Integrated Multimodal Interaction Using Texture Maps

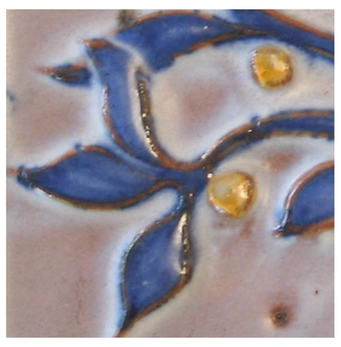
Auston Sterling and Ming C. Lin

Motivation

Texture representations of detail are used extensively in visual rendering, but not for other modalities of interaction. This disparity can lead to *sensory conflict* and a break in presence in VR/AR applications. We present an integrated multimodal system using normal maps and relief maps for consistent interaction with textured surfaces through sound, haptics, and rigid-body dynamics

Texture Representations

Normal maps are widely supported for interactive applications and are often included with color maps



Color map

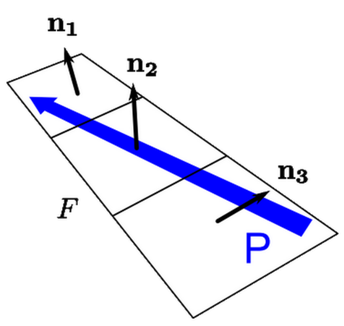
Normal map

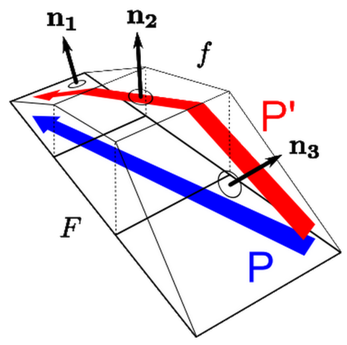
Relief maps add a depth map in the alpha channel to create self-occlusion and self-shadowing effects

Depth map

Normal + depth map (Relief map)

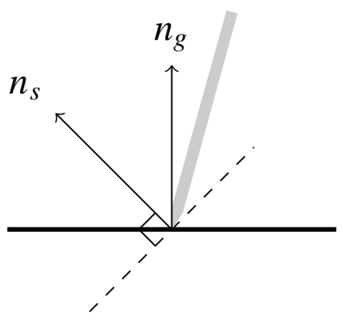
Methods

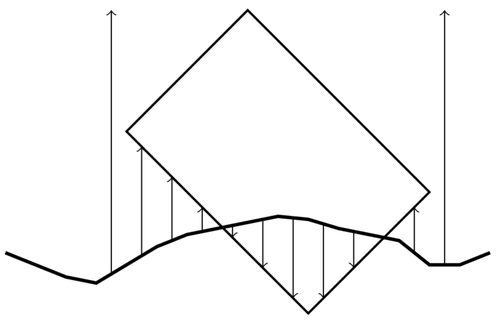




Sliding and rolling sounds are generated using modal synthesis and varying normals from textures as the contact point moves across the surface [Ren et al. 2010]

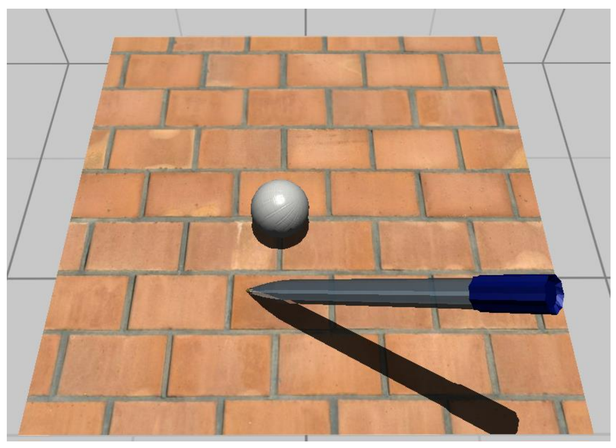
Haptic feedback uses a Phantom Desktop, which simulates a plane with the sampled normal n_s from the texture, instead of the geometric normal n_g



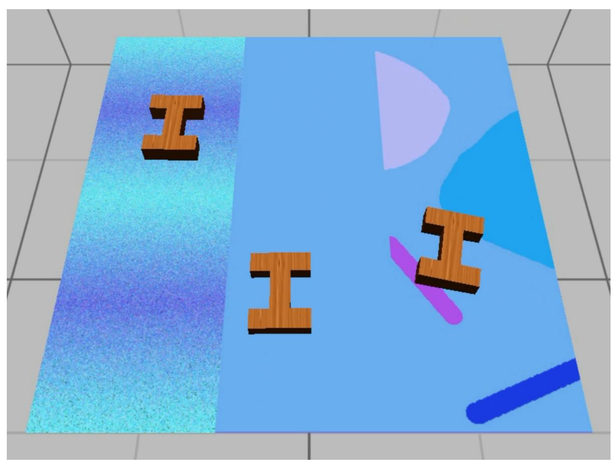


Collision detection between an object and a relief map converts the object into a depth map for comparison. Normal and relief maps use sampled normals to modify collision response on the fly

Results



Multimodal interaction with a normal-mapped surface (left) and a relief-mapped surface (right)



Normal-mapped surfaces with sliding blocks (left) and an interactive pinball simulation on a textured plane (right)

Normal Map Identification Study

	Always	Frequently	Occasionally	Rarely	Never	Accuracy (1-10)
Haptics	88%	0%	6%	0%	6%	9.3 ± 0.9
Sound	34%	22%	22%	11%	11%	7.6 ± 1.4
Physics	29%	6%	47%	6%	12%	7.3 ± 2.6

How often subjects report using each mode, and how well subjects report that each mode represented the visuals (10 is best)

- 78% correct identification rate when using all modes
- Perceived ease of texture identification significantly improved when all modes used texture information

Comparison Study: Normal vs. Relief Maps

- When considering a specific mode, subjects did not significantly prefer normal maps or relief maps
- When considering overall quality of interaction, subjects somewhat preferred relief maps over normal maps
- Normal/relief preferences varied from surface to surface

Acknowledgements

Supported in part by the National Science Foundation and the UNC Arts and Sciences Foundation