A Photograph Browser Applying Photomosaic

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Abstract
Photomosaic arranges many small photographs to represent a large image. Our study applies the photomosaic to a photograph browser CAT. Our implementation displays photomosaic while zooming out, and individual photographs while zooming in. Here, many photograph browsing software displays a set of photographs in the order of their times. To maintain this order of photographs, our photomosaic generation technique firstly arranges the given set of photographs in the order of their times, and then retouches so that the set of photographs forms a photomosaic-like scene. This paper presents our technique for photomosaic generation, and a user evaluation to discuss what kinds of photographs are preferable to be applied. We think this discussion should be fruitful for our future development of automatic photograph selection for photomosaic generation.

1. Introduction
We often store a large number of photographs due to the digitalization and downsizing of cameras. Photograph browsing [1][2][3] has been an active research topic which assists users to explore and browse the large number of photographs. We aimed the development of a new photograph browser featuring an artistic representation in addition to the all-in-one display of sets of photographs, because we think such features would make photograph browsing more enjoyable. Based on this discussion we focused on applying a photomosaic to the photograph browser. Photomosaic is a technique to generate large images representing particular scenes, by arranging large numbers of small images. We feel photomosaic is very artistic and enjoyable, because it looks like a particular scene of impressionism arts while zooming out, or a set of well-arranged scenes while zooming in.

This paper presents our study on application of photomosaic to a photograph browser CAT [1], which features a level-of-detail control with a zooming user interface. Supposing the given set of photographs are hierarchically clustered, CAT displays representative photographs of higher clusters while zooming out, or individual photographs in the clusters while zooming in. This feature effectively assists interactive exploration of large photograph collections. Here, our study replaces the representative photographs by the photomosaic images. The new photograph browser displays photomosaic images while zooming in, or individual photographs while zooming in. This feature improves the smoothness of the photograph replacement between representative and individual photographs.

The former part of this paper presents a new technique to generate photomosaic-like images and its application to CAT. The latter part of the paper introduces the user evaluation to discuss what types of photographs are suitable to be applied to the photomosaic generation in our study.

2. Related Work
2.1 Zooming interface for photo browser
This study applies a photograph browser CAT[1] which features a zooming user interface. We suppose that photographs are hierarchically clustered, and representative photographs are selected for each cluster. CAT places photographs in the rectangle subregions of the display space by applying a space-filling algorithm featured by a hierarchical data visualization technique "HeiankyoView"[4]. CAT also features a level-of-detail control technique with a zooming user interface. It displays representative photographs as shown in Figure 1(a)(b) while zooming out, and individual photographs as shown in Figure 1(c) while zooming in. Other existing photograph browsers such as PhotoMesa[2] also features automatic photograph placement algorithm and zooming user interface; however, we think CAT is better for our purpose because it displays representative photographs in the appropriately sized and shaped rectangular subregions while zooming out.

CAT had a problem that switch of displayed photographs may look very sudden. We expect this problem would be solved by applying photomosaic as representative images of the clusters.

2.2 Photo mosaic generation
Automatic photomosaic generation is an active research topic. AndreaMosaic [5] is an orthodox technique which selects small block
images based on color matching and places them in a reticular pattern. Gianpiero et al. [6] presented a unique technique which generates randomly edged small block images based on the edges of the original image, so that the generated photomosaic well preserves the edges and shapes in the original image. These photomosaic generation techniques arranges block images based on local similarity of colors and shapes. In other words, they do not consider the semantics and meta information of photographs for their arrangement. We think it is inconvenient to search for particular photographs. To solve the problem, this paper proposes a technique to generate photomosaic-like images from the sets of block images arranged in the order of timestamps.

Figure 1: Example of zooming operation of CAT. (a)(b) Display of representative images while zooming out. (c) Display of individual images when zoomed in.

3. Photomosaic generation for photo browsing

This section presents a new photograph browser which displays photomosaic images as representatives of clusters of photographs. This strategy makes interactive exploration of large photograph collection smoother.

This section calls the reference image for photomosaic generation "representative image", and a set of arranged small images "block images". The new technique for photomosaic-like image generation presented in this paper firstly arranges the given set of block images in the order of their timestamps, because it makes easier for users to look for particular images. The technique then retouches the arranged block images so that they look like the particular scene in the representative image. It repeats the arrangement of block images, if the number of blocks is larger than the number of block images.

The technique applies the HSB color system for block image retouch. The HSB color system describes colors by three variables: hue, saturation, and brightness. This technique calculates the RGB values of the each pixel of the final image, from the HSB values of representative and block images. Let the average HSB value of a block image \((h_1, s_1, b_1)\), the average HSB value of the corresponding block in the representative image \((h_2, s_2, b_2)\), and the ratio of saturation and brightness between the former and latter average values \(s_{12} = s_2/s_1\) and \(b_{12} = b_2/b_1\). This technique retouches the HSB value \((h, s, b)\) of a particular pixel by the following equations:

\[
\begin{align*}
    h &= h_2 \\
    s &= s \times s_{12} \\
    b &= b \times b_{12}
\end{align*}
\]

The above formulation substitutes the average hue of representative image to the hue of all pixels of the block. They also multiples the ratio of average saturation and brightness to the saturation and brightness of each pixel of the block image. This formulation preserves the silhouette of the scene of the block images while retouching the hue.

Figure 2 shows an example of a photomosaic generated by our technique. Figure 2(Upper) is the photomosaic generated from 174 photographs used as 60 by 45 pixels of block images. The
representative image is divided into 5,256 blocks, and therefore the block image arrangement process is repeated 30 times. Figure 2 (Lower) is a partial zoom-up of the photomosaic image. This zoom-up view shows that buildings or trees are taken in the block images. Their colors are much different from the colors of real buildings or trees, but we can recognize them from their silhouette in the block images. Our implementation displays the photomosaic images as a representative images of CAT. The switch of the displayed images from the photomosaic images to the independent images looks very smooth, because it just changes in the hue of the images.

4. User evaluation

It is important to reduce manual operations to make photograph browsers easier and convenient. Therefore, automatic representative image selection is an important problem for the photograph browsers featuring the zooming user interfaces. This problem itself is a very difficult problem, and therefore many studies [7] have been already presented.

Here, we found it is important to discuss the difference what kinds of photographs are preferable as representatives between general photographs and photomosaic. Therefore, we first conducted a user evaluation of the preferences of photomosaic images.

We showed photomosaic images generated by our technique to 28 subjects, and asked to answer the questions regarding the preference for photomosaic images; for example, “which representative image do you think the best to be the photomosaic?” as five-level rating evaluations. We prepared photograph collections of abroad trips, and generated several photomosaic images from each of the collections. We randomly selected four to eight pieces of photomosaic images for each question, which were made with our study are included.

Figure 3 shows an evaluation result of photomosaic images where one or more persons are taken in the original photographs. The result denotes that photographs which take too distant or close persons (e.g., close-up and group photographs) had relatively low rating. We suppose that photomosaic images may get bad impressions if the original photographs are focused only on human faces, because it is often difficult to identify who they are. We therefore think it should be careful to select photographs focusing only on human faces as representatives.

At the same time, we found that subjects joined to the trips or parties could identify the persons taken in the photomosaic images, while it was impossible to identify them for the other subjects who do know them. According to this, we suppose that showing photomosaic images instead of original photographs may lead to privacy protection. For example, it will be useful to develop a photograph browser on the Web, where everyone can see photomosaic images while zooming out, but the only users permitted the zooming operations can look at the photographs that compose the photomosaic images. While using this kinds of browsers on the Web, we can let every visitors know the mood of the events while protecting the personal information.

Figure 4 shows another evaluation result of photomosaic images where famous landmarks are taken in the original photographs. Big Ben and London Tower had relatively higher ratings among. We suppose the main reason of the higher rating is the contrast between the buildings and backgrounds, which makes the recognition of the landmarks easier, as well as these landmarks are famous. We suppose this knowledge may be useful for the automatic representative photograph selection, because it is possible to calculate the contrast between the buildings and backgrounds. This strategy is also good to avoid to select too dark or single colored photographs as representatives.

5. Conclusion

The former part of this paper presented a photomosaic browser applying photomosaic images. This technique displays photomosaic images as representative images on a photograph browser CAT. It realizes smooth switch of displayed images by applying photomosaic images rather than original photographs. Moreover, we think this approach realizes more artistic photograph browsing.

The latter part of this paper introduced a user evaluation to determine what kinds of photomosaic images are preferable for representative images of the photograph browsing. We found that photographs focused only on human faces got relatively lower ratings, because it is generally difficult to identify who are taken from the
photomosaic images. However, these images even got higher ratings from subjects who know the taken persons. We supposed that preference of the representative photograph selection depend on the possibility of identification of taken persons, according to the free comments of the subjects. We discussed this aspect can be applied to the development of privacy preserving photograph browsers. We would like to discuss to develop this photograph browser as open communication tools on the Web. At the same time, we found that photomosaic images of landmarks got higher ratings if contrast between buildings and backgrounds are clearer. We expect this aspect can be applied to the development of automatic representative image selection from the contrast between foreground objects and background scenes.

In addition to the above discussions, we have the following future issues. We would like to improve CAT for more smooth switch of the images while the zooming operations. Also, we would like to adjust the photomosaic image generation technique with user experiments.

References


