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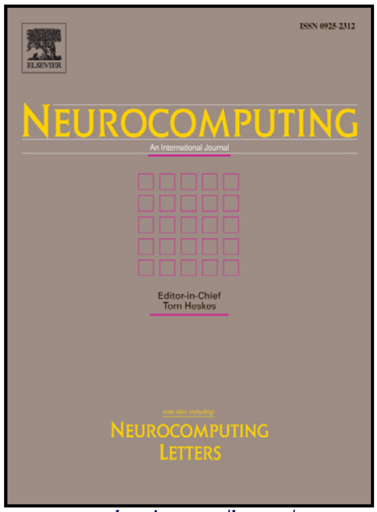

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Shape Analysis based on Feature-preserving Elastic Quadratic Patch Modeling

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Abstract: An explicit shape representation, which is robust to noise and feature-preserving, is important to various tasks such as shape analysis and image processing. Elastic Quadratic Wire (EQW) is a recently proposed spline based shape representation model. It is particularly highlighted for good capacity in eliminating shape noises and preserving salient shape features, but is limited in representing only 2D planar shapes. In this study, we extend the EQW model into an Elastic Quadratic Patch (EQP) model to represent 3D parametric surfaces. In our model, we construct a planar overlapping parameterization space and represent all the surface points by quadratic patches. We then form the 0^{th} and 1^{st} order discontinuities between the neighboring patches into a quadratic energy function with an analytic minimal value. Therefore, the shape can be gradually fitted using an efficient iterative style. In experiments, we validate the EQP model in terms of efficient computation, effects on the adjustable parameter selection and performance in de-noising and preserving features. Experimental results on 3D facial surfaces demonstrate that our EQP model inherits all the strong points of the seminal EQW model, and is comparable or better than other frequently-used models in the shape smoothing task.

Keywords: Elastic Quadratic Patch, Elastic Quadratic Wire, Parametric surface, Shape representation, Shape smoothing

1 Introduction

The shape of a real-world object is one of its basic visual attributes, and reveals geometric properties of the object's boundary. It plays important roles in image processing and computer vision tasks e.g. object segmentation [1], image classification [2], object recognition [3] and shape analysis [4], to name but a few. On the one hand, shapes themselves can be of the central role in tasks such as shape retrieval [5] and correspondence computing [6]. On the other, shapes can be regarded as geometric regularizers for ill-posed problems in image analysis by extracting their statistical properties [7].

In the above mentioned research, constructing or choosing a proper shape representation forms the backbone in these fields. In the following, we briefly review the main shape representation methods. In digital images and computer graphics, a subset of points, as well as their connections, sampled from the original boundary/surface in 2D/3D is a most fundamental way to represent shapes. This representation is usually preferred in tasks which make use of explicit morphologies to constrain the model evolution or minimize the imaging noise. For

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