【Grant-in-Aid for Scientific Research (S)】

Integrated Disciplines (Complex Systems)

Title of Project : Toward New Frontiers in High-Resolution 3D Color Radiology Imaging

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Research Project Number : 15H05720　Researcher Number : 90334507
Research Area :　Radiological physics and technology
Keyword :　Medical imagin system, 3D imaging, Compton camera

【Purpose and Background of the Research】

3D image processing is commonly used in projection mapping, stereo vision, and even printers. In contrast, only monochromatic 2D static images are currently available for radiology imaging applications such as radiographs and X-ray CT. Our challenge is to obtain high-resolution, color X-ray/gamma-ray images in real time in order to visualize the 3D structure and materials of a subject as well as the dynamic evolution of phenomena of interest. In this research, we realize three innovations: (A) high-precision X-ray and gamma-ray imaging technology, (B) 3D medical Compton imager, and (C) wide-field 3D monitor for applications to environmental surveys.

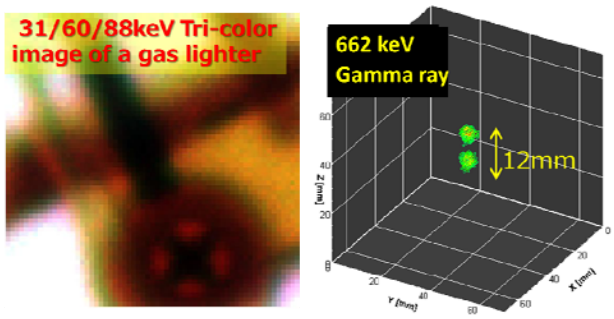

Fig.1: (left) Tri-color image using diced scintillaotr array (right) 3D gamma-ray image using Compton camera.

【Research Methods】

As a high-precision X-ray image sensor, we fabricate various scintillator plates that are cut using a microdicing saw. We aim to demonstrate improved SNR (signal to noise ratio) in the photon counting image in order to reduce the radiation dose in the X-ray CT scan. With regard to gamma-ray energies, we use two approaches: (1) 3D Compton imaging of multiple radionuclides and (2) beam-online monitor for proton/ion beam therapy. By using our prototype Compton camera, we optimize the detector design to achieve a high-resolution handheld medical Compton camera. This camera can also be used for applications to environmental surveys; for example, it can serve as the payload of a helicopter to measure the radiation dose in the forests near Fukushima or as a wearable gamma camera for performing effective decontamination operations.

【Expected Research Achievements and Scientific Significance】

Since Roentgen's discovery of X-rays in the 19th century, the visualization of "invisible" radiation has remained a challenge. The image sensor developed in this study is very simple, cost effective, and versatile. To date, we have developed a novel method to localize the incident gamma rays three dimensionally with 1-mm precision. While this technique has already been implemented in a PET (511 keV) detector, we will now apply it to the 3D measurements of gamma rays with arbitrary energy (up to 2 MeV) that is not limited to 511 keV.

【Publications Relevant to the Project】

・J.Kataoka *et al.*, "Recent progress of MPPC based scintillation detectors in high precision X-ray and gamma-ray imaging", *Nucl. Instr. and Meth. A.*, vol.784, pp.248-254 (2015)
・T.Fujita, J.Kataoka *et al.*, "Two dimensional diced scintillator array for innovative, fine resolution gamma camera", *Nucl. Instr. and Meth. A.*, vol.765, pp.262-268 (2014)
・J.Kataoka *et al.*, "Handy Compton camera using 3D-position sensitive scintillators coupled with large-area monolitic MPPC-arrays", *Nucl. Instr. and Meth. A.*, vol.732, pp.404-407 (2013)

【Term of Project】 FY2015-2019

【Budget Allocation】 112,200 Thousand Yen

【Homepage Address and Other Contact Information】

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