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Developing ADR-POS for Worker's Safety during Dismantling Nuclear Power Plant

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1. Introduction

Nuclear power plants need to integrate the technology developed in the 4-th industrial revolution as the direction of industrial development is shifting to taking advantages of the fourth industrial revolution[1]. The 4-th industrial revolution applicable to nuclear power plants has various fields such as security, control, medical care and safety. The above task aims to apply the technology developed in the 4-th industrial revolution to nuclear power plants for the purpose of control and safety. There are two reasons for applying the technology developed in the 4-th industrial revolution. First, there is not only a risk of external exposure inside a nuclear power plant, but also is a risk of accident occurrences due to mechanical defects in the mechanical components inside the plant. Second, the present government is dismantling old nuclear power plants while trying to gradually reduce the establishment and the operation of nuclear power plants.

But there are not enough technique and experience to decompose the nuclear power plants ensuring the worker safety. Thus, the utilities have to come up with the safety solutions for worker during this process. In this study, the NESS propose the way of monitoring the workers for safety during the dismantling of nuclear power plant coupled with IOT technique[2]. The advantage of the new model(ADR-POS) is that it is possible not only to check the dose level but also to track the operator's location in collaboration with work control and safety countermeasures from the viewpoint of nuclear control. So, the worker and the outside person in charge of the work flow control can monitor simultaneously. Also it is possible to manage the radioactivity of each zone within a nuclear power plant.

2. System Construction – ADR-POS

The NESS design the new model which is called ADR-POS that can detect the dose level and personnel's location. The circuit was configured to control the main processor (Arduino Pro mini) by combining the radiation sensor[3] circuit and the UWB[4] location tracking circuit in order to manufacture ADR-POS module based on the location tracking module and the radiation sensor board. The circuit consists of the main processor, the UWB positioning circuit, the radiation sensor circuit, and the ESP8266 Wi-Fi circuit. Based on this, the part of module is selected as shown in the left of Fig. 1 for the actual PCB work.

The power can be supplied by a 5V battery. The terminal uses a micro B type terminal. Wi-Fi uses ESP8266. ADR-POS is designed to lower the voltage using Level Shifter because the required driving voltage is 3.3V.

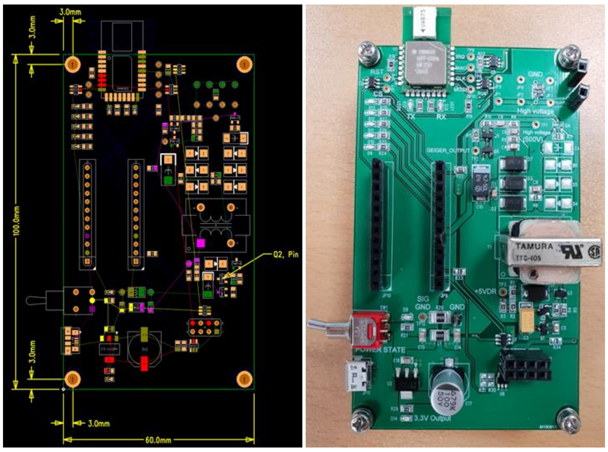

Fig. 1. Positioning dose module PCB board (left), component placement PCB board (right)

3. Experiment for position and dose level

3.1 Experiment

The experiment was conducted in the normal condition and the environment containing 0.2% Uranium Glass using the ADR-POS manufactured for the location and dose test. The experiment was conducted in the laboratory on the 1st floor. The size of laboratory is 10.86m width and 8.98m length. Tracking path for real time location is as follows. Start near the laboratory door (4.05m, 0.35m) and moved along the guide, which was denoted on floor. First, move 7.13m in the y direction, then 4.45m in the x direction, -4.98m in the y direction, and -4.45m in the x direction (4.05m, 2.15m) along the path. Four anchors were installed at each position. The positions of the anchors were (0.35m, 0.6m), (0.45m, 8.58m), (9.87m, 8.57m), and (10.27m, 3.05m). The experiment was performed twice. The first experiment followed along the path to measure the dose level in the laboratory environment. The second experiment was conducted in same path but in the environment of 0.2% uranium glass.

3.2 Result

Experiment results show the great accuracy. Tracking path and dose values are visualized as shown in Fig. 2 and 3. The Anchor is marked with a red X and the guideline for tracking path is indicated by a light green dashed line. The actual moving path measured using the ADR-POS is shown in blue line and the final location is indicated in red circle. In the final position, the current coordinate value (m) and the dose value (μSv/hr) are indicated. Fig. 2 shows the result of the first experiment, where the radiation dose value which is 0.1949 μSv/hr in the usual laboratory environment are appropriately represented. In addition, the result shows that moving path followed well along the tracking path guide. Fig. 3 also shows location tracking is highly accurate in the environment of 0.2% uranium glass. The dose value measured was approximately 2.0462 μSv/hr.

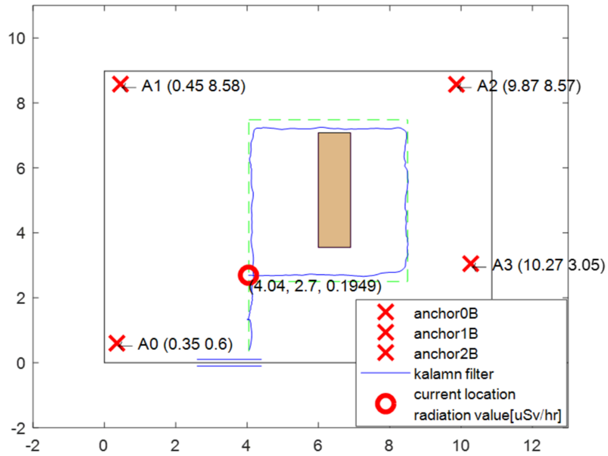

Fig. 2. Visualization of experiment result using ADR-POS(normal condition)

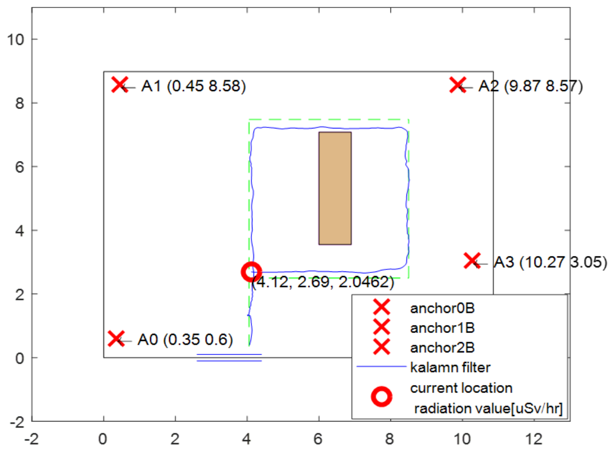

Fig. 3. Visualization of experiment result using ADR-POS(0.2% uranium glass condition)

4. Conclusions

In order to secure the safety of the workers in the nuclear power plant, ADR-POS is developed to transmit the workers' location and dose level data. UWB sensor and GM Tube were used for real-time location tracking and dose measurement. Arduino Pro Mini (MCU) was operated by main processor. In order to embed the program in the MCU, coding was done through the Arduino IDE, and then real-time position and dose information was graphically visualized through MATLAB based on the distance and dose level data obtained through the serial program. Through this, not only the worker but also the manager can obtain the real-time location of the worker and the dose data for each location, so that the worker's safety and the area's radiation leakage can be checked.

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