Multimodal Floor for Immersive Environments

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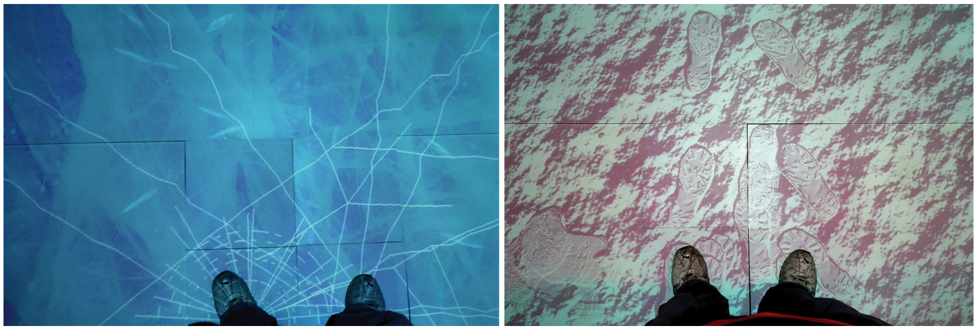

Figure 1: *Virtual ground surfaces exhibit their interactive, material-dependent characteristics when walked upon, through visual, auditory, and vibrotactile feedback. Shown are a frozen pond simulation (left) and a snowy field (right).*

We have developed an interactive system that allows untethered users to experience walking on virtual ground surfaces resembling natural materials. The demonstration consists of a multimodal floor interface for providing auditory, tactile and visual feedback to users' steps. It is intended for immersive virtual and augmented reality environments (VE) that provide the impression of walking over natural ground surfaces, such as snow and ice. To date, immersive environments with interactive floor surfaces have been largely focused on visual and auditory feedback linked to a VE simulation (e.g., [Gronbaek 2007]; see also the comparative review in [Miranda and Wanderley 2006]). However, while walking in natural environments, we receive continuous, multisensory information about the nature of the ground we walk on – the crush of dry leaves, the soft compression of grass. The static nature of floor surfaces in existing VEs typically bears little resemblance to a given natural ground material. This creates a perceptual conflict with the dynamic visual and/or auditory feedback that users are provided in the VE. This project illustrates a novel approach to reconciling such perceptual conflicts, based on multisensory feedback provided through a floor surface in response to users' steps.

The demonstration consists of a 6x6 foot, 36-tile floor surface. An array of force sensors within the floor (Interlink FSRs), is used to acquire the steps of users. Multimodal feedback is rendered, via physically-motivated models for the vibrotactile, auditory, and visual response of the material to the steps of a user [F. Fontana 2003; Law et al. 2008], and is displayed at the site of a footstep via an array of vibrotactile and audio actuators in the floor, as well as top-down video projection. Figure 1 and the accompanying video show a smaller 4 tile system along with a temporary projection surface as currently set up in our lab, pending completion of the larger system. The parts to construct the 36 floor tile array to be exhibited at SIGGRAPH have all arrived and are being assembled with planned completion in mid March. The final floor consists of a set of rigid wooden tiles with a durable, grey reflective paint. The prototype has been tested with hundreds of users during a McGill open house.

The two demonstration simulations consist of a frozen pond and field of snow (Figure 1). In the former, users can tip-toe over the virtual pond surface and observe fish swimming below. A hard step will cause the ice to fracture, accompanied by the sound of ice fracturing, the appearance of cracks, and synchronous vibrations. The snow setting allows one to leave footsteps onto virtual snow, with acoustic and vibrotactile response similar to the feeling of stepping onto real snow. The latter simulation requires motion capture (via a Vicon MCam2 system) of the posture of the feet in order to render the footsteps.

Figure 2: *The floor, in the configuration in which it is installed in the rear-projected CAVE-like environment of our lab.*

This system introduces a novel approach to affording natural walking activity in virtual environments, on virtual terrains. It may be used to enhance existing immersive VEs (Figure 2) or for augmented floors in other settings. Potential future applications can be envisioned in areas such as immersive VE training simulations, responsive floor-surfaces for entertainment parks, and interactive rehabilitation.

References

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SIGGRAPH 2009, New Orleans, Louisiana, August 3–7, 2009.
ISBN 978-1-60558-726-4/09/0008