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## **JUGAAR**

# **Holographic Imaging with the HoloLens Head Mounted System to Enhance Angio Suite Ergonomics During an Endovascular Procedure**

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## **INTRODUCTION**

Augmented reality (AR) technology consists of adding digital information to the direct view of an existing physical environment, and its application in enhancing visualisation has recently emerged in medical imaging. HoloLens glasses (Microsoft, Redmond, WA, USA) are an optical see through head mounted display (HMD), currently considered to be one of the most suitable augmented reality devices for surgery, enabling visualisation of virtual objects superimposed on the real environment. Endovascular surgery requires peri-operative digital subtraction angiography, which is currently visualised on a display screen, leading to transient loss of direct vision of the surgical field, possibly requiring increased focusing changes and hand–eye coordination. This may lead to physical discomfort such as neck or back pain, underpinning the need to improve ergonomics during endovascular procedures.

## **TECHNIQUE**

Pioneering work on the adaptation of AR-HMD in enhancing surgical workflow during endovascular procedures is presented. Using the HoloLens glasses (Fig. 1A), a program was created that displays holograms in the operator's visual field. Up to four images (including two and three dimensional reconstructions) from different sources can be displayed simultaneously into the HoloLens system and superimposed onto the real environment (Fig. 1B). The visualisation system was tested in real conditions in one patient undergoing lower limb angioplasty (Fig. 2). The system efficiently projected images, with computational time and image quality similar to those provided by the display screen. This device is operated by voice commands and allows visualisation of images directly within the visual field. It offers the advantage of enhanced ergonomics while preserving environmental sterility. The system is compatible with the use of radioprotective glasses. Visualisation through the HoloLens can be further optimised to allow holographic images to move simultaneously with the user's head movements.

## **CONCLUSION**

This technical innovation could potentially help to improve ergonomics and surgical workflow. It brings the potential of developing “screenless display” interventions and new tools to help visualisation and navigation during endovascular procedures.

## FIGURE LEGENDS

**Figure 1.** (A) Augmented reality head mounted display (HMD). A HoloLens device (Microsoft, Redmond, WA, USA) is used and the characteristics of the device are detailed on the manufacturer website (<https://www.microsoft.com/fr-fr/hololens/hardware>). (B) Visualisation of holographic imaging displayed in HoloLens HMD in a virtual patient. Up to four images originating from different sources can be displayed simultaneously in the device, including: (1) two dimensional angiography; (2) operative vital signs monitoring; (3) three dimensional (3D) fusion image; and (4) 3D computed tomography scan reconstruction.

**Figure 2.** Actual view of holographic imaging in the HoloLens head mounted display in real condition during endovascular procedure in one patient undergoing angioplasty of the lower limb. (A) Blue square: image of digital subtraction angiography (DSA) holograms displayed in the surgeon's visual field through the HoloLens glasses. (B) Red square: DSA image provided by the handling display screen which has been flipped in a "screenless" like

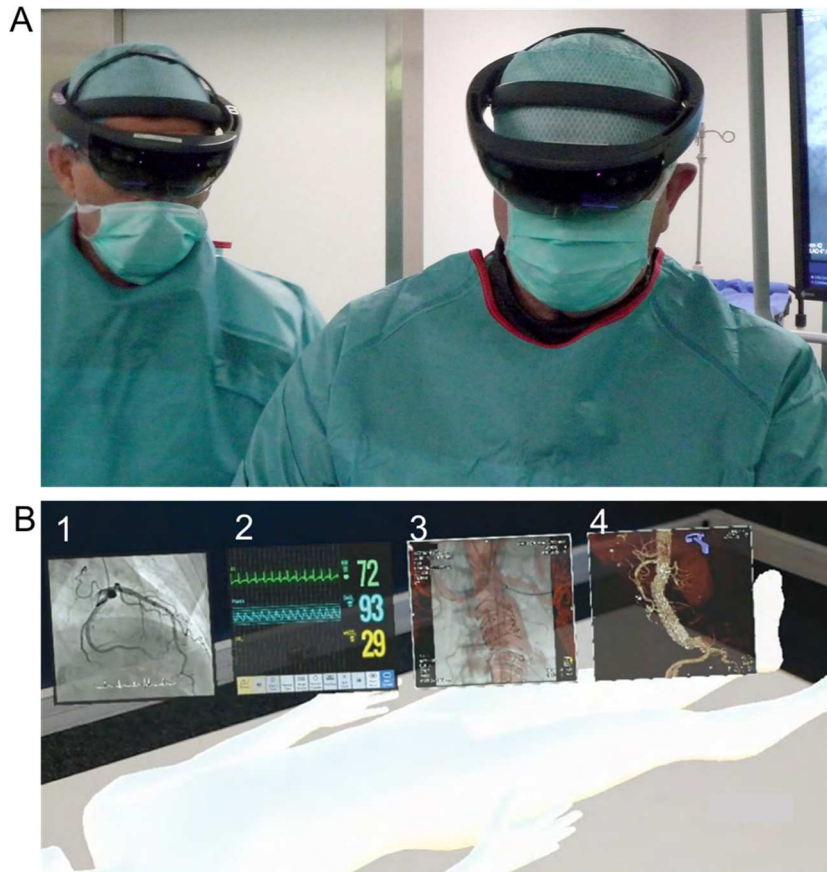


Figure 1: (A) Augmented reality head mounted display (HMD). HoloLens device (Microsoft, Redmond, WA, USA) is used and the characteristics of the device are detailed on the manufacturer website (<https://www.microsoft.com/fr-fr/hololens/hardware>). (B) Visualization of holographic imaging displayed in HoloLens HMD in a virtual patient. Up to 4 images originating from different sources can be displayed simultaneously in the device including (1) 2D-angiography; (2) Operative vital signs monitoring; (3) 3D-fusion image; (4) 3D CT-scan reconstruction.

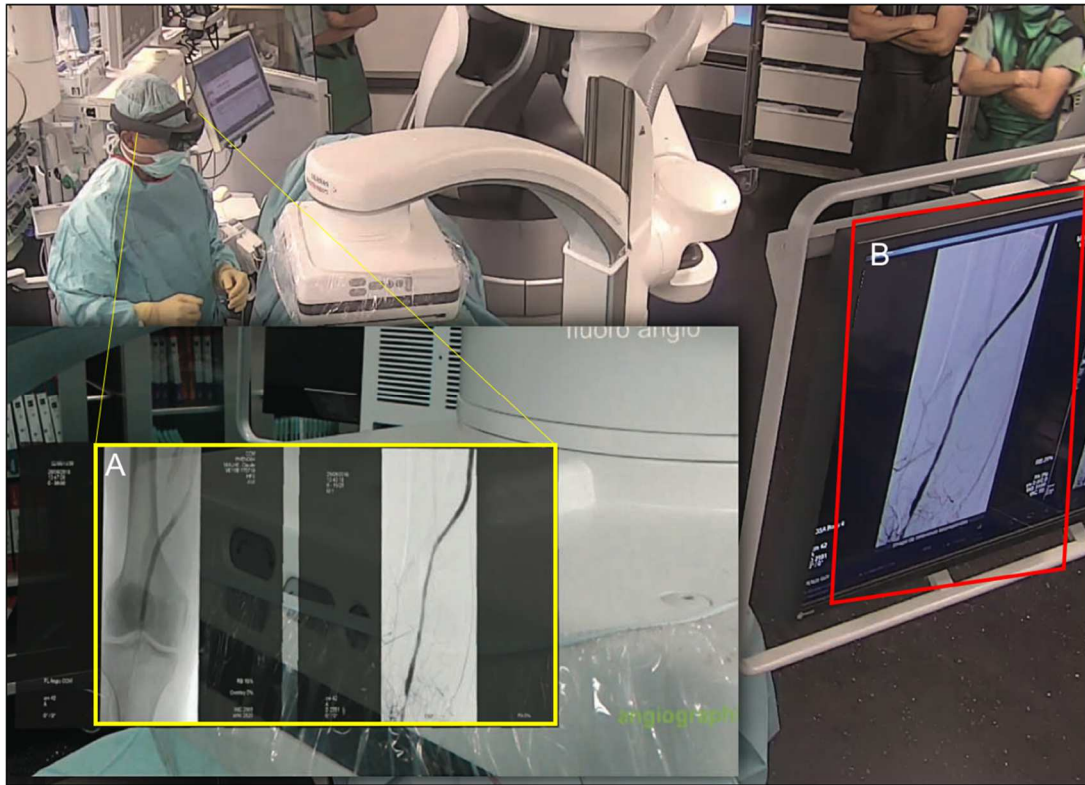


Figure 2: Actual view of holographic imaging in HoloLens head mounted display in real condition during endovascular procedure in one patient undergoing angioplasty of the lower limb. (A) Yellow square: Image of digital subtraction angiography (DSA) holograms displayed in the surgeon's visual field through the HoloLens glasses. (B) Red square: DSA image provided by the handling display screen which has been flipped in a "screenless" like position. The image quality displayed by the HoloLens system is similar as those provided by the handling display screen