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Development of the Multipurpose System for Environmental Radiation Survey and Its Application to the Unmanned Aerial Vehicle

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1. Introduction

The importance of environmental radiation survey (ERS) has increased for the purpose of the efficient response and risk management in the nuclear accident. Especially, the quick measurement of radioactive deposits in the ground should be achieved to support the decision making by the accident phase, such as early, intermediate, and recovery phase. The airborne gamma-ray spectrometry using unmanned or manned aerial vehicles is widely used to assist mineral exploration as well as emergency response by surveying natural and anthropogenic radiations, respectively [1-3].

In the case of airborne survey, a gamma-ray spectrometer should be loaded in the aerial vehicle with positioning system, that is, GPS (global position system) and altimeter. The interface method between gamma-ray spectrometer in the vehicle and PC on the ground should be also determined to acquire the survey data. However, the most important thing is to produce the appropriate data for the decision making through the analysis and correction of survey results of several flight heights. In general, it is necessary to obtain the accident information about the variation of ambient dose rate at 1 m above the ground in the air due to the deposits of anthropogenic source terms.

The multipurpose system for environmental radiation survey (MS_ERS) was developed to apply to several survey platforms, such as ground-based gamma-ray spectrometry using a tripod and mobile gamma-ray spectrometry using a backpack, carborne, and airborne survey. In this study, the airborne survey was conducted by mounting the MS_ERS to a drone in Jeju Island, Korea. The performance of developed system was evaluated as assessing the dose rate at 1 m above the ground from survey results of several flight heights and ling spacing in two survey sites.

2. Methods and Results

2.1 MS_ ERS

Figure 1 shows the developed MS_ERS and example of the application to the airborne survey using a drone. The GPS (global positioning system) and laser altimeter are equipped in the system to link airborne survey results with positioning data in the air. Two gamma-ray spectrometers, which consist of a 2"φx2" $LaBr_3(Ce)$ detector (51S51_B380, Saint Gobain, FRA) with digital signal processing unit (SI Detection Co. Ltd., HAMPack MCA 527, KOR), are basically inserted in the system. The multipurpose ERS system has total weight of below 6 kg including two spectrometers and low battery power consumption. The acquisition time can be controlled from 1 sec with an intervals of 1 sec. The measured energy spectra during whole airborne survey are then transferred to a tablet PC through the Bluetooth interface.

Fig. 1. The multipurpose system for environmental radiation survey and its application to the airborne survey

2.2 Attenuation correction due to the flight height

In the case of integrating airborne survey results, the data consistency have to be maintained to reduce the uncertainty induced from the different survey heights. Therefore, the results of airborne survey with diverse flight heights should be corrected to those at 1 m above the ground in the air. The attenuation correction factor according to the flight height was then calculated from several measured energy spectra, which were acquired in the hovering state of a drone at several heights, such as 3, 9, 20, 30, and 50 m. Figure 2 shows the GPS data in the hovering states at five flight heights. The ambient dose rate was then calculated at five heights, and finally, the attenuation correction factor was calculated from the exponential regressions according to the flight heights.

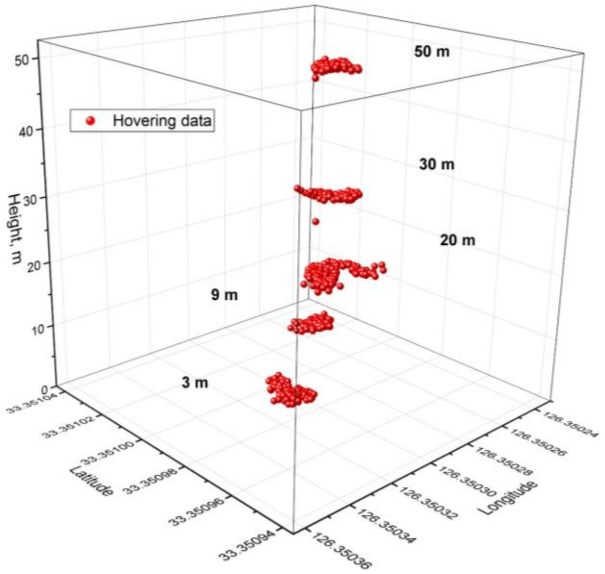

Fig. 2. The GPS data in the hovering states of a drone at five flight heights

2.3 Airborne survey

After preparing the attenuation correction due to the flight height, the airborne survey was conducted to obtain the averaged ambient dose rate in wide area. Two sites of Jeju Island was selected to make the performance test of a MS_ERS. The flight speed was maintained to be about 10 km/h and the aerial measurement was performed at three flight altitudes of 20, 30, and 50 m. Figure 3 shows the track of airborne survey at the flight altitude of 20 m. The GPS data was linked with the ambient dose rates, which were calculated from measured energy spectra with a 2 s live time. The averaged ambient dose rate was then calculated to be about 28.2±9.9 nGy/h.

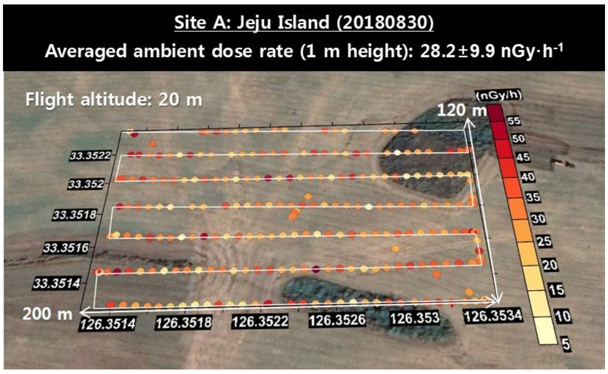

Fig. 3. The results of airborne survey at the flight height of 20 m: The ambient dose rates were corrected into those at 1 m above the ground.

The backpack survey using the same MS_ERS was also conducted in the same site to calculate the averaged ambient dose rate with a different survey platform. In addition, a ground-based gamma-ray spectrometry using a tripod was conducted at a fixed position in the site. A good performance was shown in the calculated ambient dose rate at 1 m above the ground with the data consistency for diverse survey platforms, such as airborne, backpack, and tripod.

3. Conclusions

The airborne survey using a drone was conducted to assess the ambient dose rate in wide area of Jeju Island. The multipurpose system for environmental radiation survey of KAERI was mounted to a drone for the airborne survey. All survey results at diverse flight heights were then corrected into those at 1 m above the ground. Finally, its performance was evaluated by comparing the airborne results with mobile and ground-based gamma-ray spectrometry using a backpack and tripod, respectively.

ACKNOWLEDGMENTS

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