

Abstract

In medicine, the diagnosis based on computed tomography (CT) imaging is fundamental for the detection of abnormal tissues by different attenuation values on X-ray energy, which frequently are not clearly distinguished for the radiologist. Different methods have been developed to reconstruct images. In this work we analyse and compare analytical and iterative methods to resolve the reconstruction problem.

Today, in practice, the reconstruction process is based on analytical methods and one of the most widely used algorithms is known as Filtered back projections (FBP) algorithm. This algorithm implements the inverse Radon Transform, which is a mathematical tool used in Biomedical Engineering for the reconstruction of CT images.

From the very beginning of the development of scanners, it was important to reduce the scanning time, to improve the quality of images and to reduce the reconstruction time of images. Today's technology provides powerful systems, multi-processor and multicore processor systems, that provide the possibility to reduce the reconstruction time.

In this work, we analyze the FBP based on the inverse Radon Transform and its relation to the Fourier Transform, with the aim to achieve better performance while using resources of a system in an optimal way. This algorithm uses parallel projections, is simple, robust, and the results could be extended for a variety of situations.

In many applications, the set of projection data needed for the reconstruction, is incomplete due to the physical reasons. Consequently, it is possible to achieve only approximated reconstruction. In this conditions, the images reconstructed with analytical methods have a lot of artefacts in two and three dimensions.

Iterative methods are more suitable for the reconstruction from a limited number of projections in noisy conditions. Their usage may be important for the functionality of portable scanners in emergency situations. However, in practice, these methods are less used due to their high computational cost. In this work, the reduction of the execution time is achieved by performing the parallel implementation on multi-core and many-core systems of such iterative algorithms as SART, MLEM and LSQR.

The iterative methods have become a hot topic of interest because of their capacity to resolve the reconstruction problem from a limited number of projections. This allows the possibility to reduce the radiation dose during the data acquisition process. At the same time, in the reconstructed images appear undesired artefacts.

To resolve the problem effectively, we have adopted the LSQR method with soft threshold filtering technique and the fast iterative shrinkage-thresholding algorithm for computed tomography imaging and present the efficiency of the method named LSQR-STF-FISTA.

The reconstruction methods are analysed through the reconstructions from simulated and real projection data. Also, the quality of the reconstructed images is compared with the aim of drawing conclusions regarding the studied methods.

We conclude from this study that iterative methods are capable to reconstruct images from a limited number of dataset at a low computational cost.