Interactive Photomosaic System Using GPU

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ABSTRACT

A photomosaic is a type of decorative art made up from various other photographs. We present a method for quickly generating photomosaics and propose an interactive recursive photomosaic system. Users can operate the system by using a large display with a touch input function, which allows them to alter the appearance of the image dynamically.

Categories and Subject Descriptors

I.4.9 [**Image Processing and Computer Vision**]: Applications

General Terms

Algorithms, Experimentation

Keywords

Photomosaic, GPU

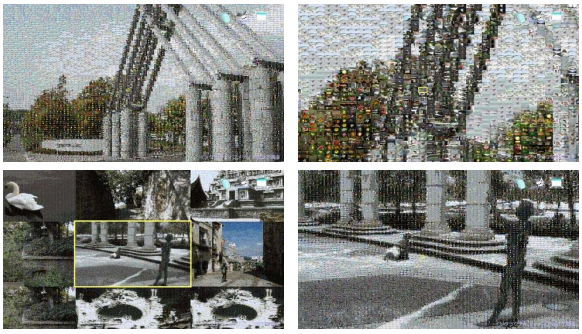

Figure 1: Scaling up by the recursive photomosaic

1. INTRODUCTION

Recent advance of a display that mainly used to provide informations to user gives us a high resolution representation such as high-definition (HD). The resolution of the display will become more higher, e.g. 4K, Ultra High definition (UHD). On the other hand, contents for such display is the one just enhance the resolution of existing contents. Although the high resolution itself would give a new experience to a user, we need a new content making use of the feature of the high resolution display.

We focus on a robustness against the distance between the display and the viewpoint, which is one of the important feature of the high resolution display. This demonstration uses a photomosaic as a content that it make use of the feature. The photomosaic is a type of decorative art made up from various other photographs. An original image is divided into small rectangular tiles and then each tile is replaced with a tile image chosen from a large number of other images based on color similarity. Impression of the photomosaic changes depend on the distance. We recognize it as a array of different images in short distance, whereas the original image would be cognized in long distance. The high resolution display can represent this feature of the photomosaic because we can recognize the each images even if the distance is very short.

The photomosaic had been applyed to some applications, such as video[3], navigation[2]. Our main purpose is to develop an interactive application for exploring new way that make use of the feature of the display with high resolution. To this purpose we develop a fast generation method of the photomosaic with parallel computation using GPU and propose an interactive photomosaic system with a touch-screen display. Our system generates the photomosaic in real-time and draw it to screen. The user can select any tile and the system scaling up the image. Futhermore, the system calculates the new photomosaic from the selected tile image at the moment of touch operation, then display it as the scaling up image to give a new experience to user. We demonstrate our system by using a large touch-screen display.

MM'12, October 29–November 2, 2012, Nara, Japan.
ACM 978-1-4503-1089-5/12/10.

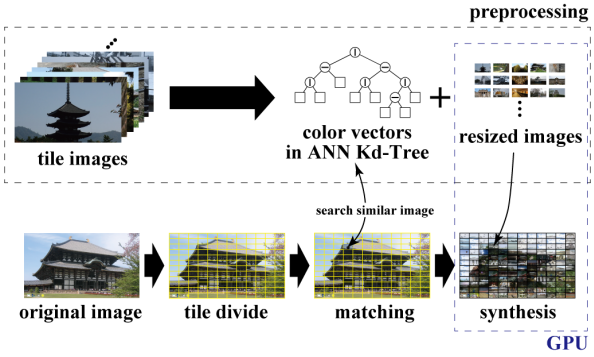

Figure 2: Procedure of photomosaic generation

2. PHOTOMOSAIC GENERATION

Our system make a photomosaic in real-time to achieve interactivity and recursiveness. In this section, we explain about our photomosaic generation method.

Tran[4] generated the photomosaic by comparing all pixels of the tile image to find a most similar image. But the method is unsuitable to apply to interactive applications due to high computational cost. Di Blasi et al.[1] proposed a method that uses a color vector with 27D for matching. They divided the tile image into 9 regions (3×3) and calculated the vector by taking the average of the RGB color of each region. Their method consists of 3 steps: 1) calculation of the color vector, 2) tile image matching, 3) synthesis of final image (photomosaic) and drawing. The main bottleneck of computation is the photomosaic synthesis and drawing when you want to use high resolution images. We speed up the process by using GPU.

The procedure of our method is below.

1. The color vectors of all images in database are calculated and stored in Approximate Nearest Neighbor (ANN) Kd-tree for the matching. Moreover, the system makes resized images whose size is same to the tile (w_t, h_t). Each resized image are realigned in 1D array and a 2D texture image that has a resized image in a line is transfered to GPU memory. These processes are done as preprocessing.

2. The images similar to each tile region are searched according to the color vector. The original image is divided into $n \times m$ regions and calculate the color vector of each tile region. The searching is done by ANN Kd-tree in real-time even if we just use CPU for calculation.

3. The photomosaic is synthesized in GPU by using the matching result and the resized images precomputed in first step. The pixel shader is used to make the final image. The system transfer the result of matching to GPU as a texture that the size is $n \times m$.

Fig.2 shows these processes. We designed above steps so that the amount of data tranfer between CPU and GPU might decrease because it will take long time to send the data to GPU.

Figure 3: Picking up the tile image using touch panel

3. RECURSIVENESS

In our system, the user can select the tile image from displayed photomosaic image. In order to give new experience, We add the recursiveness to the photomosaic. When a tile is selected, the system quickly make a photomosaic of the tile image and then display the photomosaic instead of the original tile image with a zooming effect. The user will feel as though the photomosaic is consist of another photomosaics. Fig.1 shows the snapshots during the scaling up process. Images around the selected tile will also be replaced by the photomosaic to prevent unnatural feeling during the zooming.

4. DEMONSTRATION

We explain the set up of the demonstration. We use 65inch PDP with touch-screen to display the generated photomosac and to realize the selection of a tile (Fig.3). The touch operation result sends to the PC equipping the GPU to get the index of the selected tile. Finally, a photomosaic is displayed with zooming effect. By using our algorithm, the system can generate the photomosaic in 1/20 sec. Moreover, we provide the online video photomosaic generation with a video camera as an application of real-time photomosaic generation.

5. CONCLUSIONS

We developed a fast method for generating a photomosaic using GPU and propose the interactive photomosaic system with a touch-screen display to explore the new way that make use of the robustness of the high resolution. Future works includes more speeding up by GPU implementation of matching, a photomosaic with adaptive tile size.

6. REFERENCES

[1] G. Di Blasi, G. Gallo, and M. P. Petralia. Smart ideas for photomosaic rendering. In *Proceedings of Eurographics Italian Chapter Conference*, 2006.

[2] K. Kim, I. Essa, and G. D. Abowd. Interactive mosaic generation for video navigation. In *MULTIMEDIA '06: Proceedings of the 14th annual ACM international conference on Multimedia*, pages 655–658, 2006.

[3] A. W. Klein, T. Grant, A. Finkelstein, and M. F. Cohen. Video mosaics. In *NPAR 2002: Second International Symposium on Non Photorealistic Rendering*, pages 21–28, June 2002.

[4] N. Tran. Generating photomosaics: an empirical study. In *SAC '99: Proceedings of the 1999 ACM symposium on Applied computing*, pages 105–109, 1999.