The Contour Mapping Program for Prompt Environmental Radiation Distribution Display

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1. Introduction

For prompt response and consequent measure at the environmental radiation emergency of nuclear installations which include nuclear power plants, needed is rapid and movable monitoring system which can display and analyze distribution of overall environmental radiation around surrounding area. At occurrence of the nuclear emergency including the disastrous accident like the Fukushima Nuclear Power Plants accident or detected radiation in the public city environment, the comprehensive understanding of rapid radiation distribution, which has measurement error, is essential for the quick measuring on the public protection in the surrounding area. For that, 2D and 3D contour mapping method are developed for the distribution of natural radiation, major artificial radiation (^{137}Cs, ^{131}I), and total radiation, which is based on the information which is auto-recognized and interpolated for virtually measured radiation data by using random number generation. Especially, the radiation contour is displayed on the map image of the measured area so that the radiation distribution can be understood at a glance.

2. Methods and Results

Represented are the concept and process on programming for 2D & 3D radiation contour mapping on the measured area by using MATLAB of commercial software. The process consists of data generation, noise elimination, contour mapping, display of radiation distribution and file type designation.

2.1 Concept of Radiation Contour Mapping Program

In general, the contour mapping is carried out by the help of commercial programming language such as MATLAB once that the numerical data are given. First of all, the radiation data are obtained by measurement instrument (H/W) as seen in Fig. 1. [1, 5, 6] where they are stored as data file in a suitable folder in the laptop. The measured data are transferred into the laptop by serial communication or radio signal sensor in the Fig. 1. The data include geographical ones such as longitude and latitude of the measured points, and radiation data such as natural radiation, artificial radiation and total radiation as represented in the Fig. 2. In this figure, the contour lines are generated over the map image of measured area through the contour mapping program (S/W) installed in laptop. Unlike the previous contour mapping technique which represents only the information on the total radiation dose rate, the present study approaches the realization of 2D and 3D radiation distribution recognizing radionuclides including artificial ones as seen in the Fig. 2.

Fig. 1. Environmental radiation detection and analysis system

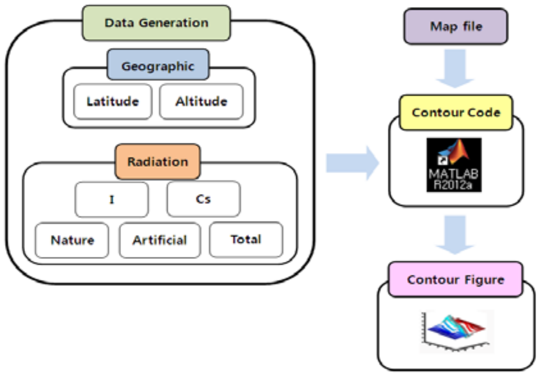

Fig. 2. Concept of the nuclide recognizing prompt environmental radiation distribution monitoring system

2.2 Data Generation

The radiation contour lines have to be overlapped on the map image of the measured area. So, the geometrical and radiological data are needed. In the present study, the values of latitude and longitude are generated as geometrical information. Also, for the values of radiological data, natural radiation, ^{137}Cs, ^{131}I, artificial radiation and total radiation are produced by using random number generation instead of real measurement.

2.3 Noise Elimination

In real measured data, not only radiological data caused by radiation source (meaningful data) but also electrical noise or statistical fluctuation (meaningless data) can exist. The meaningless data distorts distribution of radiation. So those noise or fluctuation must be eliminated. First of all, if one or two data's values are non-continuously larger than other data, it might be meaningless data. However when radiation accident occurs, specific region's radiological data can be detected largely. Therefore process to distinguish between radiological data and electrical noise or statistical fluctuation is very important. The algorithm to distinguish data is as follows.

- Calculate the average of random point and its front and back data.
- If value of random point is in the range of mean ± 1.96 × standard deviation (m ± σ), it could be considered as radiological data. (Radiation counter statically follows poison distribution and if number of sample is larger than 30, it would follow normal distribution. Conventionally accepted *k*-value of 1.96, which is corresponding to confidence interval of 95%, is used.
- If the data don't satisfy this rule, it would be classified as meaningless data (noise or fluctuation).

2.4 Contour Code using MATLAB

Based on generated data, the 2D and 3D contour mapping code is composed by using MATLAB. Before making contour mapping code, there are some considerations. First is way to overlap contour figure to map image. We match each map image and contour figure's lower end of left and right top. Second is number and thickness of contour line. If the number of contour lines is too large and their thickness is too thick, the map image is not seen well. If the number of contour lines is too small and their thickness is too thin, the distribution of radiation is difficult to distinguish. According to those considerations, the MATLAB contour mapping code was composed by using function of plot, linear, quadratic interpolation and so on. On the other hand, the radiation dose rate at the specific region of contour map can be checked by using zoom in and zoom out function. In the Fig. 3, the contour is displayed over the map image, which shows distribution of radiation.

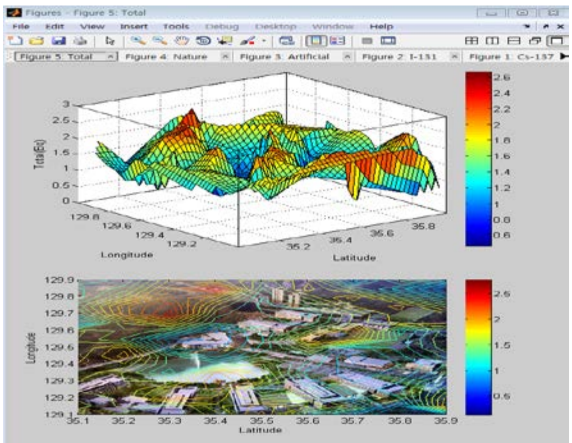

Fig. 3. 2D & 3D display of radiation distribution by contour mapping program

2.5 File Type Designation

The file type of contour mapping code is converted into 'exe' format to enable to be operated in the environment where MATLAB is not installed. As a result, contour mapping program is operated by mouse one-click without MATLAB. Table 1 shows of the time needed for the results of radiation distribution on the number of data.

Table I: Relationship between number of data and spent time in non-MATLAB environment

Number of data(#)	Spent time(sec)
1000	10.87
2000	11.12
10000	11.87
60000	18.38
100000	30.81

3. Conclusions

2D and 3D mapping programming for the distribution of radiation on the simulated measured radiation data was carried out by using MATLAB language. It showed the operation time of a few ten seconds which was more than 100 times faster than conventional technique. It was thought that the present study could be directly employed for the understanding of rapid and comprehensive radiation distribution on the public environment at the nuclear or radiation emergency.

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