A Study of Drone-based Aerial Radiation Monitoring System Operation

Beom-Kyu Kim[a], Hee-Kwon Ku[a], Min-Bum Heo[a], Ji-Hoon Kang[a], Hwa-Jeong Han[b], Byung-Gi Park[b] and Sang-Hun Shin[a*]
[a]*FNC Technology Co Ltd, 32 Fl. Heungdeok-1ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea*
[b]*SoonChunHyang University, 22, Soonchunhyang-ro, Asan-si, Chungcheongnam-do, Korea*

**Corresponding author: ssh9431@fnctech.com*

1. Introduction

As a nuclear power plant accident releases highly radioactive gaseous or particulate matter, the diffusion of the atmosphere negative effects nearby areas such as radioactive fallout, dry and wet deposition, and chemical changes in particles. Therefore, nuclear power plant accidents are likely to cause secondary disasters and damage to nearby areas. The main role of detecting social disasters is to detect them early before a human disaster situation occurs and to inform residents around them to evacuate. The monitoring posts for regular monitoring and inspection of radiation perform environmental radiation measurement and monitoring in real time. However, it is widely leaked to the atmosphere in the event of an accident and impossibility to identify radiation from the height at which the monitoring post is installed. The need to analyze the effects of the spread of radioactive materials and the importance of a monitoring system to detect them were revealed. Therefore, environmental radiation information for each altitude is very important for an early response through aerial radiation monitoring in normal and emergency situations around the nuclear power plant. The Korea Institute of Nuclear Safety [1] has developed an aerial radiation probe for unmanned helicopters as a study for environmental radiation detection. Flight research using an unmanned helicopter equipped with a radiation detector provided basic data on the accident area and information on radiation disaster countermeasure technology. In addition, Korea Atomic Energy Research Institute [2] conducted a study to prepare for the case where rapid radioactivity evaluation of large-area contaminated sites is required in an area that is difficult for humans to access in the event of a nuclear accident. From this study, field applicability evaluation was performed.

Recently, drones that fly remotely or autonomously perform missions using measurement equipment mounted thereon. Drone is increasingly utilizing technology such as preventing, monitoring and responding to social disasters in advance, detecting accidents, checking whether they have accidents, and acquiring accident information. However, studies using drones and detectors are not universal and use cases are lacking, and no studies conducted by altitude have been conducted.

This study proposes a drone operation plan to specify the operating concept to provide radioactive materials or radiation measurement information of the environment around the nuclear power plant in normal situations and to apply airborne radiation measurements around the monitoring post using drones equipped with radiation detectors.

2. Methods and Results

2.1 Radiation Detector and Drone Operation Strategy

The radiation detector that can be mounted on the drone has excellent energy resolution compared to small size, and a Cadmium Zinc Telluride (CZT) detector is selected from among the radiation detectors that have the appropriate performance to discriminate radiation intensity and nuclides.

The drone operation strategy is as follows. First, although it will depend on the situation, the first factor to be considered when deploying a drone is the drone operating time. In detail, variables such as operating time using the battery, maximum load weight, and flight altitude should be considered. Second, the source term and nuclide information to be specifically measured are predicted and selected. In this case, it is necessary to understand the information of the emission source and the weather conditions in advance, and set the exposure route, measurement item, measurement point, and measurement method in detail to determine the measurement of the spatial radiation dose rate and the concentration of nuclides in the atmosphere. Finally, the measurement is carried out considering the physical and chemical properties of the radioactive material of high

importance and the effect of the measurement target on the environment.

The purpose of drone operation under normal conditions is to provide regular real-time information on atmospheric radiation. Considering the radioactive plume that moves locally, the radiation value maybe different according to various environmental conditions such as the radius of movement in the air and diffusion in the atmosphere. Therefore, the drone performs a measurement according to the altitude high step based on the installation location of the monitoring post. Since most monitoring posts are installed with the weather stations, real-time weather information can be identified at the same time.

Therefore, it is possible to acquire information such as wind direction, wind speed, temperature, and atmospheric pressure at the measurement point in the vertical direction based on the monitoring post, depending on the altitude, and possible to quickly detect the nuclides and radiation. The drone acquires the information data while hovering after ascending to a designated altitude from the monitoring post point. A plurality of drone is operated to obtain continuous information depending on the situation. The operation of the drone must transmit data measured by altitude. therefore the most important consideration for drones must be operated for a long periods of time. One of the alternatives is to use multiple drones, where the first drone takes measurements while the other drone charges. Another method is to supply power by connecting a power line to the monitoring post. The operation plan of the configured drone is shown in Fig.1.

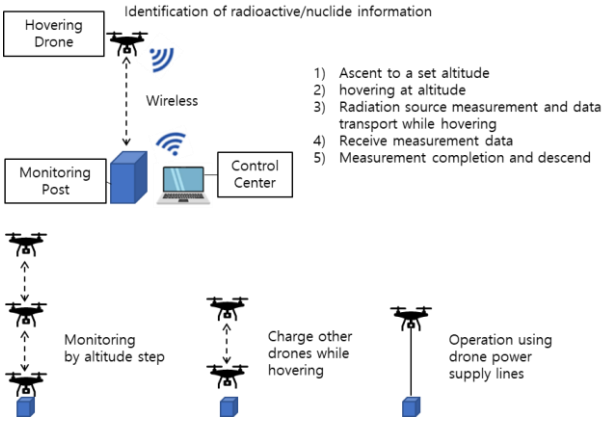

Fig.1. Drone-based aerial radiation monitoring system operation plan conceptual schematic

3. Conclusions

A drone is a platform that can be combined with a detector to quickly measure desired information by altitude. Utilization of such drones can provide information on wide-area polluted sites and atmospheric spread. As a result of the study, it is expected that it can be used to provide information for protection measures based on radioactivity level, prevention of the spread of contamination and protection of workers.

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