Stochastic Restoration and Reconstruction Filters for 2-D and 3-Dimensional Image Reconstruction

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Based on minimum-mean-sqare error criterion, a noise filtering algorithm for the reconstruction of an image function from noisy projection data is suggested. The filter is constructed with a few projection data. This algorithm requires less computational time compared with other noise filtering algorithm.

General form of the deblurring filter for the reconstruction is of the form [1] ;

$$\Phi(\omega,\theta) = |\omega| H(\omega,\theta) \tag{1}$$

where $H(\omega,\theta)$ is an apodizing function. It is generally believed to optimize the filter apodizing function for noisy version according to SNR. The function $H(\omega,\theta)$ to minimize the mean-square error has the following well-known form, i.e. Wiener filter [1] ;

$$H(\omega,\theta) = \frac{H_1(\omega,\theta)^* \Psi_s(\omega,\theta)}{|H_1(\omega,\theta)|^2 \Psi_s(\omega,\theta) + \Psi_n(\omega,\theta)} \tag{2}$$

where $H_1(\omega,\theta)$ is point spread function, and $\Psi_s(\omega,\theta)$ and $\Psi_n(\omega,\theta)$ are the power spectra of reconstructed image and noise, respectively. To realize the filter function, it is necessary to know the image and noise power spectra. We have assumed the image power spectrum to be Markovian, which enabled us to estimate the image power spectrum from the projection data. The noise characteristic of Computerized-Tomography projection data is of Poisson statistics. In filter design implementation, the noise, however, is assumed to be independent of projection data.

In simulation, noise the variance of which is proportional to the

projection data is added. The results are compared with the images which are reconstructed by the Shepp and Logan's filter[2]. The results are promising in noise reduction with some loss of the resolution, which is expected from the characteristic of the Wiener filter. It is believed that the stochastic approach to the optimal filter design in Computerized Tomography provides unbiased (human biased) reconstructed images based on the available data obtained from the actual system.

REFERENCES

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