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Improvement of a Spectrum-to-Dose Conversion Function for Electronic Personal Dosimeters

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The electronic personal dosimeter (EPD) based on a 3×3 mm2 PIN diode coupled to a 3×3×3 mm3 CsI(Tl) scintillator was designed for measuring an ambient dose equivalent (**$H^*(10)$**). The designed EPD was capable of measuring **$H^*(10)$** within the energy range of 40 keV to 2 MeV from the gamma spectroscopy. However, since the inorganic scintillator differs from human tissue, the energy response to 137Cs has a large error, when applying the count-to-dose conversion method which is the conventional method used in a GM counter or ionization chamber [1]. Therefore, it is necessary to apply an appropriate dose conversion method to correct this problem.

The G(E) function is a common method for spectra-to-dose conversion that has been developed and published [2]. It is necessary to find the A(K) parameters in the G(E) function. In general, A(K) parameters are obtained by the least-square method (LSM) using the spectrum data and dose data from Monte Carlo simulation or radio-isotope sources. In this manuscript, we apply a gradient-descent method (GDM) and an adaptive moment estimation (ADAM) [3], which are widely used in neural networks, to accurately estimate A(K) in G(E) function. The gamma spectrum data and **$H^*(10)$** data that correspond to 5000 mono-energies from 40 keV to 2000 keV with the random number of particle histories randomly were acquired by Monte Carlo simulation using MCNP6. The newly G(E) functions were found and these conversion methods were verified by using 241Am, 57Co, 137Cs, 22Na, 54Mn, and 60Co radioisotopes.

The relative difference of **$H^*(10)$** from single radioisotopes were in the range of ±16.11%, 12.6% and 9.92% in LSM, GDM, and ADAM, respectively. Furthermore, the energy response to 137Cs was laid in between the values 0.86 and 1, between 0.87 and 1.02, and between 0.9 and 1.03 in LSM, GDM, and ADAM, respectively. Thus, this clearly demonstrates that the obtained G(E) functions can correct the energy response of the designed EPD very well in comparison to the conventional counting method. In addition, it can be confirmed that **$H^*(10)$** is estimated more accurately than the LSM and GDM when the ADAM is used.

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