Multimodal imaging systems with photoacoustic tomography, optical coherence tomography, and fluorescence imaging

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We present fiber-based multimodal imaging systems that integrated non-contact photoacoustic tomography (NCPAT) and optical coherence tomography (OCT), and NCPAT and Fluorescence imaging (FI). These two combined systems can provide PA & OCT image and PA & Fluorescent image, respectively.

NCPAT is utilized a Mach-Zehnder interferometer with a fiber laser of 1550 nm, which measures the photoacoustic signal on the sample surface remotely. The fiber-based OCT is composed of Michelson interferometer with a swept-source laser (center wavelength: 1310 nm, bandwidth: 100 nm), which allows combining with NCPAT by sharing the same optical fiber.

The fluorescence imaging system consisted of fiber optics such as a fiber laser of 405 nm, a double cladding fiber (DCF) coupler and a fiber-type spectroscopy.

In the combined NCPAT and OCT system, two lights from 1550nm laser and OCT source are guided into one probe using optical fiber coupler and illuminate the sample. Back-reflected lights from the sample are guided to the respective imaging systems by the same probe. While, in the combined NCPAT and FI system, two laser light sources of FI (405nm) and NCPAT are combined through a wavelength-division multiplexing coupler, and guided via the core of DCF. Reflected light (1550nm) from the sample surface is detected after guiding through the same core of DCF, whereas the fluorescent emission light is separated from excitation light and 1550nm laser and detected through the inner cladding of DCF coupler.

To demonstrate the feasibility of the combined systems, we have carried out a phantom experiment. We believe that the proposed combined systems; NCPAT & OCT system, and NCPAT & FI system, can be applied in the field where noninvasive, noncontact, or minimally invasive imaging is specifically required.

This work was supported by Industrial strategic technology development program, 15ZC1710 funded by the Ministry of Science, ICT and Future planning in Korea.