CCIT Report #621

May 2007

LOCAL VERSUS GLOBAL IN QUASI-CONFORMAL MAPPING FOR MEDICAL IMAGING

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Abstract. A method and algorithm of flattening of folded surfaces for two-dimensional representation and analysis of medical images are presented. The method is based on extension of classical results of Gehring and Väisälä regarding the existence of quasi-conformal and quasi-isometric mappings.

The proposed algorithm is basically local and, therefore, suitable for extensively folded surfaces encountered in medical imaging. The theory and algorithm guarantee minimal distance, angle and area distortion. Yet, it is relatively simple, robust and computationally efficient, since it does not require computational derivatives. Both random starting point and curvature-based versions of the algorithm are presented.

We demonstrate the algorithm using medical data obtained from real CT images of the colon and MRI scan of the human cortex.

Further applications of the algorithm, for image processing in general are also considered.

Moreover, the globality of this algorithm is also studied, via extreme length methods for which we develop a technique for computing straightest geodesics on polyhedral surfaces.

1. Introduction

2D representation by flattening of 3D object scans is a fundamental step, required in medical volumetric imaging. For example, it is often required to present three-dimensional fMRI scans of the brain cortex as flat two-dimensional images. In the latter case it is possible, for example, to better observe and follow up developments of neural activity within the folds. Flattening of 3D-scans is in particular important in CT virtual colonoscopy; a non-invasive, rapidly advancing, imaging procedure capable of determining the presence of colon pathologies such as small polyps [16]. However, because of the extensive folding of the colon, rendering of the 3D data for detection of pathologies requires the implementation of cylindrical or planar map projections [17]. In order to map such data in a meaningful manner, so that diagnosis will be accurate, it is essential that the geometric distortion, in terms of angles and lengths, caused by the representation, will be minimal. Due to these medical applications, this problem has attracted a great deal of attention in the last few years.

Date: March 20, 2007.