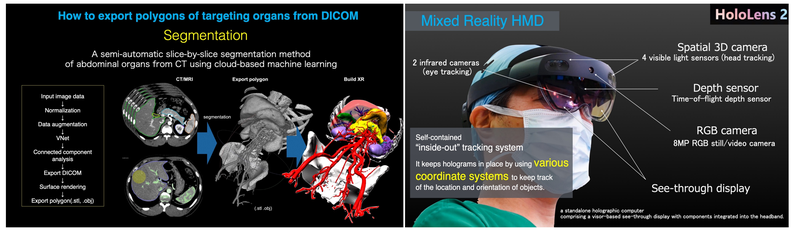
The metaverse and XR-guided navigation improves spatial awareness in robot-assisted endoscopic pancreatic surgery

Maki Sugimoto, MD, PhD, Takuya Sueyoshi
Innovation Lab, Teikyo University Okinaga Research Institute. Tokyo, JAPAN

【Purpose】

Robot-assisted endoscopic surgery lacks tactile perception, and stereoscopic endoscopes overcome its limitations. However, that spatial awareness is lacking as long as surgical aids such as 3D-CT images are displayed on a flat display (TilePro in daVinci). To improve spatial recognition in robot-assisted endoscopic surgery, we developed a surgical support system utilizing metaverse and XR (extended reality) technology and verified its usefulness in 20 pancreatectomies.

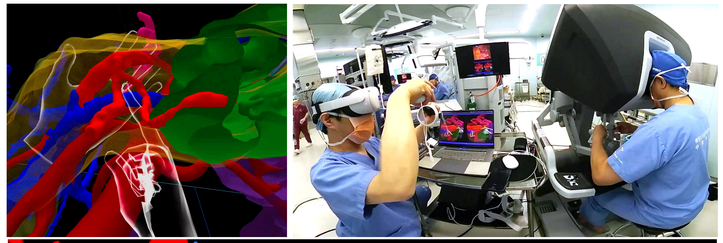
The metaverse is a network of 3D virtual worlds focused on social connection. These worlds are accessed through a virtual reality headset which immerses the user, stimulating what is known as presence, created by generating the physical sensation of actually being there. The core technology of the metaverse is XR, which encompasses virtual reality (VR), augmented reality (AR), and mixed reality (MR).

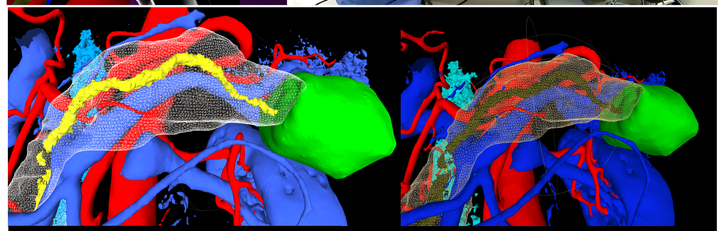


【Methods】

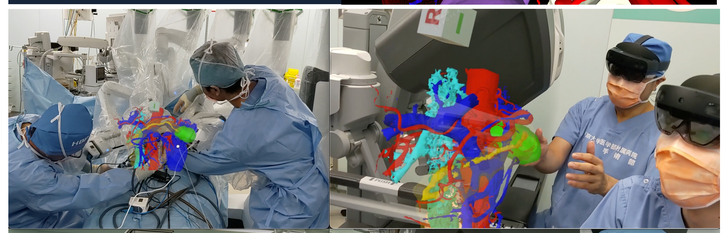
Over 5 Asian surgeons received the training in a virtual environment. All the equipment they needed was a head-mounted display (HMD).

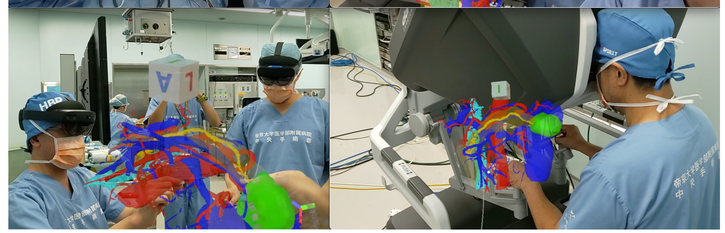
We applied a holography-like 3D guide to organs, lesions, and procedures based on 3D-CT images of individual patients, to create a stereoscopic view in the real space above the surgical field to allow viewing in all directions. We also created lifelike 3D avatars of the surgeons, acting as if next to each other in the metaverse.











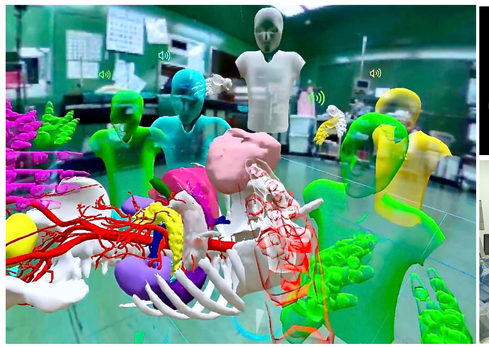
【Results】

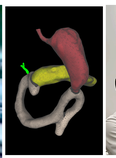
In all surgeries (20/20, 100%), we could accurately reproduce the organs (pancreas, pancreatobiliary tract, artery, vein, duodenum, stomach, jejunum, ileum, and peripheral organs) and tumorous lesions from the preoperative CT images as holography and display the resection lines to guide surgical procedures in a sterile space above the patient's abdomen during actual surgeries.

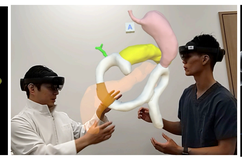
These systems were set up at an average of 5 minutes and did not affect postoperative adverse events (0/20, 0%).

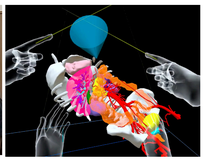
The positioning error of superimposing virtual models was within 2 mm.

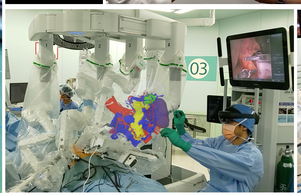
The avatars enabled them to work more efficiently and effectively brainstorming, and sharing virtual contents at room scale as if they were in the same room.

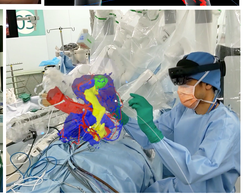












【Discussions & Conclusions】

The holographic guidelines presented in the operating field were helpful in on-the-job training, as surgeons could share their positions and movements of their hands.

Compared with conventional expensive navigation systems, this system is far easier to introduce. The program is already certified as a medical device in Japan, allowing all clinical cases to be XR-application from all over the country for efficient telemedicine.

Conclusions

Our cross-platform metaverse XR collaboration app enabled holographic telepresence through augmented reality, turning any operation room into a 3D workspace. With our system, users connect remotely and express ideas seamlessly using lifelike avatars, unlocking a new level of computing that is not confined by space, no matter what device they are using.