Development of Two Dimensional Filter for the Reconstructive Image Processing

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ABSTRACT

Two dimensional kernels which reconstruct the tomographic image from the blurred one formed by simple back-projection are investigated and their performances are compared. These kernels are derived from the point spread function of the tomographic system and have the form of a ramp filter modified by several window functions to suppress ringing in the reconstruction. Computer simulation using a computer generated phantom image data with different correction fuctions(kernels) has been carried out. In this simulation, filtering in frequency domain by 2-D FFT technique or in space domain by 2-D direct convolution is considered. It is found that the computation time required for real space convolution technique is much larger than that of Fourier 2-D filtering technique in the pratical situation.

SUMMARY

The 3-D reconstruction techniques have been of great interest to many researchers who are engaged in medical diagnostic imaging, and many other related fields such as the nondestructive analysis.

In computerized tomography the actual 3-D reconstruction of an object was obtained by a series of 2-D cross sections of the object. Each 2-D cross section was obtained by proper summation(filtering) of a series of projection data resulting from different projection angles.

There are two convolution methods in the 2-D reconstruction. The widely used method in practical X-ray computed tomography is the 1-D convolution method(1) in which the projections are convolved with 1-D correction function and then projected back onto a reconstruction plane. Another one which needs further study is the 2-D convolution method which involves 2-D correction kernels applied to the image formed by simple back-projection. The 2-D correction functions(kernels) have not yet been extensively studied though it has been suggested earlier(2,3). We, therefore, attempted to study problems involved in implementation of the actual 2-D filters in 2-D image reconstruction.

In this paper, 2-D kernels are obtained by windowing the impulse response of the 2-D ramp function with the suitable window functions such as Hamming, Hann, Parzen, and Butterworth. It is then further truncated to obtain a finite 2-D array for the calculation. The convolution operations are performed in frequency domain by FFT technique or in real space by 2-D direct convolution. The simulated image consists of a 64x64 array which is the same as the one used by Shepp and Logan(1). The resulting reconstructed images are displayed on TEKTRONIX-4010 graphic terminal and compared with the original phantom. The computation time for the real space computation with a 9x9 kernel was found almost three times larger than the frequency domain technique in the case of reconstructing a 64x64 input image array.

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