



CASCADE 2027 NON-CONFIDENTIAL SUMMARY »

Meta-Optic Ultrathin Catheter Endoscopes for Image-Guided Interventions

Overview

Every year, more than 800,000 people in the US suffer from stroke, a number that is continuously increasing as the life expectancy of the general public improves. Thrombectomy gives the best chance for recovery from strokes, but current medical instrumentation, which incorporates traditional refractive optics, are too bulky to maneuver deep into narrow and tortuous arteries. GuideEye is an ultrathin, flexible forward-viewing endoscope featuring a metasurface lens for accessing constrained and previously inaccessible parts of the human body. To truly reach arbitrary locations for stroke removal in the brain, with minimal impact on the surrounding tissue, we have developed optics capable of being reduced to the order of 500 μm , enabling access to even the narrowest blood vessels in the brain.

Description

GuideEye is a miniaturized endoscope featuring a sophisticated combination of ultraminiature optical elements and a computational backend. We replace the commonly used refractive lens with sub-wavelength diffractive optics, known as meta-optics, which are not only thinner (only ~ 1 μm thick) than a common refractive lens (~ 1 mm), but also implement the desired optical functionality to encode the spatial information at the end of the fiber tip into a distinct spectral signature for computational reconstruction. This effectively reduces the number of physical channels required to convey information to a measurement setup at the other end of the fiber, where the signal is decoded, and a spatial intensity image is reconstructed. In total, we achieve a size reduction in the rigid tip length, due to the smaller size of the meta-optic and minimize the diameter of the endoscope, by limiting the fiber size that is used for imaging. Surgeons will consider GuideEye an indispensable tool for direct visualization in image-guided surgical treatment of cardiovascular diseases.

Technology Readiness Level (TRL)

TRL 4 — System or subsystem components tested in a laboratory environment. The team has demonstrated image capture with a metasurface as an endoscope lens and are working on the computational backend for further image clarity.

COMOTION REFERENCE »

BDP 8841

INNOVATION MANAGER »

Forest Bohrer

SECTOR »

Medical Device

LEAD INVESTIGATORS »

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Value Proposition

- Ultraminiature optics in a single fiber endoscope will enable access to previously inaccessible blood vessels in the brain where strokes may not be treatable using conventional methods.
- Removing the mechanical portion of the optic will further reduce overall volume and rigidity of the angioscope tip, further enabling access to tortuous vessels.
- Computational image processing will enable reductions in the optical bundle, increasing space for the interventional elements of the tool.

Intellectual Property Position

[US20250362175A1](#) – Patent application pending.

Market Opportunity

- The market size for endovascular neurosurgery for ischemic stroke treatment is \$2B with ~ 240,000 interventions per year in the US.
- Potential for non-medical markets, including microscopic tool inspection, in high technology fields like semiconductor processing.
- Adjacent medical markets include endovascular cardiac surgery, bronchoscopy, otolaryngology, and peripheral vasculature re-opening.

References

1. Xie, N.; Tanguy, Q.; Fröch, J.; Böhringer, K.; Majumdar, A. "Spectrally Encoded Nonscanning Imaging through a Fiber." ACS Photonics, 2024, 11(3), 1117–1124. URL: <https://pubs.acs.org/doi/10.1021/acsp Photonics.3c01582>