Mathematical Methods for Image Synthesis - Readings/Project 4

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1 Readings 4 - Lectures 7-8

In this class you will need to do one project and one article reading that will be presented at the end of the semester. If you take a project with me, you will need to take a reading from Nicolas's part, and conversely, if you take the reading with me, you'll need to take a project from Nicolas. A project is expected to take between 15 and 30 hours, and can be implemented with any *imperative* programming language you want. Readings go much more in-depth than the class lectures, and are thus more complex.

- Stable Region Correspondences Between Non-Isometric Shapes, V. Ganapathi-Subramanian, B. Thibert, M. Ovsjanikov, L. Guibas `http://www.lix.polytechnique.fr/~maks/papers/stable_regions.pdf`
- Analysis and Visualization of Maps Between Shapes, Maks Ovsjanikov, Mirela Ben-Chen, Frederic Chazal, Leonidas Guibas, Computer Graphics Forum 2013 `http://www.lix.polytechnique.fr/~maks/papers/obcg_map_vis.pdf`
- Shape Matching via Quotient Spaces, Maks Ovsjanikov, Quentin Mérigot, Viorica Patraucean, Leonidas Guibas `http://www.lix.polytechnique.fr/~maks/papers/symmetry_matching.pdf`

2 Project 4 - Manifold Harmonics for shape filtering and correspondence

This projects aims at studying applications of the Manifold Harmonics. There are three parts in this project, the further you go the higher your final evaluation will be!

- First, we aim at studying filtering using manifold harmonics. The principle of this approach is described in [1]. The first task is to experiment with the manifold harmonics with respect to added noise, missing parts, subsampling...
- Second we use the manifold harmonics basis, explained during the lecture, for deriving common signal processing filters (low pass filter, high pass filter...). The effects of applying these common filters to the coordinates functions should be studied on various meshes with different filters construction.
- [More challenging] Third, the shape correspondence problem should be solved as described in the functional maps approach [2] (section 7.2) using heat kernel signatures to extract dense correspondences.

Assignment You are allowed to use a library for reading and handling surface meshes (CGAL in C++ for example, or a mesh library for matlab) and a library for matrix manipulation (eigen in C++ for example) but no other library is allowed. You should build first the laplace beltrami matrix L and use it to form the manifold harmonics basis and then derive the filters. Surface meshes undergoing nonrigid isometric transormations can be found in the tosca database `http://tosca.cs.technion.ac.il/book/resources_data.html`. There is an important experimental part in this project, your evaluation will strongly depend on your critical analysis of your experiments and the way you design your tests. A project report as well as the code are expected.

References

[1] [VB08] Vallet B, Lévy B., *Spectral geometry processing with manifold harmonics*. Computer Graphics Forum,2008,27(2):251-260.

[2] [OBSG12] Maks Ovsjanikov, Mirela Ben-Chen, Justin Solomon, Adrian Butscher, Leonidas Guibas, *Functional Maps: A Flexible Representation of Maps Between Shapes*. ACM TOG. Proc Siggraph 2012.