Haptic Rendering for Rigid Body Simulator based on Analytical Methods

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1 Perception based Haptic Rendering

Haptic perception is essential for dexterous object manipulation in both real and virtual world. Recently, haptic interaction is being researched for manipulation in virtual environment.

Conventional haptic rendering employs penalty method which calculates feedback forces using only spring-damper model [Ruspini et al. 1997]. High frequency (1 kHz-) simulation is required for stable control over haptic interfaces for meaningful haptic interactions [Love and Book 1995]. However, high frequency simulation tends to cause overflow of computational quantity and make simulation for virtual worlds in large scale difficult.

A proposal of haptic rendering calculates feedback forces regarding not only physical law but also nature of human perception. This rendering is make possible using haptic interfaces whose frequencies are around 1 kHz and physical simulators based on analytical methods. Consequently, the proposal of haptic rendering presents rich haptic perception for large scale virtual worlds with ordinary haptic devices(Fig.1).

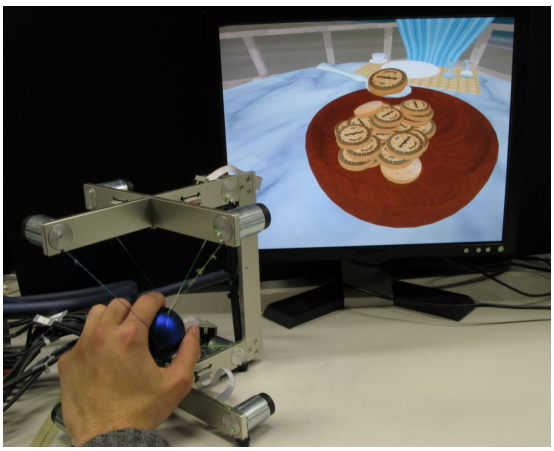

Figure 1: *Demonstration*

2 Innovation

The proposal of haptic rendering displays properties of objects such as viscosity and elasticity respecting the nature of human perception and cognition under the constraints of controls and computational quantity. Humans perceive objects shape via normal forces, dynamics (inertia and visco-elasticy) from the relations of applied forces and motions of objects which are touched by hands. Simulations of this relation require high frequency update and consideration to effects of all objects that are in contact with the users hands.

Therefore, we propose a linear model for the relation as an approximation and calculate the parameter of the model in the low frequency simulation for the whole virtual world. Then, the high frequency simulator calculates only the linear model whose computational cost is far small than the original simulation. The linear model cannot account for collision impulses given from objects not belonging to the contact group. Impulsive forces should be applied to the user 's hand for consistency involving visual and haptic cues. Because visual cues have low time precision, these forces are easily achieved by simple transmission of impulsive forces.

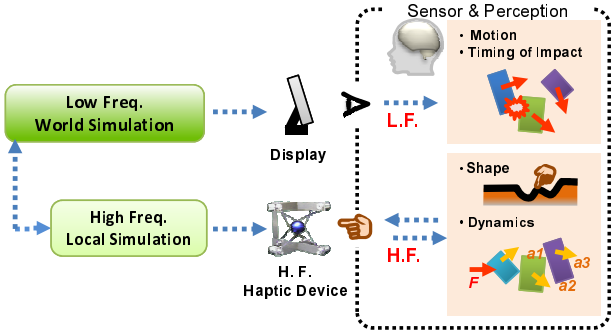

Figure 2: *The System Overview*

References

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