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Peak Identification in Low-Resolution γ-ray Spectra Using the Cosine Similarity Measure

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M. Nakhostin and P. J. Sellin
Department of Physics, University of Surrey, Guildford, GU2 7XH, UK

Automated identification of radioisotopes through γ-ray spectroscopy with low-cost γ-ray detectors such as NaI(Tl) is of great interest for applications such as nuclear security, nuclear emergency, and environmental radiation monitoring. This task is generally accomplished by using algorithms that search for γ-ray peaks in the spectra. However, the performance of the peak search algorithms can be seriously affected by the intrinsic statistical variations in the shape of γ-ray spectra collected over a short period of time. This paper reports on a novel approach for the identification of peaks in low statistics γ-ray spectra by using the cosine similarity measure [1, 2]. The cosine similarity measure is used to simultaneously serve two purposes: (i) smoothing the spectra to suppress the effect of statistical variations, and (ii) enhancing the intensity of peaks against the non-peak features of the spectra such as Compton continuum. The theoretical basis of the method is described and the results of test experiments with NaI(Tl) detectors of different sizes are shown. The method exhibits excellent performance of 95 % successful identification of 137Cs γ-ray peak in the laboratory measurements with a 2"×2" cylindrical NaI(Tl) detector when the total number of recorded events is as low as eighty. The performance of the method is also examined against the international performance standard ANSI N42.34 for 152Eu, 60Co and 137Cs [3]. The method easily meets the requirements of the ANSI standard by making more than 80 % successful identification of radioisotopes at dose rates of 0.5 μSv/h in less than 120 seconds. Simple implementation and computational economy are other advantages that make this algorithm well suited for implementation in handheld radioisotope identification devices.
[1] P.-N. Tan, M. Steinbach, V. Kumar, "Introduction to Data Mining," Addison-Wesley (2005).
[2] S. Cha, "Comprehensive survey on distance/similarity measures between probability density functions," Int. Journal of Mathematical Models and Methods in Applied Science, Vol. 1 (2007) 300.
[3] American National Standard Performance Criteria for Hand-Held Instruments for the Detection and Identification of Radionuclides, IEEE Std., Rev. ANSI N42.34-2006, 2007.

Primary author: Dr NAKHOSTIN, Mohammad (Department of Physics, University of Surrey)

Co-author: SELLIN, Paul (University of Surrey)

Presenter: Dr NAKHOSTIN, Mohammad (Department of Physics, University of Surrey)

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