or the photos that the user has recorded successively in the same composition such as the photos of the collection items for hobby.

Fig. 5 shows the results of event grouping for a group of photos recorded on Nov. 21, 2004. These photos were recorded during a temple tour made and they are grouped according to the temples. Users can browse these photos per temple.

Fig. 5(b) shows the results of grouping with fine event granularity by adjusting the width of the window function. This makes it possible to browse photos of a temple by specifying a detailed event such as the gate, the inner sanctuary, a squirrel found during a walk, the garden or the colored leaves.

Fig. 5 (c) shows the output of the redundant photo detection

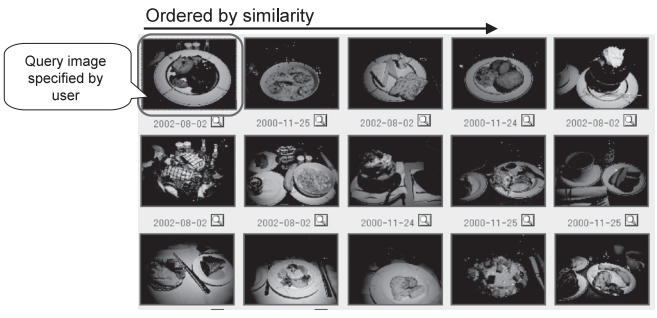

Fig. 4 Similar image search results.

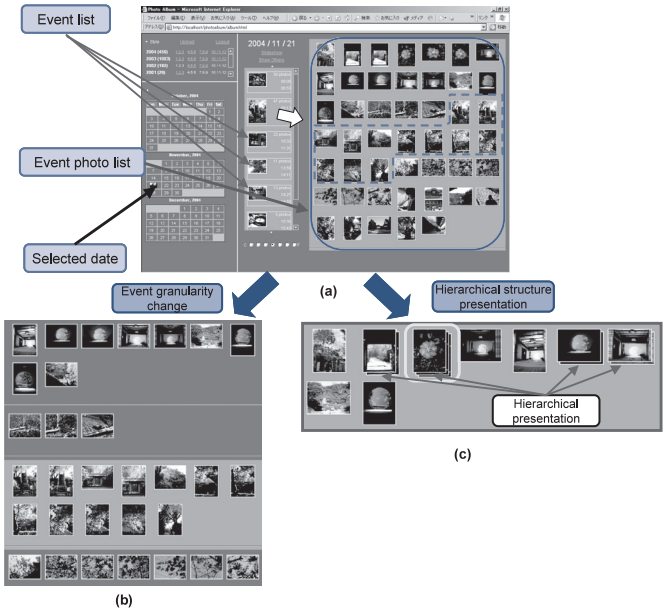

Fig. 5 Event grouping results and their hierarchical presentation.

/ hierarchical presentation module for the photo groups obtained with an event grouping .These results show that a hierarchical display of photos with similar compositions improves users' browsing.

5. Future Perspectives

This paper has introduced photo management functions for use in the effective filing and browsing of a large number of recorded photos.

Combining similarity search, event grouping and hierarchical presentation functions make it possible to search and browse photos effectively and efficiently. In the future, we will refine the configurations and functions of the modules in targeting embedded modules.

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