

ESTIMATION OF CURVATURES IN POINT SETS BASED ON GEOMETRIC ALGEBRA

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Abstract: For applications like segmentation, feature extraction and classification of point sets it is essential to know the principal curvatures and the corresponding principal directions. For the purpose of curvature estimation conformal geometric algebra promises to be a natural mathematical language: Local curvatures can be described with the help of osculating circles or spheres. On one hand, conformal geometric algebra is able to directly compute with these geometric objects, as well as with lines and planes needed for the description of vanishing curvature. On the other hand, distance measures for fitting these objects into point sets can be handled in a linear way, leading to efficient algorithms. In this paper we use conformal geometric algebra advantageously in order to locally compute continuous curvatures as well as principal curvatures of point sets without the need of costly pre-processing of raw data. We show results on artificial and real data. Numerical verification on artificial data shows the accuracy of our approach.

1 INTRODUCTION

The curvature of a surface is a feature which describes local surface properties in a well defined manner. Each certain location has a minimal and a maximal principal curvature with orthogonal principal directions. In (Alliez et al., 2003) this information is used to obtain lines of curvature and umbilical points as basis for a remeshing of surfaces. Other domains are feature extraction for local comparison of shapes (Gatzke et al., 2005), classification, registration or for instance the estimation of surface properties such as surface roughness (Lavoue, 2007) which uses this measure for object segmentation. Therefore, curvature estimation has become an important topic of research (Kalogerakis et al., 2007; Yang et al., 2006). Point set surfaces are very popular in computer graphics because they are powerful surface representations based on raw scanner data (Gross and Pfister, 2007), although it requires some effort to reconstruct the surface from these (noisy) point clouds (Hornung and Kobbe, 2006; Mederos et al., 2005; Kollari et al., 2004; Mitra et al., 2004; Adamson and Alexa, 2003). As a consequence, computing curvatures from

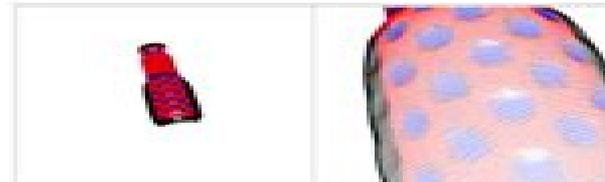


Figure 1: Point rendering of shape index estimated from a point, the shown point-set is the raw output of a structured light reconstruction system without preprocessing like smoothing or reduction. A pattern of concave areas and some noise caused by the reconstruction process can be observed at the surface of the bottle. The proposed algorithm extracts the curvature on a local neighborhood yielding a basis for object segmentation or feature detection.

point clouds without explicitly computing the surface (-mesh) is extremely difficult. Approaches to tackle this problem use statistics (Kalogerakis et al., 2007), or fitting of quadratic functions as local polynomial (Gois et al., 2006). In order to determine local cur-

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