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 Kobbelt, 2006; Mederos et al., 2005; Kolluri et al., 2004; Mitra et al., 2004; Adamson and Alexa, 2003). As a consequence, computing curvatures from
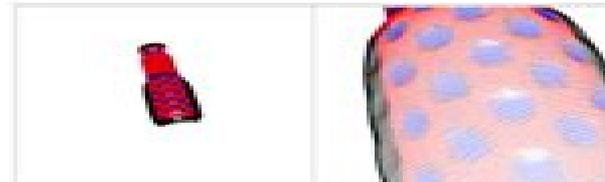

Figure 1: Point rendering of shape index estimated from a point, the shown point-set is the raw output of a structured light reconstruction system without preprocessing like smoothing or reduction. A pattern of concave areas and some noise caused by the reconstruction process can be observed at the surface 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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   Cognitive Cities Jian Shen,Yao-Chung Chang,Yu-Sheng Su,Hiroaki Ogata,2020-06-19 This book constitutes refereed proceeding of the Second International Cognitive Cities Conference IC3 2019 held in Kyoto Japan in September 2019 The 37 full papers and 46 short papers were thoroughly reviewed and selected from 206 submissions The papers are organized according to the topical sections on cognitive city for special needs cognitive city theory modeling and simulation XR and educational innovations for cognitive city educational technology and strategy in cognitive city safety security and privacy in cognitive city artificial intelligence theory and technology related to cognitive city Internet of Things for cognitive city business application and management for cognitive city big data for cognitive city engineering technology and applied science for cognitive city maker CT and STEAM education for cognitive city   **Point-based Graphics 2007** Matthias Zwicker,2007   **Curves and Surfaces** Jean-Daniel Boissonnat,Patrick Chenin,Albert Cohen,Christian Gout,Tom Lyche,Marie-Laurence Mazure,Larry Schumaker,2012-01-07 This volume constitutes the thoroughly refereed post conference proceedings of the 7th International Conference on Curves and Surfaces held in Avignon in June 2010 The conference had the overall theme Representation and Approximation of Curves and Surfaces and Applications The 39 revised full papers presented together with 9 invited talks were carefully reviewed and selected from 114 talks presented at the conference The topics addressed by the papers range from mathematical foundations to practical implementation on modern graphics processing units and address a wide area of topics such as computer aided geometric design computer graphics and visualisation computational geometry and topology geometry processing image and signal processing interpolation and smoothing scattered data processing and learning theory and subdivision wavelets and multi resolution methods

   Computer Aided Engineering Design Anupam Saxena,Birendra Sahay,2007-12-08 A new discipline is said to attain maturity when the subject matter takes the shape of a textbook Several textbooks later the discipline tends to acquire a firm place in the curriculum for teaching and learning Computer Aided Engineering Design CAED barely three decades old is interdisciplinary in nature whose boundaries are still expanding However it draws its core strength from several acknowledged and diverse areas such as computer graphics differential geometry Boolean algebra computational geometry topological spaces numerical analysis mechanics of solids engineering design and a few others CAED also needs to show its strong linkages with Computer Aided Manufacturing CAM As is true with any growing discipline the literature is widespread in research journals edited books and conference proceedings Various textbooks have appeared with different biases like geometric modeling computer graphics and CAD CAM over the last decade This book goes into mathematical foundations and the core subjects of CAED without allowing itself to be overshadowed by computer graphics It is written in a logical and thorough manner for use mainly by senior and graduate level students as well as users and developers of CAD software The book covers a The fundamental concepts of geometric modeling so that a real understanding of designing synthetic surfaces

and solid modeling can be achieved b A wide spectrum of CAED topics such as CAD of linkages and machine elements finite element analysis optimization c Application of these methods to real world problems **Representations, Analysis and Recognition of Shape and Motion from Imaging Data** Boulbaba Ben Amor,Faten Chaieb,Faouzi Ghorbel,2017-06-27 This book constitutes the refereed proceedings of the 6th International Workshop on Representations Analysis and Recognition of Shape and Motion from Imaging Data RFMI 2016 held in Sidi Bou Said Village Tunisia in October 2016 The 9 revised full papers and 7 revised short papers presented were carefully reviewed and selected from 23 submissions The papers are organized in topical sections on 3D shape registration and comparison face analysis and recognition video and motion analysis 2D shape analysis BMVC92 David Hogg,Roger Boyle,2012-12-06 This book contains the 61 papers that were accepted for presenta tion at the 1992 British Machine Vision Conference Together they provide a snapshot of current machine vision research throughout the UK in 24 different institutions There are also several papers from vision groups in the rest of Europe North America and Australia At the start of the book is an invited paper from the first keynote speaker Robert Haralick The quality of papers submitted to the conference was very high and the programme committee had a hard task selecting around half for presentation at the meeting and inclusion in these proceedings It is a positive feature of the annual BMV A conference that the entire process from the submission deadline through to the conference itself and publication of the proceedings is completed in under 5 months My thanks to members of the programme committee for their essential contribution to the success of the conference and to Roger Boyle Charlie Brown Nick Efford and Sue Nemes for their excellent local organisation and administration of the conference at the University of Leeds **Symposium on Geometry Processing 2007** Alexander Belyaev,2007 **Information Engineering and Applications** Rongbo Zhu,Yan Ma,2011-11-13 In past twenty years or so information technology has influenced and changed every aspect of our lives and our cultures Without various IT based applications we would find it difficult to keep information stored securely to process information and business efficiently and to communicate information conveniently In the future world ITs and information engineering will play a very important role in convergence of computing communication business and all other computational sciences and application and it also will influence the future world s various areas including science engineering industry business law politics culture and medicine The International Conference on Information Engineering and Applications IEA 2011 is intended to foster the dissemination of state of the art research in information and business areas including their models services and novel applications associated with their utilization International Conference on Information Engineering and Applications IEA 2011 is organized by Chongqing Normal University Chongqing University Shanghai Jiao Tong University Nanyang Technological University University of Michigan and the Chongqing University of Arts and Sciences and is sponsored by National Natural Science Foundation of China NSFC The objective of IEA 2011 is to will provide a forum for engineers and scientists in academia industry and government to address the most innovative research and development

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    - Chapter 3: Estimation Of Curvatures In Point Sets Based On Geometric in Everyday Life
    - Chapter 4: Estimation Of Curvatures In Point Sets Based On Geometric in Specific Contexts
    - Chapter 5: Conclusion

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