

Live-Streaming From the OR Using a Plug-and-Play Device



An inexpensive device could lead to improvements in surgical education.

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The COVID-19 pandemic has highlighted the possibility of using telemedicine in ophthalmology to limit in-person visits and prioritize the safety of our patients and staff members.^{1,2} With many elective operations canceled or postponed, educational conferences and didactics transitioning from in-person to virtual, and reductions of nonessential personnel in the OR, there is a need to adapt and improve the surgical curriculum of clinical fellows, residents, and medical students.³⁻⁵ Video-based education, virtual didactics, and virtual simulation are some of the components that can be employed in a multipronged approach to redesigning surgical education.⁶ Other innovative solutions include implementing a flipped virtual classroom model, providing online practice questions, and engaging residents in telehealth clinics.⁷

Hands-on learning in the OR cannot be replaced, of course, but technological advancements in hardware, software, and transmission capabilities make telesurgery a promising tool to improve virtual surgical education.

Previously in *Retina Today* we have discussed the benefits of transitioning to a heads-up 3D surgical platform (Ngenuity Visualization System, Alcon) and the use of a 5G cellular network to broadcast high quality vitreoretinal surgery to a remote location.^{8,9} In this article, we explore the potential value of telesurgery in improving the educational experience of clinical trainees. We present our experience with a user-friendly, off-the-shelf video capture device that enables clinicians to seamlessly

livestream surgeries from the OR. We review how to capture, transmit, and view live surgery using this plug-and-play solution in an effort to enhance surgical education.

BASIC SETUP Video Capture

The Magewell USB Capture HDMI 4K Plus (Figure) is an inexpensive, commercially available (\$459 on Amazon.com) plug-and-play device that enables transfer of 4K resolution video from an HDMI source to a computer for livestreaming. We have been using the input source in the OR from the Ngenuity 3D surgical platform connected to the Magewell device, with output of surgical video to a

AT A GLANCE

- ▶ New uses of telemedicine have emerged during the COVID-19 pandemic.
- ▶ A plug-and-play device can be used to stream live video from the OR to a distant audience of fellows, residents, and medical students.
- ▶ The technology could also be used to offer consultation to surgeons in areas with limited access to specialty care.

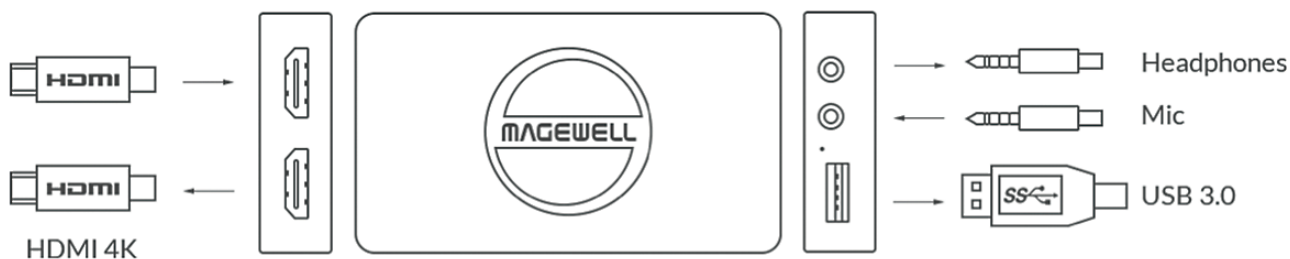


Figure. Design of the Magewell device used in the OR. Source: Magewell.

MacBook Pro. The device is compatible with Windows, Linux, Mac, and Chrome OS operating systems.

The Magewell interface features input resolution up to 4,096 x 2,160 pixels, loop-through HDMI signal, and audio input via microphone, and extraction of HDMI embedded audio output via headphones. The device is compact (5.4 x 5.3 x 1 in), light (8 oz) and can function continuously for 24 hours, 7 days a week, without an external fan or other cooling mechanism, as it has a built-in cooling fan.

Transmission

Two-dimensional or 3D video (using Ngenuity) can be transmitted using open-source software such as OBS or commonly used platforms such as Zoom, YouTube, and Facebook Live to broadcast live surgery. We have been piloting the use of Zoom to transmit vitreoretinal surgical cases to viewers in several states in the United States and in other countries.

Zoom has the benefit of allowing real-time discussion during surgery. Zoom provides high level end-to-end encryption with AES 256 GCM transport encryption for an added level of privacy and security.

We have also explored the use of YouTube Live private channels to allow multiple viewers to attend live surgery channels; however, latency on YouTube varies from 10 to 30 seconds, thus precluding real-time discussion.

Other supported software that can record or transmit 4K video captured by the Magewell device includes VLC,

vMix, and XSplit. Video processing features of the system include cropping, scaling, deinterlacing, aspect ratio conversion, and color format conversion, allowing a high degree of video editing if desired.

Viewing

Viewing options include 2D and 3D, depending on video transmission type and viewing hardware and software. The Magewell device supports extraction of 3D format information, including side-by-side (SBS), top-and-bottom, and frame-packing (single frame) 3D modes.

Viewers can use a desktop or laptop computer to watch 2D video or choose a 3D viewing experience on a desktop or laptop by using video software conversion to Anaglyph 3D combined with compatible 3D glasses. In addition, 3D SBS video can be viewed on a low-cost virtual reality headset with mobile phone insertion.

VARIED USES

The Magewell video streaming device can be used in a variety of settings. Live broadcasting of surgeries can offer surgical training to a widespread audience of remote trainees. As noted, viewing platforms such as Zoom allow surgeons to discuss important aspects of the case, and trainees have the ability to ask questions in real time. In addition, the surgeon's view with superimposed instrument settings of the Ngenuity can be made visible to the audience.

Live video streaming can also be used for telementoring, to provide

surgical expertise and remote consultation to geographic areas without access to specialty surgical care. A pyramid structure, whereby an expert retina surgeon is on call to provide assistance to multiple junior surgeons operating in remote locations, could be used to improve access to specialized surgical care for difficult cases and improve surgical outcomes.

Furthermore, use of this video capture technology may offer a practical tool to address disparities in global surgery by improving surgical education.¹⁰ An anterior segment colleague, Kevin M. Barber, MD, has demonstrated success using the Magewell device and our protocol to train cataract surgeons in Honduras with real-time communication. Thus, this plug-and-play technology has the potential to democratize access to specialty surgical care and education on a global scale.

FUTURE DIRECTIONS

The Magewell video capture device offers a simple solution to live-streaming vitreoretinal surgery with applications in surgical education, telementoring, and remote consultation, on both a local and global level.

Robotic ophthalmologic surgery is still in its nascency, but the use of robotic assistance and smart instruments has the potential to improve the precision and safety of vitreoretinal surgery.¹¹ Livestreaming of robotic surgery may become an important tool to teach novel surgical approaches to trainees while allowing feedback and discussion.

With the growth of video-based and virtual education, imagine a future in which trainees can tune in live to cases from across the globe based on their individual learning needs and preferences. With telesurgery expanding access to expert surgical education, in the future, surgeons will be able to gather more surgical knowledge and virtual experience before entering the OR in person. ■

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