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P1.7: Development and performance evaluation of high-speed gamma imaging system for Korea Customs Service

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The Korea Customs Service presently employs radiation portal monitors (RPM) and hand-held survey meters to detect nuclear and radioactive materials in imported cargo at airports and harbors. However, these devices lack imaging capabilities and only provide count rates or dose rates, making it time-consuming to localize nuclear or radioactive materials. This study introduces a high-speed gamma imaging system developed for the Korea Customs Service, which quickly localizes and identifies radioactive materials in cargo using a hybrid gamma imaging technique that combines Compton imaging and coded aperture imaging. The system consists of eight rectangular (146 mm x 146 mm}) NaI(Tl) crystals, 72 square-type PMTs, a 72-channel high-speed FPGA-based DAQ, and a notebook computer. It offers exceptional performance in source localization, isotope identification, and dose rate estimation, while maintaining high mobility on a motorized cart that absorbs shocks and vibrations. The system's performance was assessed using Cs-137 check sources at various locations. In low dose rate scenarios (0.03 μSv/h above background dose rate), the system detected the source in approximately 0.3 milliseconds and localized its position within roughly 2 seconds. Even under lower dose rate conditions (9 μCi Cs-137 source at 5 m or 0.001 μSv/h incremental dose rate), the system imaged the location of the source within 5 minutes. Under these conditions, the system also estimated the ambient dose rate with an error of less than 25%. These experiments demonstrate the system's ability to quickly localize and identify nuclear and radioactive materials, and it is anticipated that this technology will effectively supplement existing radiation imaging devices at airports and harbors.

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