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Fundamental Study on Reconstruction of 3D Image Using Camera and Ultrasound

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Abstract : The Government of Japan and Tokyo Electric Power Company Holdings, Incorporated (TEPCO) are struggling with the decommissioning of Fukushima Daiichi Nuclear Power Plants, especially fuel debris retrieval. In fuel debris retrieval, amount of fuel debris, location, characteristics, and distribution information are important. Recently, a survey was conducted using a robot with a small camera. Progress report in remote robot and camera research has speculated that fuel debris is present both at the bottom of the Pressure Containment Vessel (PCV) and inside the Reactor Pressure Vessel (RPV). The investigation found a 'tie plate' at the bottom of the containment, this is handles on the fuel rod. As a result, it is assumed that a hole large enough to allow the tie plate to fall is opened at the bottom of the reactor pressure vessel. Therefore, exploring the existence of holes that lead to inside the RCV is also an issue. Investigations of the lower part of the RPV are currently underway, but no investigations have been made inside or above the PCV. Therefore, a survey must be conducted for future fuel debris retrieval. The environment inside of the RPV cannot be imagined due to the effect of the melted fuel. To do this, we need a way to accurately check the internal situation. What we propose here is the adaptation of a technology called 'Structure from Motion' that reconstructs a 3D image from multiple photos taken by a single camera. The plan is to mount a monocular camera on the tip of long-arm robot, reach it to the upper part of the PCV, and to taking video. Now, we are making long-arm robot that has long-arm and used at high level radiation environment. However, the environment above the pressure vessel is not known exactly. Also, fog may be generated by the cooling water of fuel debris, and the radiation level in the environment may be high. Since camera alone cannot provide sufficient sensing in these environments, we will further propose using ultrasonic measurement technology in addition to cameras. Ultrasonic sensor can be resistant to environmental changes such as fog, and environments with high radiation dose. these systems can be used for a long time. The purpose is to develop a system adapted to the inside of the containment vessel by combining a camera and an ultrasound. Therefore, in this research, we performed a basic experiment on 3D image reconstruction using a camera and ultrasound. In this report, we select the good and bad condition of each sensing, and propose the reconstruction and detection method. The results revealed the strengths and weaknesses of each approach.

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