Two-Dimensional Spatial Frequency Spectra of Radioisotope Images

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The two-dimensional spatial frequency spectra of the radioisotope images can be simply and in a moment obtained by using optical transformation (Fraunhofer's diffraction). Spatial filtering on the spectral plane, too, can give us simply an improved image. In order to obtain very good low frequency components, three lenses with very long focal length were made to use. These lenses can give us better spatial frequency spectra than those when using optical magnifying systems. Spatial frequency spectra can give some classification of radioisotope image patterns.

Fraunhofer's diffraction apparatus with the laser light source of He-Ne (single mode, wave length: 9328 Å, made by Nalumi Opt. Co.). Fourier's transformation $G(n_x, n_y)$ of the amplitude transparency $g(x, y)$ of a minified radioisotope image corresponds to the amplitude φ (p, q) of the diffracted image on the focal plane.

$$\varphi(p, q)=\text{const}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} q(x, y) \exp\left(-i\frac{2\pi}{\lambda}(xp+gq)\right) dxdy=\text{const } G(n_x, n_y)$$

$$n_x=\frac{p}{\lambda F},\quad n_y=\frac{q}{\lambda F}$$

where (x, y) and p, q) are two coordinates in a sample image and diffracted image plane; λ is the wave length of an used light; F is the focal length of a condenser lens; n_x and n_y are two coordinates of spatial frequencies (line pair/mm). One line pair per mm of an one-tenth minified image becomes 0.6 cm wide on the diffracted image plane, when using a lens of focal length of 6000 mm.

Fraunhofer's diffraction apparatus with the very much long focal length of lenses can give good low frequency components. Therefore it is convienent to improve sample images by spatial filtering, too. Scinticamera images of some diseases of the thyroid gland and the liver can be classified in the other patterns by their frequency spectral patterns. It will be useful as a kind of auxiliary diagnostic scale of radioisotope images.

Some Processing Methods for the Section Imaging

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Digital computer simulations were tried on methods for processing the section imaging which was devised to obtain the information of the depth dependent R.I. distribution.

For the first approximation, the next equation is estimated;

$$I(x, \theta)=\iint\delta(x-x'\cos(\theta)+y'\sin(\theta)\, S(x', y')\, dx'dy' \quad\text{.........(A)}$$

where I: profile image obtained depending on the rotated angle,

S: 2-dim. R.I. distribution of the concerning section.

When digitized, $I(x, \theta)$ is described by the following equation:

$$I_{ij}=\sum_{kl}\delta(i, k\cos(aj)-l\sin(aj)\, S_{kl}$$

$$\delta(i, j)=\begin{cases}1, & \text{if } |i-j|\leqq 1\\ 0, & \text{if } |i-j|>1\end{cases}$$

We have tested following methods for section imaging, and got some results.

1) inverse matrix