Towards Universal Haptic Library: Library-Based Haptic Texture Assignment Using Image Texture and Perceptual Space

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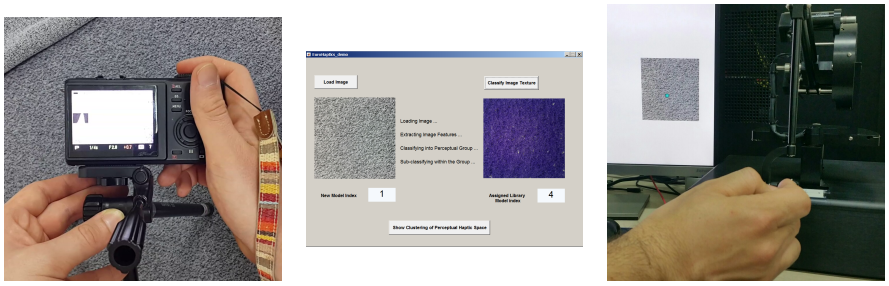
Abstract. In this study we focused on building a universal haptic texture models library. This library is used to automatically assign haptic texture models to any given surface based on image features. The library is built from one time data-driven modeling of a large number (84) of textured surfaces, which cover most of the daily life haptic interactions. In this demonstration, we will show automatic assignment of haptic texture models to new arbitrary textured surfaces based on their image features, from the universal haptic library of haptic texture models. Afterwards, the automatically assigned haptic model will be rendered.

Keywords: Perceptual space· image feature· multidimensional scaling· haptic texture· image texture

1 Introduction

It is reported that haptic texture has, up to some extent, correlation with image texture [2]. Our hypothesis is to utilize this relationship in the automatic selection of haptic texture models, instead of using pure image based selection. It is well known that two similar looking images can have totally different haptic perception and vice versa. Therefore, it is of utmost importance to cater for the perception aspects of every image and use that knowledge in automatic assignment of haptic texture models. The overall framework required to accomplish this task can be tabulated as follows:

1 - One time data driven modeling of texture surfaces to form a library. The range of surfaces should cover most of the daily life haptic interactions.
2 - A user study to establish a perceptual space where all the texture surfaces from the library are represented based on their perceptual characteristics of haptic texture.
3 - Extract multiple image features of all the texture surfaces.
4 - Establish a relationship between haptic perception (step 2) and image features (step 3). Haptic texture models are stored along with the associated image features.



(a) Capturing image of a new textured surface.

(b) Automatic assignment of a haptic model from library.

(c) Rendering the automatically assigned haptic model.

Fig. 1. Illustration of the demonstration process.

5 - Based on the relationship established in step 4, carry out automatic haptic texture model assignment, to newly encountered - outside library - texture surfaces, using the library.

6 - Render the assigned model from library as a haptic model for the newly encountered texture surface.

2 Implementation

The universal haptic library was built using 84 real life texture surfaces. The data driven models of all these surfaces were built using the modeling algorithm that is proposed in [1]. Since the library is limited to the isotropic haptic textures, we reduced the input space of the algorithm down to two dimensions, which are the magnitudes of the normal force and the tangent velocity.

3 Demonstration

This demonstration aims at showing the performance of our system for automatic selection and rendering of haptic texture models. As a first step, the image of any textured surface is captured using a camera. This image is then loaded into the algorithm for automatic selection. The algorithm assigns perceptually the closest haptic texture model from the library based on the image features of the new surface. The assigned model is then rendered for the new textured surface. The overall process can be seen in Fig. 1. A small video for this demonstration is available at `http://haptics.khu.ac.kr/Universal_Haptic_Library_AsiaHaptics.mp4`.

4 Requirements

For this demonstration, we would require a table of 6×3 feet (or smaller tables making up the same size). Additionally, availability of at least four electric sockets would be appreciated.

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