Spectral spacetime mesh processing

The first eigenvectors of the Laplace operator (when ordered according to the corresponding eigenvalues) on a static mesh give the natural principal directions of the shape.

Context

In computer graphics, discretizations of the Laplace operator have been widely used these last 15 years for various mesh processing tasks, such as editing, interpolation or filtering [Sor06]. In particular, the eigendecomposition of the matrix representation of this operator has been of major interest [LZ10,ZvKD10]. In order to analyse the geometry and the motion of moving shapes, we propose to extend some of these works to dynamic meshes, that is to say meshes that evolve over time. A discretization of the Laplace operator has been recently proposed in the team (see [Het12] for an early report). It is now time to use it for various spacetime mesh processing applications.

Objectives

The goal of this project is to investigate the spectral behaviour of the proposed 3D+t discrete Laplace operator, and possibly to adapt it. If the eigenvectors of this operator relate to the principal shape and motion directions of the spacetime mesh, as it is the case in 3D (see image above), the student will choose among several possible extensions of standard signal/mesh processing techniques to spacetime meshes:

- shape or motion filtering (see e.g. [HS13]);
- spectral shape or motion clustering [vL07];
- 3D+t keypoints and shape or motion descriptors [ZBH12];
- spacetime mesh classification w.r.t. shape or motion [ROA13].

Student profile

Master student, preferably in computer science or applied mathematics.
Creative and highly motivated.
Solid programming skills; the project involves programming in C++ or Python and using Matlab.
Solid mathematics knowledge (especially linear algebra and computational geometry).
Fluent English or French spoken, and fluent written English.

Advisor

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Following the Master project, a PhD thesis is possible on this topic.

References

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