WSCG 2023

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Vol.30., No.1-2, ISSN 1213-697

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Detail preserving non-rigid shape correspondences

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ABSTRACT

Understanding shapes is an organic process for us (humans) as this is fundamental to our interaction with the surrounding world. However, it is daunting for the machines. Any shape analysis task, particularly non-rigid shape correspondence is challenging due to the ever-increasing resolution of datasets available. Shape Correspondence refers to finding a mapping among various shape elements. The functional map framework deals with this problem efficiently by not processing the shapes directly but rather specifying an additional structure on each shape and then performing analysis in the spectral domain of the shapes. To determine the domain, the Laplace-Beltrami operator has been utilized generally due to its capability of capturing the global geometry of the shape. However, it tends to smoothen out high-frequency features of shape, which results in failure to capture fine details and sharp features of shape for the analysis. To capture such high-frequency sharp features of the shape, this work proposes to utilize a Hamiltonian operator with gaussian curvature as an intrinsic potential function to identify the domain. Computationally it is defined at no additional cost, keeps global structural information of the shape intact and preserves sharp details of the shape in order to compute a better point-to-point correspondence map between shapes.

Keywords
shape matching, shape correspondence, functional maps

1 INTRODUCTION

Shapes in computational context refers to digital representation of any real world object such as humans, chairs, etc. These digital representations can be meshes, point clouds or voxel grids. With ever increasing technological advancements, the accuracy with which these digital representations are being captured has transformed the field of shape analysis. Particularly, shape matching is quite an interesting area enticing researchers across multiple domains from Computer Graphics, Image processing, Geometry Processing and Computer Vision. A sub-area focusses on the fundamental task of computing shape correspondences, where rather than just specifying if two shapes match, a mapping is also desired between various elements of given shapes. Major applications constitute object reconstruction, attribute transfer, Statistical modelling, Shape Interpolation and morphing, etc.

Figure 1: Reconstructed hand from human mesh via (left) 150 Laplace-Beltrami eigenfunctions (right); 150 Hamiltonian eigenfunctions

Based on how shapes can deform, varied approaches have been suggested [VKZHCO11]. Rigid shapes undergo transformations that preserve extrinsic features i.e. euclidean distances remain intact while non-rigid shapes deform anyhow [BBK07]. Rigid deformation tends to transform the shape without changing its geometry or topology via rotation or translation. Non-rigid involves changing in geometry as well as topology via stretching or bending. Finding correspondences for rigid shapes has plethora of efficient solutions. However, due to the vast space of deformations for non-rigid shapes, it is an interesting area to work. Another con-