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Article / Book Information

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（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	Information Processing 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 (Engineering) Doctor of
学生氏名： Student's Name	Zeng Xi	指導教員（主）： Academic Supervisor(main)	Kentaro Nakamura
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Noninvasive imaging and sensing technology for health diagnosis and biomedicine research is one of the most stimulating fields. There are several conventional methods available, such as X-ray, magnetic resonance imaging, ultrasound and optical methods (microscopy or optical coherence tomography). But these have limitations in imaging depth or spatial resolution or cost. Photoacoustic method is a promising solution combining optical and acoustics techniques and has a possibility to overcome some of the limitations with conventional methods. Photoacoustic tomography could provide good detecting depth with higher resolution and contrast. It is a suitable method for opaque and solids, especially for biological structures. Photoacoustics has been applied in different fields in the past 30 years, including material science, gas analysis, and biomedicine. Number of paper publications related to photoacoustics has been increasing for this decade. Among them, medical application of photoacoustic tomography is rapidly expanding. In the first generation of photoacoustic imaging, it adopts human elements as target absorber. Recently, second generation adopting high-absorption contrast agent is becoming hot topic since it has a possibility to extend the application from genetic to whole human body imaging. Thus, it is important to shorten the development period of highly efficient contrast agent.

To meet the demand, we have proposed a compact and cost-effective evaluation system for photoacoustic contrast agents for biomedicine application. This system adopts dual laser diodes at different wavelengths (660 and 785 nm) working with modulated continuous waves and a small microphone of low-frequency (kHz) region. As preliminary measurement, the characteristics of the photoacoustic system were experimentally invested for ink solutions (black ink and dye ink) and their mixture. The proposed system could distinguish a 10-mg/dl concentration difference of the black ink solution and the mixture ratio of black and dye ink. It was also possible to discriminate a small absorption difference of water at the wavelengths of 660 and 785 nm.

Next, some of known contrast agents were tested using this photoacoustic system to confirm its effectiveness and sensitivity as a standard evaluation system. It was succeeded to distinguish 2.5 mg/dl of the concentration difference of ICG solution. It was proved that the proposed method could be applied for sample with small volume, and could be used for liquid, solid and powder. Moreover, the high sensitivity and characteristics of this PA evaluation system have been demonstrated in this thesis.

Beside the photoacoustic evaluation system, a novel acoustic detector array was proposed and investigated with thinking future application for photoacoustic imaging. Piezoelectric ceramic (PZT) transducer has been used for conventional acoustic detector and its array has problem with metal wire bundle, which are heavy, large and short in transmitting distance. Here, we proposed a new acoustic detector, called 'LED-PZT sensor array,' which consists of light emitting diode (LED) and PZT element, and its output signals are transmitted through a plastic optical fiber. Preliminary measurements using a single LED-PZT sensor were demonstrated for 26-kHz, 38-kHz and 1.6-MHz ultrasound fields underwater, respectively. Then, the sensor array with four LED-PZT sensors were utilized to measure sound pressure distribution in the 26-kHz ultrasonic field in water and demonstrated its effectiveness by comparing the results with a conventional hydrophone. Sound intensity is an important vector quantity in acoustics and capable to provide both magnitude and direction of the energy flow by sound waves. We used four LED-PZT sensors, called sound intensity probe, to measure sound intensity distribution in 26-kHz ultrasonic field in water. Differences were successfully observed in the sound intensity maps between with and without absorbers on the walls of water tank. It has no limitation to extend cable length of sensor and no concern with the weight of cable (33% of conventional hydrophone weight). A possible configuration for large scale arrayed detector utilizing wavelength division multiplexing technique was discussed.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).