Eurographics/ ACM SIGGRAPH Symposium on Computer Animation (2016)
Jan Bender (Editor)

Friction Sound Synthesis of Deformable Objects based on Adhesion Theory

T. Nakatsuka[1] and S. Morishima[2]

[1]Waseda University, Japan [2]Waseda Research Institute for Science and Engineering, Japan

Abstract

Friction sound is one of the closest sounds for us in any situations. Most of those sounds are created by Foley artists in computer animations. However, synthesizing sounds in all scenes need technical skills and take high costs. In this research, we propose a novel physically-based approach to synthesize various kinds of friction sounds based on dynamics simulation.

Categories and Subject Descriptors (according to ACM CCS): I.3.5 [Computer Graphics]: Computational Geometry and Object Modeling—Physically Based Modeling I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Animation

1. Introduction

Both friction and its sound are familiar phenomena. However, extracting a complete principle of them is very challenging. This is because friction is a complicated phenomenon from a macro scale to a micro scale. Ren at al. [RYL10] synthesized the friction sounds using a modal analysis and the surface model of the object in three phases of scales, but it is difficult to consider non-linear properties such as the deformation of the clothes. On the other hand, An et al. [AJM12] synthesized the friction sounds to the cloth animation using sound database. However, the database needs record many samples of rubbing clothes in different speeds. To solve these problems partially, we implement a novel surface model extracted essential of friction based on Adhesion Theory.

2. Overview

Our physically-based method passes three steps (See Fig.1). First, we separate an object surface into micro rectangles (local shape) around each vertex of the object, and define their initial size. The initial size of micro rectangles is decided by its texture (e.g., in the case of a cloth, it is the diameter of thread), and distorted by on the two assumptions: the extent to which the size of micro rectangle (1) changes by a velocity of the contacting vertex and (2) obeys normal distributions. A deformation of micro rectangle is indicated by the following equation:

$$D\nabla^4 w + \rho \frac{\partial^2 w}{\partial t^2} = 0 \quad (1)$$

where D is a flexural rigidity, w is a displacement and ρ is a density of an object. Then, we decide a global shape of the object using Position Based Dynamics [MHHR07]. As constraints, we adopt a distant constraint between the vertices of the object, and an adhesion constraint between two objects. Finally, we synthesize the sounds which is generated by each micro rectangle of the objects at the observation point by calculating a wave equation. The synthesized sound enables to be expressed by a linear sum of sounds due to an independency of sound waves. Our method can be adapted to deformable objects like a cloth (See Fig.2).

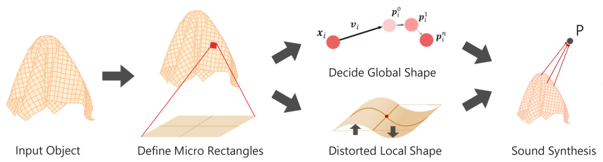

Figure 1: *An overview of our method*

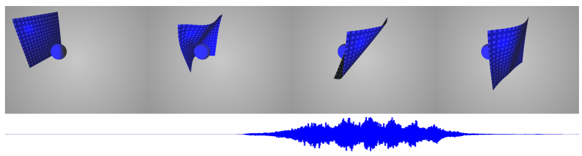

Figure 2: *A cloth dragged across a sphere*

References

[AJM12] An S. S., James D. L., Marschner S.: Motion-driven concatenative synthesis of cloth sounds. *ACM Transactions on Graphics (TOG) 31*, 4 (2012), 102–111. 1

[MHHR07] Müller M., Heidelberger B., Hennix M., Ratcliff J.: Position based dynamics. *Journal of Visual Communication and Image Representation 18*, 2 (2007), 109–118. 1

[RYL10] Ren Z., Yeh H., Lin M. C.: Synthesizing contact sounds between textured models. In *Virtual Reality Conference (VR), 2010 IEEE* (2010), IEEE, pp. 139–146. 1

DOI: 10.2312/sca.20161246