**Thesis outline**

Title: Audio-Based Haptic Effects Synthesis for 4D Films

**Chapter 1: Introduction**

* 4D film technologies
* Surface haptics technologies: electrovibration and ultrasonic vibration
* Related Work
  + Audio-based approaches for haptic rendering
  + Haptic effects generation for movies

**Chapter 2: Auditory-to-vibration conversion transparent**

* Effects of the transfer function of the system
  + Transfer function of the mechanoreceptor system
  + Transfer function of the tactile device system
  + Dynamic and static behaviors
* Formative study: whether lateral force only can render primitive 3D geometries
  + Basic gradient algorithm for lateral force computation
  + User study to compare a force-feedback device with an electrovibration display
  + *Side study: preliminary results on the effect of size on recognition*
* Summative study: rendering general 3D objects represented by 3D meshes
  + Generalized gradient estimation algorithm including force bounding procedure
  + Edge detection algorithm
  + User study to investigate whether 3D Gaussian/frustum bumps/holes are identifiable in the presence of limited visual information
* *Potential extension: supporting dynamic 3D models*
  + *3D object can be moved/rotated/scaled by user*
  + *Modified generalized algorithm to update estimated force boundaries (fmin and fmax)*

**Chapter 3: Data-driven texture rendering on electrovibration display**

* Linear tribometer: for measuring force, acceleration, and displacement
  + Texture data collection of 3 (or 4) distinguishable real texture samples
  + Device characterization with respect to input waveform, frequency, and amplitude
    - Electrovibration display: 3M Microtouch capacitive panel
    - Dynamic and static behaviors
* Texture modeling (neural network, or hybrid model)
  + Static model
  + Vibrational model
* Texture rendering:
  + Applying MDS for similarity rating among all real and synthesized textures
* *Potential extension: spatial texture rendering* 
  + *Mapping textures on virtual 3D objects*

**Proposal committee members**

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