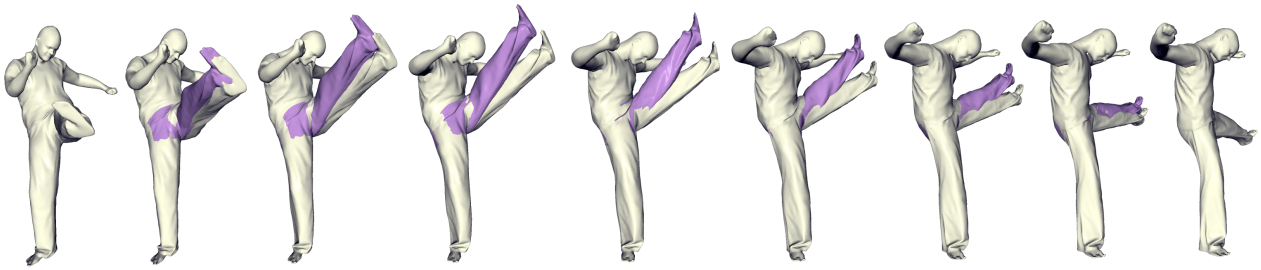
Bachelor/Master short internship:
3D+t Laplace operator for geometry processing

Franck Hétroy-Wheeler
hetroywheeler@unistra.fr

1 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 [5]. In particular, the eigendecomposition of the matrix representation of this operator has been of major interest [3,6]. 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.

We have recently proposed a discretization of the Laplace operator for this case, and used it to help the edition of mesh sequences [1,2] (see image below). We now want to focus on the eigendecomposition of this operator. Goals are twofold: first, define an efficient algorithm for such purpose, knowing that in the 3D+t case, the Laplacian matrix is huge but very sparse; second, use this decomposition for interesting geometry processing applications.



2 Objectives

During the project, the student will have to:

1. design and implement an algorithm to compute an eigendecomposition of a 3D+t Laplacian matrix;
2. use this algorithm for spectral clustering of a moving shape [4], allowing to segment this shape according both to its geometry and its motion.

Code will be developed in Python (Matlab can be used for linear algebra computations) and added to the 3DtLaplace software [2].

3 Student profile

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

4 Advisors

Franck Hétroy-Wheeler, IGG team, ICube laboratory, University of Strasbourg
E-mail: `hetroywheeler@unistra.fr`
Location: ICube Laboratory, Illkirch, France.

Bibliography

[1] V. Fernandez Abrevaya, S. Manandhar, F. Hétroy-Wheeler, S. Wuhrer. A 3D+t Laplace operator for temporal mesh sequences. Computers and Graphics 58, 2016.

[2] V. Fernandez Abrevaya, S. Manandhar, F. Hétroy-Wheeler, S. Wuhrer. `3DtLaplace` software. `http://3dtlaplace.gforge.inria.fr/`

[3] B. Lévy, R.H. Zhang. Spectral mesh processing. SIGGRAPH Course, 2010.

[4] U. von Luxburg. A tutorial on spectral clustering. Statistics and Computing 17(4), 2007.

[5] O. Sorkine. Differential representations for mesh processing. Computer Graphics Forum 25(4), 2006.

[6] R.H. Zhang, O. van Kaick, R. Dyer. Spectral mesh processing. Computer Graphics Forum 29(6), 2010.