

Photoacoustic Fiberscope for Gastroenterology

Gastrointestinal (GI) cancer is a significant public-health problem, causing more than 1 million deaths worldwide every year. Early screening and diagnosis of GI cancers rely on endoscopy, which typically uses a camera at the distal end of a flexible probe to view the internal organs. However, endoscopy's low imaging contrast and penetration depth hinder the detection rate for GI cancers.

Recently, we demonstrated a photoacoustic endoscope based on fiber optics.¹ The imaging probe contains two optical fibers, one for guiding laser pulses to the biological tissue for ultrasound generation and the other for ultrasound detection. Helically scanning the probe enables a 3D photoacoustic image to be formed. We demonstrated, for example, that this endoscope can image the vascular structure and visualize the oxygen saturation changes of a rat rectum due to acute inflammation. The resulting image of the hemodynamic response can provide valuable diagnostic information to doctors.

Photoacoustically induced ultrasound waves in biological tissues are significantly weak in themselves—but the acoustic waves can induce strong modulations in intensity, phase or polarization of light that can be picked up using optical sensors. Our setup used a tiny continuous-wave fiber laser for ultrasound detection. The laser converted acoustic deformation into a phase variation of the laser light to amplify the ultrasound sensitivity. Heterodyne phase detection using the two highly correlated orthogonal laser beams was employed to exclude the disturbance of thermal drift and mechanical vibrations. As a result, the sensor maintained

a stable ultrasound response during fast rotational scanning.

We believe the photoacoustic endoscope we demonstrated promises to complement video endoscopes to detect GI lesions, as it can be inserted through the same instrument channel. Our hope is that it can help distinguish cancerous tissues from the healthy ones and estimate the tumor boundaries. The team is performing further experiments in larger animals such as swine, aiming ultimately at clinical applications. **OPN**

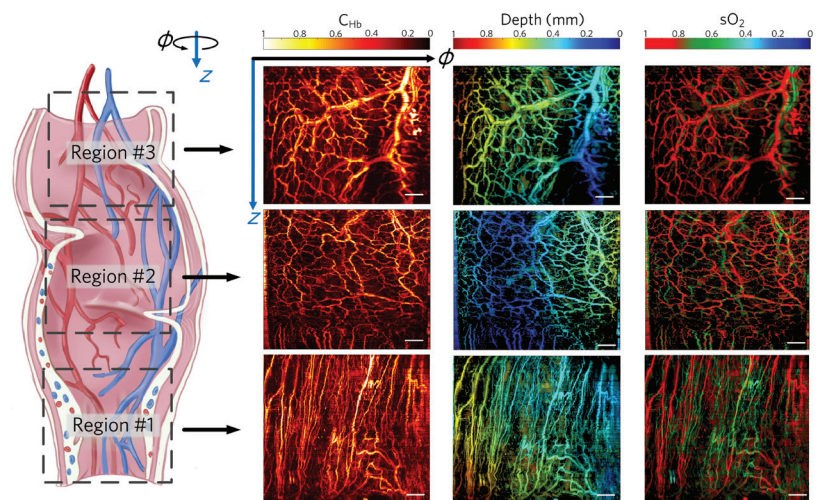
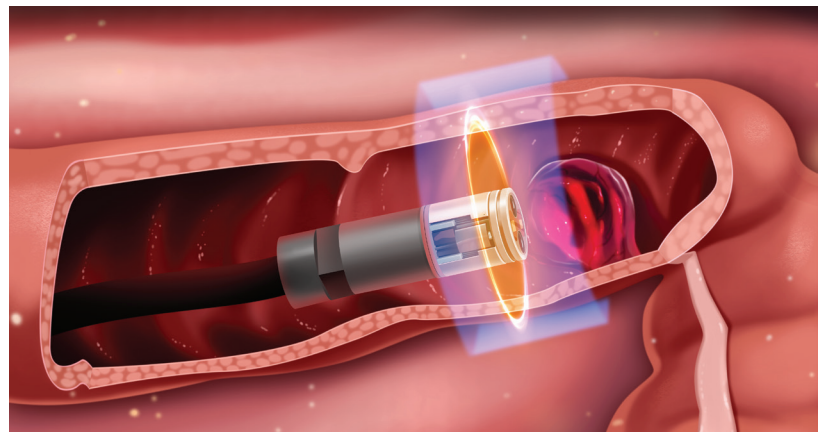
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REFERENCE

1. Y. Liang et al. Nat. Commun. **13**, 7604 (2022).



Top: Schematic of the photoacoustic fiberscope for gastrointestinal endoscopic imaging. Bottom: *In vivo* imaging results of the hemoglobin concentration (C_{Hb}), depth and oxygen saturation ($s\text{O}_2$) in three different regions of a rat rectum.