Hands-Free Augmented Reality for Vascular Interventions

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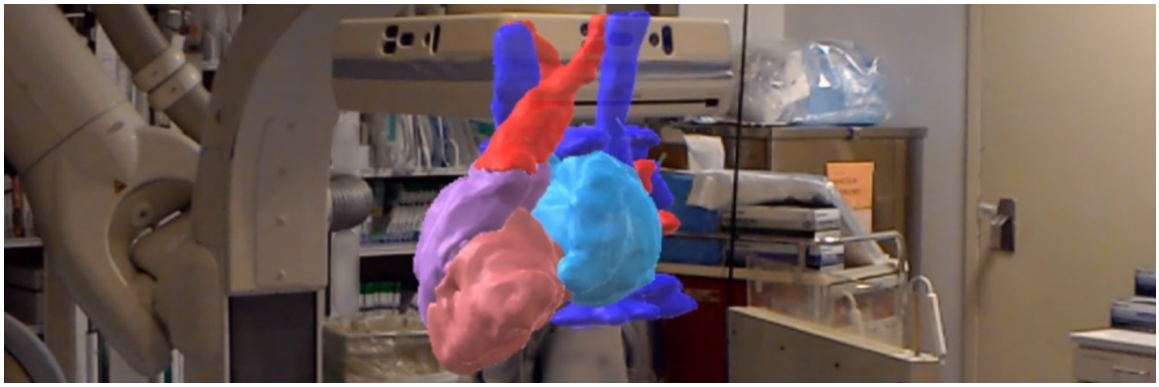

Figure 1: Model of patient heart viewed through HoloLens in procedure room.

ABSTRACT

During a vascular intervention (a type of minimally invasive surgical procedure), physicians maneuver catheters and wires through a patient's blood vessels to reach a desired location in the body. Since the relevant anatomy is typically not directly visible in these procedures, virtual reality and augmented reality systems have been developed to assist in 3D navigation. Because both of a physician's hands may already be occupied, we developed an augmented reality system supporting hands-free interaction techniques that use voice and head tracking to enable the physician to interact with 3D virtual content on a head-worn display while leaving both hands available intraoperatively. We demonstrate how a virtual 3D anatomical model can be rotated and scaled using small head rotations through first-order (rate) control, and can be rigidly coupled to the head for combined translation and rotation through zero-order control. This enables easy manipulation of a model while it stays close to the center of the physician's field of view.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality**; **Graphics input devices**; **Interaction techniques**; *User interface design*; *Information visualization*; • **Social and professional topics** → **Medical technologies**; • **Computing methodologies** → *Graphics input devices*;

KEYWORDS

Hands-free interaction, augmented reality, vascular interventions, head tracking, head-worn display.

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1 INTRODUCTION

When performing vascular interventions, physicians frequently need both hands for intraoperative tasks. However, augmented reality (AR) and virtual reality (VR) systems for surgical procedures often rely on hand-based or foot-pedal input, sometimes complemented by head tracking, to enable targeting and selection (e.g., [Hasan and Yu 2017; Jalaliniya et al. 2013; LaValle et al. 2014; Mewes et al. 2017]).

To address the need for hands-free visualization control, without involving the physician's feet, we present the head-tracking and voice-based 3D user interface to an AR guidance system for vascular interventions that uses Microsoft HoloLens to present 3D models of patient anatomy (Figure 1) [Grinshpoon et al. 2018; Loeb et al. 2018]. Since current AR head-worn displays (HWDs) have a limited field of view (FOV), physicians can potentially lose sight of virtual content during manipulation. To avoid this, we use first-order (rate)