Information Sciences 372 (2016) 347–358

Contents lists available at ScienceDirect

Information Sciences

journal homepage: www.elsevier.com/locate/ins

Saliency-based stereoscopic image retargeting

Yuming Fang[a], Junle Wang[b], Yuan Yuan[c], Jianjun Lei[d,*], Weisi Lin[c], Patrick Le Callet[b]

[a] School of Information Technology, Jiangxi University of Finance and Economics, Nanchang, China
[b] IRCCyN UMR CNRS 6597, Polytech Nantes, Nantes, France
[c] School of Computer Engineering, Nanyang Technological University, Singapore
[d] School of Electronic Information Engineering, Tianjin University, Tianjin, China

ARTICLE INFO

Article history:
Received 25 May 2016
Revised 13 August 2016
Accepted 17 August 2016
Available online 18 August 2016

Keywords:
Stereoscopic 3D
Visual attention
Saliency detection
Stereoscopic image retargeting
Image retargeting

ABSTRACT

In this paper, we propose a new saliency based stereoscopic image retargeting method based on the characteristics of the Human Visual System (HVS). A new stereoscopic saliency detection method is designed by adopting low-level features of intensity, color, texture and depth. Besides, the viewing bias factors including center bias and depth bias existing in the HVS are adopted for stereoscopic visual attention modeling. Since the HVS is sensitive to edges in images, we fuse the saliency and edge maps to predict the visual significance of image pixels for image resizing. With the visual significance measure, we propose an image resizing method by minimizing the structure and depth distortion for stereoscopic image retargeting. Experimental results have shown that both our stereoscopic saliency detection and image retargeting methods can obtain better performance than the existing related methods on the public databases.

© 2016 Elsevier Inc. All rights reserved.

1. Introduction

In the past decade, stereoscopic 3D has received much attention due to the development of display technologies. With the emergence of different types of 3D content and display devices, the methods of converting 3D visual content from the original size to different sizes or aspect ratios are much desired. Image/video retargeting algorithms aim to change the size or aspect ratio of the input image/video to satisfy the requirement of various display devices. Compared with traditional 2D visual content, stereoscopic visual content can provide an additional dimension of depth which leads to more enjoyment for users. However, this additional dimension would also bring along additional challenges and constraints for the quality of experience of 3D visual content.

With the emerging smart devices, it is important to improve the visual quality experiences on these devices. Generally, the screen sizes of mobile devices such as mobile phones is limited. In addition, the aspect ratios of various mobile devices are always different. To obtain good viewing experiences, the images have to be converted into smaller ones to be displayed on mobile devices with smaller screen sizes or different aspect ratios. Even though technological development might improve the resolutions of mobile devices, the physical regions of their display screens are still small with different aspect

* Corresponding author.
E-mail addresses: fa0001ng@e.ntu.edu.sg (Y. Fang), wangjunle@gmail.com (J. Wang), yyuan004@e.ntu.edu.sg (Y. Yuan), jjleitg@gmail.com, jjlei@foxmail.com (J. Lei), wslin@ntu.edu.sg (W. Lin), patrick.lecallet@univ-nantes.fr (P.L. Callet).

http://dx.doi.org/10.1016/j.ins.2016.08.062
0020-0255/© 2016 Elsevier Inc. All rights reserved.

ratios. Thus, image/video retargeting algorithms can be used to resize images to improve viewing experiences on mobile devices.

Traditional image scaling and cropping methods might cause serious distortion or important information loss in retargeted images [30,35]. To handle these drawbacks, various content-aware image retargeting methods [35] are proposed to resize images. Generally, these methods are different from each other in the following aspects: the calculation method of the importance map adopted to predict the importance of image pixels for image resizing operation, and the distortion measure for image resizing operation. Although there have been many retargeting methods designed for 2D images recently [35], there is little research on 3D retargeting for stereoscopic images in the literature. Different from 2D visual content, the depth information and potential constraints from 3D perception might cause large challenge for the importance map calculation and image retargeting operation.

In this study, a novel image retargeting algorithm is designed specifically for stereoscopic 3D images. The proposed algorithm aims to obtain the retargeted results by using a stereo image pair and its disparity map computed by the disparity prediction algorithm or depth range sensor. A new stereoscopic visual attention model is built to predict the saliency map of stereoscopic images, which is used to estimate the significance of image pixels during image retargeting. The proposed model computes the feature contrast from intensity, color, texture and depth for image saliency prediction. Additionally, we take various viewing bias existing in the Human Visual System (HVS) into account. Recent research studies have demonstrated that the factors of the central fixation bias [33,34] and depth bias [21,39,40] exist in the HVS and we model these viewing bias factors in our stereoscopic saliency detection method. Since the HVS is sensitive to edges in images, we fuse the saliency and edge maps to predict the significance of image pixels in stereoscopic images. With the calculated significance map, a stereoscopic image retargeting method is designed to resize the original stereoscopic images, where both depth perception distortion and visual structure distortion are minimized. The preliminary results of our work are shown in the study [38]. Compared with that study [38], we have provided more introduction and analysis on the related studies, the technical content and the comparison experiments in this paper. The proposed stereoscopic saliency detection method is evaluated by the comparison experiments using other related methods on public eye tracking data. Also, to demonstrate the advantages of our stereoscopic image retargeting algorithm, we conduct the comparison experiments between the proposed stereoscopic image retargeting algorithm and other existing ones. Experimental results have shown both the proposed stereoscopic saliency detection and image retargeting methods can obtain better performance than other related ones.

2. Related work

2.1. Saliency detection

Most existing image retrageting methods use the saliency map to predict visual significance of image pixels during image resizing. Generally, there are two key steps in most saliency detection methods: feature extraction and saliency calculation. The first step extracts different features from images, while saliency map is predicted by the extracted features based on different approaches such as characteristics of the HVS and machine learning techniques. In the literature, there have been some saliency detection models proposed for stereoscopic image processing applications. Current stereoscopic image retargeting methods mostly use 2D saliency detection models for saliency extraction. In the past decades, many visual attention models [3,25,27,32,44] have been proposed for various applications, including video coding [42], image classification/retrieval [46,47], object segmentation [24], object tracking [36], cloud-based applications [18,19], *etc*.

Itti et al. designed an early computational visual attention model for images [20]. In that model, the feature contrast is computed to obtain feature maps from intensity, color and orientation. To better predict the feature dissimilarity, many other visual attention methods are designed by improving the model in [20]. Harel et al. used graph theory to estimate the pixel saliency by improving Itti's model [16]. Bruce et al. adopted Shannon's self-information theory to design the saliency detection model [5]. By exploring more properties of the HVS, Le Meur et al. designed a visual attention model for images [26].

The visual attention methods can also be designed in the frequency domain. By using the concept of Spectral Residual, Hou et al. proposed a visual attention method in Fourier domain [17]. Inspired by this research work, researchers have proposed various saliency detection models in frequency domain [3]. Most of these saliency detection models are efficient due to the rapid operation in frequency domain. However, these models are not effective in salient object detection. To address this drawback, patch-based visual attention models have been designed based on the center-surround feature differences between image patches [12,14,15,49]. Goferman et al. calculated intensity and color contrast between small patches to build a context-aware visual attention model [15]. Fang et al. designed a visual attention model by center-surround differences between DCT (Discrete Cosine Transform) coefficients of image patches.

Recently, some studies have shown that the salient region extracted by depth information is important in visual attention modeling for stereoscopic images [37]. Therefore, it is highly desired to build new visual attention models of stereoscopic images by adopting depth feature and integrate it into the stereoscopic image retargeting method. In the literature, there are several studies investigating visual attention modeling for stereoscopic images [22,28,37]. Some stereoscopic image saliency methods (such as [48] and [8]) first adopt 2D low-level features (such as luminance and color) to predict 2D saliency, and then use the disparity map as a weighting factor to 2D saliency. The problem with these methods is that the depth feature is not used as the low-level feature like others such as color and intensity during visual attention modeling. Some

Download English Version:

https://daneshyari.com/en/article/4944772

Download Persian Version:

https://daneshyari.com/article/4944772

Daneshyari.com