A Nonuniform Method for Extracting Attractive Structures From Images

Yiyang Wang, School of Mathematical Sciences, Dalian University of Technology, Dalian, China
Zhiying Jiang, School of Software Technology, Dalian University of Technology, Dalian, China
Zhixun Su, School of Mathematical Sciences, Dalian University of Technology, Dalian, China

ABSTRACT
This article describes how attractive structures are always correspond to objects of interest in human perception, thus extracting attractive structures is a fundamental problem in many image analysis tasks, which is of great practical importance. In this article, the authors propose a novel nonuniform method to maintain the attractive structures of images while removing their meaningless details. Different from the existing norm based operators that are a uniform method proposed on regular image grids, our nonuniform method is not limited to special type of datum and grid structure, which has better performance for image analysis tasks. Besides, a strategy based on proximal algorithms is put forward to obtain fast convergence in practice due to the nonconvex and nonsmooth property of the corresponding optimization. Though the model with our proposed nonuniform operator can be used for various applications, the authors chose the tasks of image smoothing and saliency detection to demonstrate the good performances of our nonuniform method and show its superiority against other state-of-the-art alternatives.

KEYWORDS
Attractive Structure, Edge Extract, Image Analysis, Image Smoothing, L0 Regularization, Nonconvex Optimization, Nonuniform Method, Proximal Alternating Algorithm, Saliency Detection

INTRODUCTION
When we look at an image, attractive structures often draw our immediate attentions at a glance without scanning the entire image systematically. Furthermore, the distribution of attractive structures is a strong indication to help us immediately concentrate on objects of interest in the image, which appears to play a vital role in various image analysis tasks like object recognition (Cheng, Zhang, Lin, & Torr, 2014), segmentation (Zhang, Zheng, & Cai, 2010) and blur estimation (Shi, Xu, & Jia, 2015).

Benefiting from structures extraction, the applications play an important part in image analysis, many efforts have been carried out to extract the attractive and meaningful structures based-on different purposes. Local filters, like bilateral filtering (BF) (Tomasi & Manduchi, 1998) is proposed for removing noise-like structures while maintaining significant edges by means of a nonlinear combination of nearby image value. In (Zhang, Zheng, & Cai, 2010), Zhang et al. partition the image along semantically meaningful edges by designing an anisotropic diffusion framework for preserving

DOI: 10.4018/IJGHPC.2018070102
attractive structures which considers the seeds pixels as the heat sources and the heat diffusion producing from the source. Shi et al. (2015) propose an effective method based on dictionary learning to extract the attractive structures in partially blurred image after they found with an addictive manner decomposing a local image patch into dictionary atoms, clear and unclear dictionaries show different results quantitatively and visually. As one of the most well-known edge-preserving operators, Total Variation (TV) (Rudin, Osher, & Fatemi, 1992) whose solution can be obtained by the gradient-projection method is widely used in optimization frameworks to extract attractive structures for subsequent tasks. However, Xu et al. (2011) propose an $L_0$ norm based operator which favors piecewise results and does not penalize large gradient magnitudes as TV does.

We in this paper propose a nonuniform method of attractive structures extraction and we name it as NEAS. It is worth mentioning here that our approach is not designed for edge extraction only but for the image analysis tasks that benefit from the extraction of attractive structures (see Figure 1). In other words, extracting the attractive structures is not the ultimate purpose of NEAS but an important latent process, which could be combined with fidelity term in optimization models for various image analysis tasks. By observing we can know that the attractive structures in the image include diverse intensities and directions, therefore extracting them in a uniform way may remove tiny but meaningful structures mentioned above. Hence, we extract the attractive structures non-uniformly by adding specific weight to take both intensity and direction into consideration. Moreover, NEAS is not restricted to certain datum and structure type of the image. For example, it can be applied to image smoothing which treats pixel and edge (Figure 1 (c)) as the basic datum and structure of the image. On the other hand, NEAS can also be used to saliency detection which benefits from region-based attractive structures with constrained priors (Figure 1 (d)) of the image and regards superpixel as its basic datum type. Furthermore, due to the non-convexity and non-smoothness of the optimization of NEAS, we propose to use a proximal algorithm with penalty updating strategy to ensure a relatively stable performance and get a faster convergence speed. The experimental results on applying NEAS for image smoothing and saliency detection show its superiority against other state-of-the-art alternatives.

**RELATED WORK**

There are plenty of methods proposed for image analysis tasks like image smoothing and saliency detection which need attractive structure extraction as a latent process. The following is an introduction of representative approaches for the two tasks respectively. And for the problem of $L_p$ regularization, there is also a brief review.

Figure 1. Example on (a) input image and its (b) edge extraction. For the image analysis tasks: (c) image smoothing and (d) saliency detection, we show the maintained attractive structures in the small window of each image.
Location Update Improvement Using Fuzzy Logic Optimization in Location Based Routing Protocols in MANET
[www.igi-global.com/article/location-update-improvement-using-fuzzy/56352?camid=4v1a](www.igi-global.com/article/location-update-improvement-using-fuzzy/56352?camid=4v1a)

Security Aspects in Utility Computing
[www.igi-global.com/chapter/security-aspects-in-utility-computing/139847?camid=4v1a](www.igi-global.com/chapter/security-aspects-in-utility-computing/139847?camid=4v1a)