ImpAct : Haptic Stylus for Shallow Depth Surface Interaction

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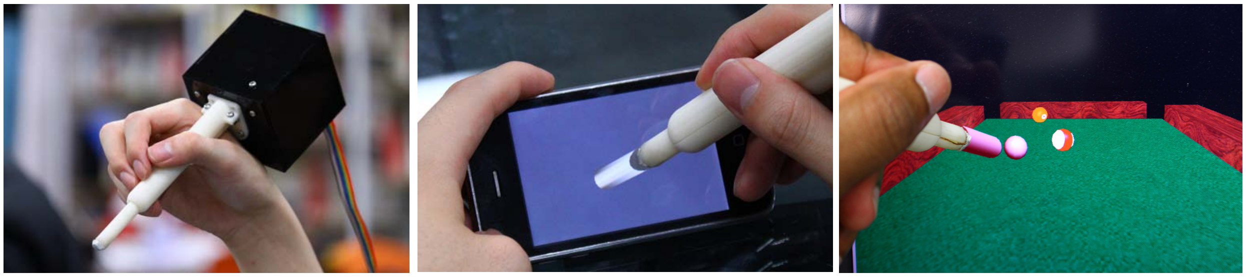

Figure 1: *Prototype of ImpAct, Illusion of permeability for shallow depth interaction and Playing billiard with ImpAct*

1 Introduction

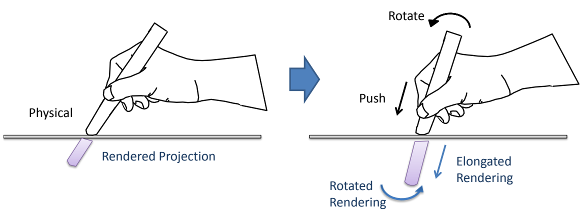

Figure 2: *Simulated Projection Rendering (SPR)*

ImpAct is a haptic stylus which can change its length dynamically and measure its orientation changes in 3 degrees of freedom. Combining it with a 3D simulated projection rendering mechanism as shown in Figure 2, it can make the illusion of going through a display surface in to the digital space below(Figure 1). Furthermore, once user get into the digital space, more realistic interactions with digital objects are provided with kinesthetic haptic feedback by applying force-feedback on the scalable stem.

ImpAct's major novelty is in the collective interaction paradigm provided by its scalable stem and Simulated Projection Rendering (SPR). We call it "through surface interaction". Above surface interactions[Hilliges et al. 2009] and below surface interactions[Wigdor et al. 2006] has been explored by previous research work. We believe "through surface" paradigm will further extend the interaction space for surface computing. Haptic cues generated by the stylus further enhances the perception of the 3D space and allow users to manipulate and probe objects within the surface with multimodal feedback. Furthermore, we derived a set of haptic stimulations possible with ImpAct's capabilities and created a haptic model for ImpAct.

2 Implementation

We have developed the length changeable stylus integrated with the actuation system to provide feedback. Furthermore, we developed the simulated projection rendering (SPR) mechanism by tracking linear length changes and angular motion of ImpAct and projecting them on the digital space. Tracking the users eye position is also an important feature for SPR. ImpAct is designed so that user grips it

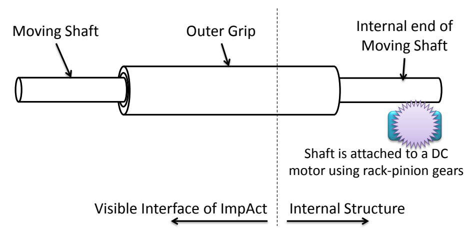

Figure 3: *Haptic actuation mechanism and internal structure of ImpAct*

with an outer tube which consists of an inner shaft which can move relative to user's grip (Figure 3). Inner shaft is attached to an actuation mechanism driven by a DC motor to provide kinesthetic haptic sensation. Most of kinesthetic haptic devices made for HCI use a grounding mechanism. In ImpAct, display surface itself is used as the grounding. Orientation changes of ImpAct is tracked by a 3 dimensional accelerometer/magnetometer mechanism and the length changes are measured using a linear encoder. All measurements are transmitted to the surface computer using a serial communication channel and use to render the virtual stem and calculate relevant haptic feedback.

ImpAct can be used as a general HCI tool, a 3D modeling tool in CAD/CAM applications, in computer entertainment such as gaming (Figure 1), in medical applications for probing, etc. We believe ImpAct is able to open new interaction possibilities for surface computing.

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