Study on 3-Dimensional Image Reconstruction Algorithm based on the Drone-based Aerial Radiation Monitoring Data

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1. Introduction

Continuous environment radiation monitoring of nuclear facilities is important to manage unexpected accidents. There is a need for a radiation monitoring system that overcomes the limitations of a fixed radiation monitoring system and does not depend on the terrain. As a way to solve this, various studies have been conducted on aerial radiation mapping and source localization using UAV(unmanned aerial vehicle). Radiation measurement using UAV evaluate radioactive nuclide and concentrations in the air for rapid response in the early stage of an accident and mapping of radioactive contamination for contaminated broad areas. These are used to support decision-making for rapid response in the early stage of an accident and to establish appropriate emergency plans. Recently, various research has been conducted to create a radiation distribution map by mounting a radiation detector on a drone. But the target is limited to the radiation on the ground. Therefore, survey technology is needed to measure not only the ground but also aerial radiation [1]. In this study, a model including an algorithm for calculating the dose rate and locating a radiation source from the measured aerial radiation was designed.

2. Methods and Results

The drone-based aerial radiation monitoring system is operated through the control and analysis system on the ground, and the ground system consists of software for analyzing aerial radiation data as well as the operation of drones and detection devices. The drone measures aerial radiation for each situation, and the model process the acquired data for estimating the localization of the radiation source and mapping the radiation contamination of the flight area.

The acquired aerial radiation monitoring data consists of location information (x, y, z) of the drone, a measurement value at the location (count per second), and a measurement time (time). And the data is classified with data obtained through the hovering flight by altitude based on the monitoring post and data obtained through the wide-area flight at regular intervals by altitude based on the monitoring post(figure 1).

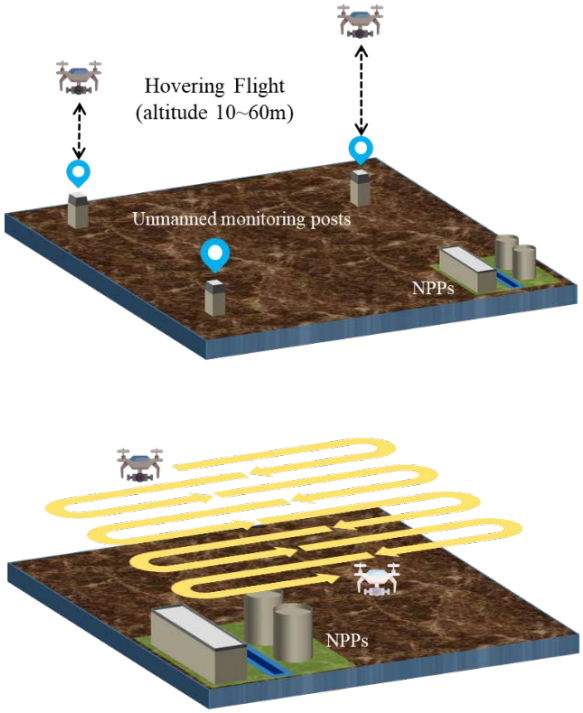

Figure 1. Drone-based aerial radiation monitoring system

The 3-dimensional image reconstruction algorithm is divided into data processing, data visualization. Figure 2 shows the series of the algorithm diagram.

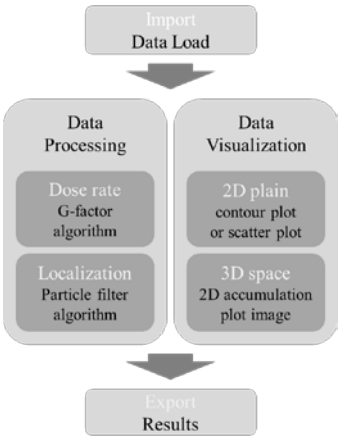

Figure 2. 3-dimentional image reconstruction algorithm diagram

2.1 Data load

Measurement data different the number and size of data according to the number of detectors and measurement time. Therefore, it should be modeled to be able to load the big size of data with several format. Data classification can be selected by channel or by coordinates (altitude or coordinates of the ground), etc., and parallel processing is performed all large amounts of data can be read and processed(figure 2).

2.2 Data processing

The step of data processing have conduct to calcultation using two algorithm. First, in order to calculate the acquired data as a dose rate, the radiation monitoring data can be converted using the G-factor method using a response function for each radiation energy. The dose rate for each nuclide is calculated by dividing the peak-to-total ratio by the calculated net peak area after finding the peak appearing in the energy spectrum for the converted dose rate [2-3].

$$\dot{X} = \int n(E)G(E)dE \qquad (1)$$

The dose rate, $\dot{X}$, E is the incident photon energy, and n(E) is the energy spectum, CPS, G(E) is the G-factor, uR/h/cps.

The Bayes filter-based particle filter is applied to estimate the position of the radioactive plume using the dose rate calculated through the above process. It is assumed that a drone with detectors is flying in the target area, and particles are generated to track the current plume location, each particle has its own coordinates. The distance between the coordinates of each drone is calculated, and the distance between the dose rate observed by the detector is calculated, and the weight of the particle is derived through the similarity between the two distances. In the particle filter, the observation step is performed to update the weight of each particle. After the probability or similarity for each particle is calculated based on the measured dose rate observed by the detector, the location of radioactive plume will be estimated(Figure 3).

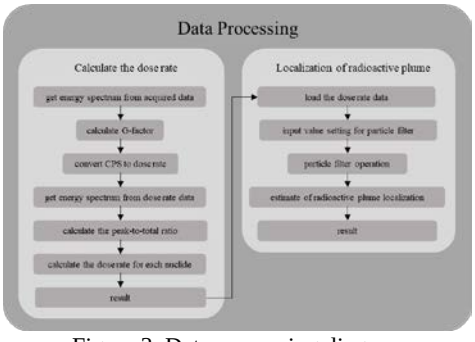

Figure 3. Data processing diagram

2.3 Visulization

Various mapping plots representing the radiation distribution can be drawn using classified data. Using the dose rate data, it can be expressed as a two-dimensional plane contour plot or scatter plot, or it can be expressed as a three-dimensional space accumulate plot including an altitude value(Figure 4).

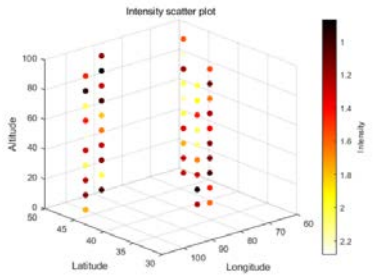

Figure 4. 3-dimentional space accmulate plot example

The result acquired to data processing can be saved in an external directory, and the storage format can be designated as text, spreadsheet, graph, etc.

3. Conclusions

In this study, we have suggested the 3-dimensional image reconstruction algorithm. A model including an algorithm for calculating the dose rate and locating a radiation source from the measured aerial radiation was designed. The model is implementing currently and this model can be ported to another program for a particular purpose in the future.

ACKNOWLEDGEMENT

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