Reduction of energy channels on spectral data in CT reconstruction

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Summary: Nowadays, the use of MULTIX detectors which provide imaging of many channels once has been so popular in some applications such as security. On the other hand, the reconstruction of energy channels can be time consuming. In this paper, we will try to reduce the number of energy beams so that we do not lose a lot of information. The results shows that we can get nearly the same result with dimensional reduction as without. It can speed up the process of reconstruction to great extend.

1. Abstract

X-ray Computed Tomography [1] is considered as a powerful tool for nondestructive testing and is broadly used in terms of medical and security. In CT, we can have three-dimensional images of the interior of an interested object based on its X-ray attenuation (The probability of reduction energy of intensity when one beam is passing through the objects). The technique for CT consists on two stages: data acquisition and image reconstruction. In the first stage, data is obtained by illuminating the object from various angles and in the second step, the cross-section image of the object is reconstructed from line integrals of the data. After data acquisition and image reconstruction, the pixel values correspond to a quantity called the linear attenuation coefficient (μ) which has been presented by Beer law and depends on the energy of photon and elemental composition of the material. In fact, attenuation coefficient of the volume of a material characterizes how easily it can be penetrated by a beam of light, sound, particles, or other energy or matter.

Nowadays by development of technology, we have privilege of MULTIX detectors which allows imaging of many energy channels at once. In fact, this type of detectors can help us in process of discrimination of chemical component of materials. They can provide us with more information compared to conventional ones (Dual and single energy which give us the information about two overlapping part of the spectra and this can be used to approximate density and atomic number).

In this paper, we investigate data acquired using the MULTIX detector that has 128 energy channels. We know that although reconstruction of all energy channels can improve the discrimination of materials to great extend but on the other hand it can be so time consuming and unfeasible. Therefore, we should find some ways to reduce the number of channels of energy for reconstruction as long as we do not lose large amount of information.

There are different methods which can be used to reduce the number of reconstruction such as principle component analysis or classical multidimensional scaling method. We also use an iterative algebraic reconstruction (Kaczmarz method) employing a total variation regularization for reconstruction. We will perform and analysis our method on a data set included Aluminium and four liquids, i.e. water, hydrogen peroxide, sucrose solution, pentaerythritol tetranitrate.

Since the linear attenuation coefficients can be used for selecting a energy which present the most contrast between particular materials in CT reconstruction, we have plotted the result of reconstruction of our data for all of energy channels in the figure 1.

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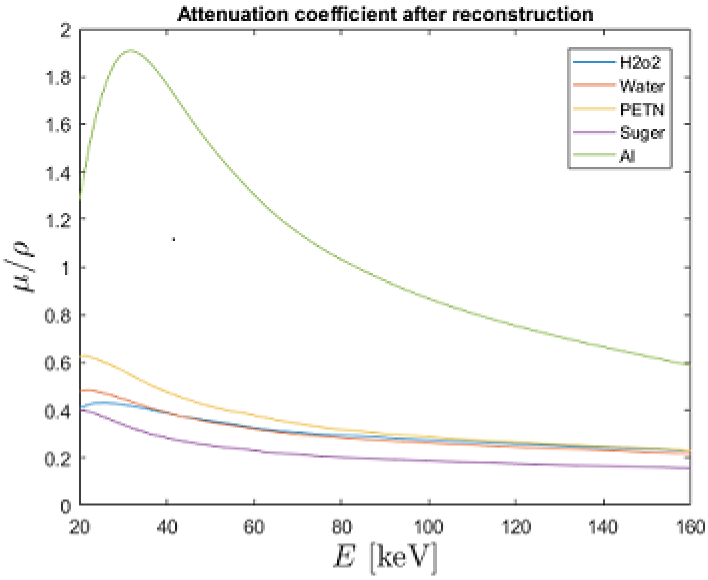

Figure 1: The graph of attenuation coefficient for original data

This paper shows that we can distinguish the materials after reduction of energy channels equally well as we consider the reconstruction of all of the channels. In fact, by dimensional reduction we just remove the energy beams which have been correlated to each others. Thus we do not lose the large amount of information while we have improved the process of discrimination and reconstruction in efficient way in term of time computation.

References

[1] Kak, A. C. and Slaney, M. (2001). Principles of Computerized Tomographic Imaging. Society of Industrial and Applied Mathematics