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Mesh saliency via ranking unsalient patches in a descriptor space

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ABSTRACT

This paper presents a novel mesh saliency detection approach based on manifold ranking in a descriptor space. Starting from the over-segmented patches of a mesh, we compute a descriptor vector for each patch based on Zernike coefficients, and the local distinctness of each patch by a center-surround operator. Patches with small or high local distinctness are named as background or foreground patches, respectively. Unlike existing mesh saliency methods which focus on local or global contrast, we estimate the saliency of patches based on their relevances to some of the most unsalient background patches, i.e. background patches with the smallest local distinctness, via manifold ranking. Compared with ranking with some of the most salient foreground patches as queries, this improves the robustness of our method and contributes to make our method insensitive to the queries estimated. The ranking is performed in the descriptor space of the patches by incorporating the manifold structure of the shape descriptors, which therefore is more applicable for mesh saliency since the salient regions of a mesh are often scattered in spatial domain. Finally, a Laplacian smoothing procedure is applied to spread the patch saliency to each vertex. Comparisons with the state-of-the-art methods on a wide range of models show the effectiveness and robustness of our approach.

1. Introduction

Visual saliency is an important and fundamental research problem in neuroscience and psychology to investigate the mechanism of human visual systems. It has also been an attractive topic in computer vision and computer graphics in recent years. Mesh saliency reflects perceptually important points or regions of polygonal meshes. While mesh saliency may not outperform some differential geometry measures, such as curvature, as a mesh feature in all the applications, it has great value for human centered visual computing applications, such as abstraction [1], simplification [2], smoothing [3], illumination [4], shape matching [5], rendering [4] and viewpoint selection [6–9], especially with the rapid growth of number and size of 3D models.

Although there has been significant progress in mesh saliency detection, most previous works depend on a local center-surround operator [10–12] and multi-scale computation [2,3,5,13]. They tend to be susceptible to noise. For example, Refs. [2,10–12] simply select regions where the curvature of a surface vertex or patch is different from its immediate neighbors. The computation of curvature employed by these methods is sensitive to noise. Ref. [3] proposes a novel approach for mesh saliency estimation considering both local contrast and global rarity, which is robust against noise. However, it is not easy to tune the parameters to obtain faithful results. Leifman et al. [13] choose 20% of the most distinct vertices and extreme vertices as focus points. Regions that are close to the focus points catch more attention than faraway regions. But some salient regions, the distinctness of all vertices within which is less than 20%, will be missed. Furthermore, the multi-scale operation employed in the above methods may only alleviate the influence of noise to some degree.

To handle the aforementioned problems, we propose a novel, simple and robust method for detecting regions of interest on surfaces. Visual forms may possess one or several centers of gravity about which the form is organized [13]. Human attention is firstly attracted by the most representative salient elements (we name them as saliency queries) and then the visual attention will be transferred to other regions [14]. We employ a semi-supervised algorithm, manifold ranking, to imitate the process. First, we oversegment a mesh into patches and compute a descriptor for each of them via Zernike coefficients, which is more informative and robust than curvature. Then the distinctness of each patch is estimated locally using these descriptors. Instead of selecting some foreground patches such as saliency queries, patches with the smallest distinctness values, i.e. some of the most unsalient background patches, are chosen as queries to improve the robustness

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of our method. With these queries and a self-adapting graph defined in the descriptor space of patches, the saliency of all the patches is determined using manifold ranking. Ranking in the descriptor space is more applicable for mesh saliency since the salient regions of a mesh are usually scattered in the spatial domain. Finally, we use simple Laplacian smoothing to spread the patch saliency to vertex saliency. The patch descriptor and the strategy to generate the queries together contribute to make our

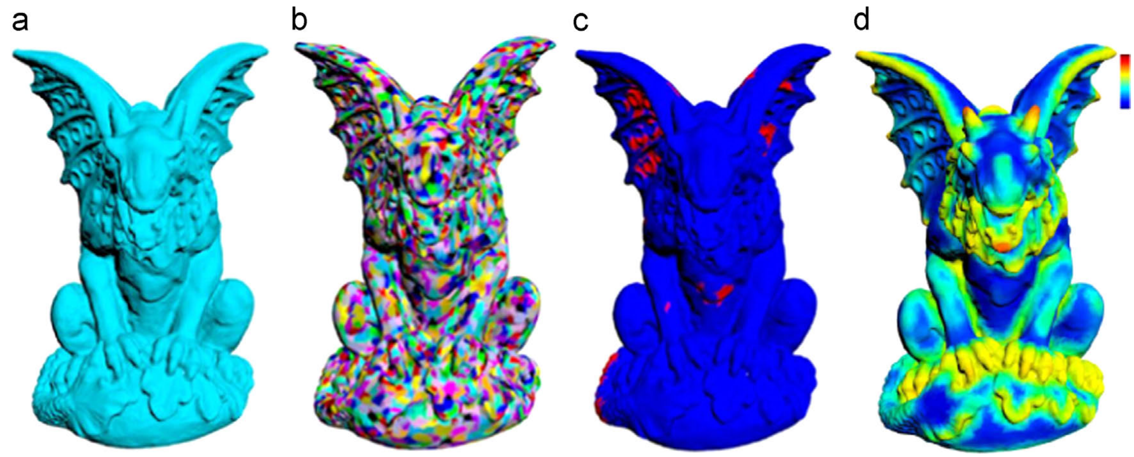

Fig. 1. Method overview. (a) Input mesh. (b) Over-segmentation. (c) Some of the most unsalient background patches (red). (d) Mesh saliency. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this paper.)

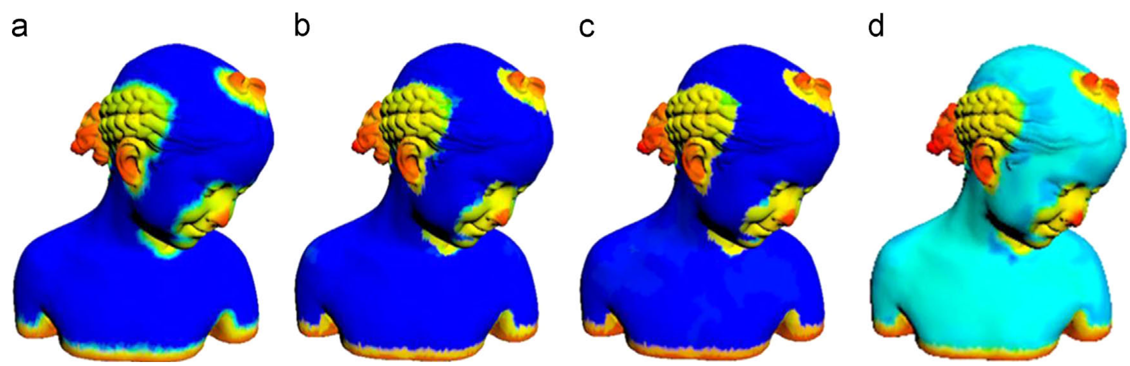

Fig. 2. Our method is robust to patch numbers. From left to right, the patch numbers are 3924, 1970, 902 and 772.

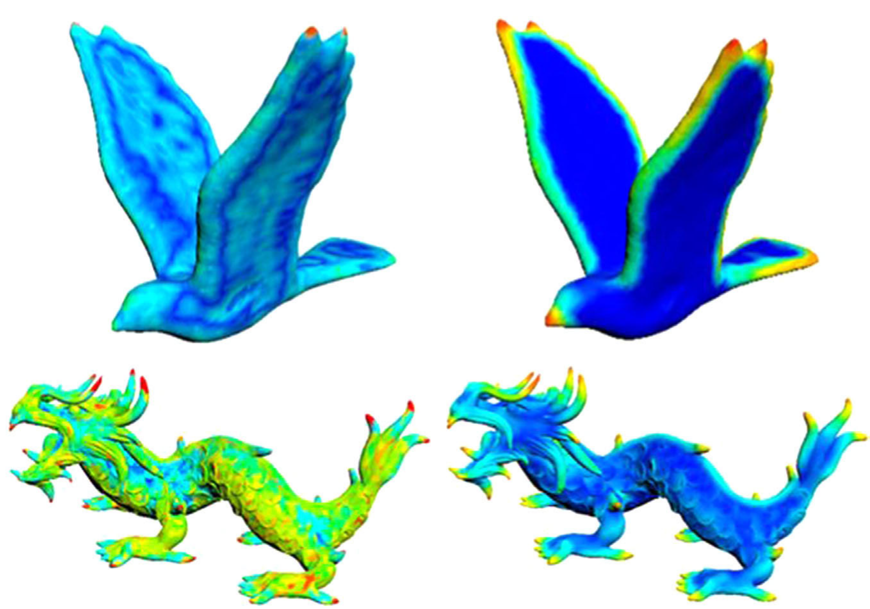

Fig. 3. Mesh saliency via ranking with curvature-based patch descriptor (the left column) is sensitive to local geometry, while using Zernike-based patch descriptor (the right column) is more tidier and faithful.