New Animation Interpolation and Proposal of its Evaluation Indicators

IMI Short-term Joint Research Project

Date： March 5th to 9th, 2012

○ Workshop： March 5th (Monday) 13:00-17:30

○ Discussion： March 6th (Tuesday) to 9th (Friday)

Venue： Institute of Mathematics-for-Industry, Kyushu University

Workshop Program (on March 5th)

13:00 – 13:20	**Opening Talk** Shun'ichi Yokoyama (Kyushu University) "Aim of this joint project"
13:20 – 14:00	Shizuo Kaji (Yamaguchi University) "Frame interpolation for character animation - Overview of the problem and our progress"
14:10 – 14:40	Ken Anjyo (OLM Digital Inc.) "Compatible mapping of 2D shapes"
15:00 – 15:30	Hiroyasu Hamada (Kyushu University) "On some matrix decompositions"
15:40 – 16:10	Shigehiro Sakata (Tokyo Metropolitan University) "Evaluation indicators for matrix interpolations"
16:20 – 16:50	Sampei Hirose (Research Institute for Mathematical Sciences) "On some geometric indicators for interpolations related to the keyframe method"
17:00 – 17:30	Yoshihiro Mizoguchi (Kyushu University) "Interpolation using eigenvectors of the Laplacian matrix of a graph"
17:30 – 17:40	**Closing**

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Workshop Abstract

Shizuo Kaji (Yamaguchi University)
"Frame interpolation for character animation - Overview of the problem and our progress"

The interpolation technique, which produces continuous images from two or more keyframes, is important in the video production fields since it drastically reduces tedious work of creating animations. Among many suggested methods, Alexa et. al. introduced so-called "As-rigid-as-possible interpolation" (ARAP, in short) in 2000. Since then, improvements and extensions have been studied mostly from CG side, and the way of comparison and evaluation for different techniques is aesthetic. Mathematically, ARAP can be formulated as the problem of finding an appropriate path connecting given polyhedral shapes. Our aim is to establish rigorous framework to study it. In this talk, I will:

1. give a brief survey of the original method,
2. introduce mathematical evaluation indicators for "rigidity",
3. provide possible improvements and extensions.

Ken Anjyo (OLM Digital Inc.) "Compatible mapping of 2D shapes"

This talk presents our approach to making 2D shape interpolation using a compatible mapping between the 2D shapes. It consists of the three steps:

1. boundary matching of locating salient features;
2. simplifying boundaries while maintaining their parametric correspondence and the embedding of the original shapes;
3. extending the mapping to shapes' interiors via a compatible triangulation algorithm.

Comparison of this method with prior work is also briefly discussed.

Hiroyasu Hamada (Kyushu University) "On some matrix decompositions"

In this talk, I will review basic properties of some matrix decompositions related to "As-rigid-as-possible interpolation", for example, polar decomposition, singular value decomposition, QR decomposition, spectral decomposition and so on.

Shigehiro Sakata (Tokyo Metropolitan University)
"Evaluation indicators for matrix interpolations"

We make a computer graphics by using a matrix interpolation from the unit matrix into a given matrix with a positive determinant. Then there are the following problems which were suggested in [1] and [2]:

1. The animation collapse through the transformation,
2. The animation has extra movement.

In order to solve these problems, we define indicators for a good interpolation. To be precise, it is sufficient to hold that the determinant of the interpolation matrix is monotone, and that the argument of the locus of any point in the circle with unit radius centered at the origin.
For the first problem, we show that the known interpolations do not always have monotonic determinants, and we suggest a new interpolation whose determinant is monotone. Moreover, we give a new time parameter which fix the velocity of the fluctuation of the determinant in a constant.
From the consideration for the first problem and the conclusion in [2], we should improve the interpolation which is made by the polar decomposition. Any matrix with a positive determinant can be decompose into the product of a rotation matrix and a positive symmetric matrix. For the rotation angle, we give an algorithm that the argument of the locus of any point in the unit circle becomes monotonic, which is our solution for the second problem.

Sampei Hirose (Research Institute for Mathematical Sciences)
"On some geometric indicators for interpolations related to the keyframe method"

An interpolation of the real general linear group with positive determinant is a basic technique in the keyframe method. In this talk, we introduce some geometric indicators for the interpolation and give meaning to this indicator in the keyframe method.

Yoshihiro Mizoguchi (Kyushu University)
"Interpolation using eigenvectors of the Laplacian matrix of a graph"

In this talk, we introduce the Laplacian Matrix of a graph and show some several properties about eigenvalues and eigenvectors in connection with image segmentations and group formations. According to these properties, we propose problems and examples to apply this method to interpolate moving objects in character animations. (cf. [3])

References

[1] Marc Alexa, Daniel Cohen-Or and David Levin, *As-rigid-as possible shape interpolation*, SIGGRAPH'00, 157-164 (2000).

[2] Ken Shoemake and Tom Duff, *Matrix animation and polar decomposition*, Proceedings of the Graphics Interface, 1992.

[3] S. Takahashi et al., *Spectral-Based Group Formation Control*, Proc. of Eurographics 2009, vol.28(2), pp.639-648, 2009.