SACI Office of Society Academia Collaboration for Innovation
KYOTO UNIVERSITY

Photoacustic 3D imaging-based devices for clinical and research applications

We are looking for companies interested in adopting our devices.

Background

Various diseases such as diabetes, cardiovascular disorders, collagen diseases, and cancer are characterized by blood vessel damage or induced angiogenesis. However, there are no technologies that allow high-resolution non-invasive imaging of blood vessels. The techniques currently used in the clinical settings require contrast agent administration and exposure to X-ray or expensive contrast magnetic resonance imaging (MRI). The present invention is a non-invasive blood vessel imaging device which is based on photoacoustic (PA) tomography (PAT) that utilizes light absorption of hemoglobin.

Technical Summary

The inventors developed a photoacoustic imaging (PAI) system equipped with a hemispherical detector array (HDA) receiving PA signals. Two prototypes were made, PAI-03 and PAI-04, utilizing 795 nm, and 756 + 797nm wavelengths respectively (Matsumoto et al. 2018). PAI-04 is an enhanced version with better specifications to ensure large-area, high-resolution blood vessel analysis (Fig. 1). The system allows for a spatial resolution of 0.27 mm and to distinguish arteries and veins by evaluating hemoglobin oxygen saturation (SO2).

Figure 1. Non-invasive, ultra-high-resolution 3D image of blood vessels is obtained.

➢ Breast cancer diagnosis and flap reconstruction surgeries

The inventors have validated the system for breast cancer imaging and confirmed that small tumour-related blood vessels could be visualized. The device can be used in the clinical setting for differentiating between benign and malignant tumors, monitoring drug treatment efficacy, as well as for mastectomy and breast reconstruction. Another application is preoperative planning for reconstruction flap surgeries. The device usage shortens operation time and reduces the risk of blood flow disorders. The system's design is also suitable for animal experiments, i.e. rodent vascular network can be visualized (Asao et al. 2023)**.**

➢ Lymph vessels can also be visualized

The device can be used for lymph vessel imaging to perform lymphatic venous anastomosis (LVA) supermicrosurgery for lymphedema. Unlike blood vessels, lymph vessel visualization requires the use of dye because lymph does not absorb light.

Technology Readiness Level

7
Medical and non-medical scanners are available

Potential Applications

- Breast cancer diagnostics
- Flap reconstruction surgeries
- Visualization of aging-associated vascular changes
- LVA surgeries
- Animal experiments

Possible Collaboration Mode(s)

- Licensing
- Rental and purchase

Patent No

Pharmaceutical approval No. 30400BZX00212000 (Japan)

Publication(s)

Matsumoto Y, Asao Y, Sekiguchi H, Yoshikawa A, Ishii T, Nagae K-I *et al.* Visualising peripheral arterioles and venules through high-resolution and large-area photoacoustic imaging. *Sci Rep* 2018; **8**: 14930.

Asao Y, Nagae K, Sekiguchi H, Aiso S, Watanabe S, Sato M *et al.* High-resolution photoacoustic 3D imaging system for animal experiments using a hemispherical detector array. In: *Photons Plus Ultrasound: Imaging and Sensing 2023*. SPIE, 2023, pp 54–66.

Luxonus is a start-up that develops photoacoustic imaging systems for vascular vessel visualization.

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