Modern interfaces supporting touch input are ubiquitous. Typically, such interfaces are implemented on integrated touch-display surfaces with simple geometry that can be mathematically parameterized, such as planar surfaces and spheres; for more complicated non-parametric surfaces, such parameterizations are not available. In this dissertation, we introduce a method for generalizable optical multi-touch detection and semantic response on uninstrumented non-parametric rear-projection surfaces using an infrared-light-based multi-camera multi-projector platform.

In this paradigm, touch input allows users to manipulate complex virtual 3D content that is registered to and displayed on a physical 3D object. Detected touches trigger responses with specific semantic meaning in the context of the virtual content, such as animations or audio responses. The broad problem of touch detection and response can be decomposed into three major components: determining if a touch has occurred, determining where a detected touch has occurred, and determining how to respond to a detected touch. Our fundamental contribution is the design and implementation of a relational lookup table architecture that addresses these challenges through the encoding of coordinate relationships among the cameras, the projectors, the physical surface, and the virtual content. Additionally, we present and evaluate two algorithms for touch detection and localization utilizing the lookup table architecture.

We demonstrate touch-based interactions on several physical parametric and non-parametric surfaces, and we evaluate both system accuracy and the accuracy of typical users in touching desired targets on these surfaces. In a formative human-subject study, we present an exploratory application of this method in patient simulation. A second study highlights the advantages of touch input on content-matched physical surfaces achieved by our method, such as decreases in induced cognitive load, increases in system usability, and increases in user touch performance.

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The public is welcome to attend.