Development of IoT-based radiation detector for real-time measurement of decontamination effects

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INTRODUCTION

- In order to confirm the decontamination effect during decommissioning of the nuclear power plant, it is necessary to measure the radiation dose before and after decontamination of the decontamination target. IoT-based portable wireless radiation detector has been developed to replace the current method of direct measurement by decontamination workers.
- By transmitting the measured dose rate to the radiation integrated management system by Zigbee-based wireless communication technology, this detector can provide basic data to check whether the worker is working in accordance with ALARA(as low as reasonable achievable) conditions.
- The detector measures the dose using two sensors(scintillation and Geiger Müller) for wide-range measurement, and a movable support was designed and developed to be loaded and moved up, down, left and right.

DEVELOPMENT

[Dual detector for gamma-ray measurement]

- General Specification
  - Detector Sensor #1 : Scintillation Detector (0.1μSv/h ~ 200 mSv/h)
  - Detector Sensor #2 : GM-Counter (100 mSv/h ~ 1Sv/h)
  - MCU: Cortex M7
  - Wireless communication: Zigbee Network (XBEE3)
- Automatically measure GM detector in high dose range and scintillation detector in low dose range.
- Decontamination factor(DF) calculation to check decontamination status as follow:

$$DF = \frac{DR_{(before)}}{DR_{(after)}}$$

- *$DF_{(before)}$: Dose Rate before Decontamination*
- *$DF_{(after)}$: Dose Rate before Decontamination*

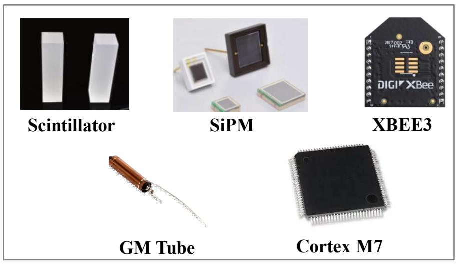

Fig. 1. IoT-based Radiation Detector Configuration

[Detector Accuracy Test]

- Comparative measurement test with a commercial calibrated detector
  - Radiation source: Cs-137, 5 μCi
  - Distance from the source: 1cm, 5cm, 10cm, 20cm

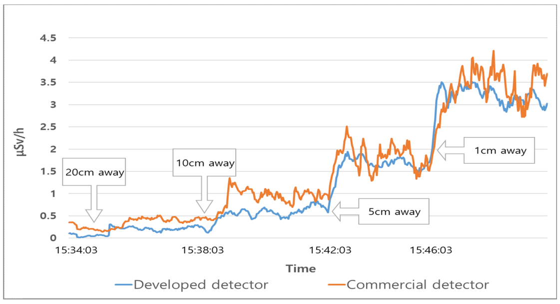

Fig. 2 Comparison of measured radiation values

[Prototype development]

- Possible to measure the radiation dose by using a tripod and support with adjustable height
- A built-in chargeable battery with a power saving function for long-term usage

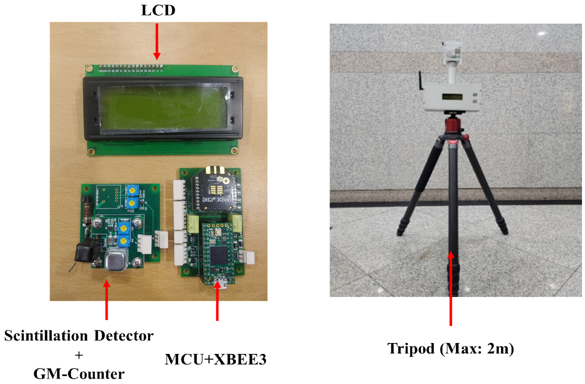

Fig. 3 Prototype of IoT-based wireless radiation detector

[IoT-based wireless communication network]

Scintillation Detector / GM-Counter + Router + Coordinator + Management Server

- Data communication between detectors and Server through multi-routers and coordinators
- Possible to check the dose value of the radiation measurement point in real time outside the reactor building such as main control room

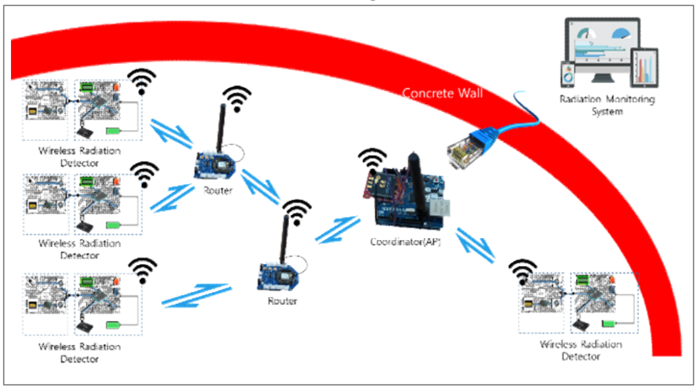

Fig. 4 Wireless network configuration using IoT-based Zigbee communication

Conclusions

- The radiation detector developed in this study can simultaneously measure a wide range of high-precision measurements by applying a scintillation detector and a Geiger-Müller counter.
- Also, It is designed to be easily moved vertically or horizontally and to transmit the measured data wirelessly through Zigbee-based wireless communication.
- Due to its portability and convenience, this developed radiation detector is expected to be used not only in measuring radiation dose in the decontamination process of nuclear power plants, but also in operating nuclear power plants.

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