Two-Dimensional Spatial Frequency Spectra of Radioisotope Images

E. TAKENAKA

Department of Radiology University of Tokyo, Tokyo

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 $\varphi(p, q)$ 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

T. SHIMIZU, T. IINUMA and E. TANAKA

National Institute of Radiological Sciences, Chiba

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

The exact original image will be obtained, if there exists the inverse matrix which satisfies the following;

$$\sum_{kl} G_{ij,\,kl}\, F_{kl,\,mn} = \delta im\ \delta jn$$

The result is rather disappointing, for it seems there is no solution in this case. $8 \times 8 \times 8 \times 8$ matrix is simulated.

2) Kuhl's method

The simple method that is;

$$S'(x,\ y) = \iint (1/\sqrt{r^2\text{-}x'^2})\ \delta\,(x'\text{-}x\cos(\theta) + y\sin(\theta))\ I(x',\theta)\,dx'\,d\theta$$

The picture with 128×128 elements and 24 directions of view was simulated.

3) Muehllehner's method

The iterative method, which is:

For the first image S1, we use the simple projection of $I(x,\theta)$ to (x,y)-plane. Next, sorting the maximal point, making S2 image and substractiong S1 by all directions, we finish one cycle of iteration. Continuing this process we may obtain the original image.

We tried on the case of 40×40 elements with 8 directions.

In these methods, a complete image was not obtainable. It is with some back-ground, so the form and quantity of phantoms is shaded.

We tend to find out the 'optimum' processing method and apply it to clinical cases.

Advantages of color-equidensitometry for clinical γ-camera-image analysis

M. Iio, K. Chiba, H. Yamada, K. Kitani
M. Yamamoto and M. Tanno
Tokyo Metropolitan Geriatrics Hospital, Itabashi, Tokyo
C. Miyakogawa
Kimoto Co., Shinjuku, Tokyo

For the clinical image analysis in Nuclear Medicine color equidensitometry analysis was performed using digital color device (Phosdac 1000—Kimoto Co.).

Advantages of this pseudo color display method is as follows. Images from 2.8×2.1 cm to 32.0×25.0 cm in size can be processed quickly in few seconds into 12 pseudo color display. Freedom of color arrangement and mechanism of black out of any color and defocusing easily enhance the contrast of the image and construct the contour image.

Off line processing of the image abtained by Nuclear Chicago PHO/GAMMA H.P. was performed.

By using build-in 10×10 mesh and planimetry mechanism size of the image and area of the organ is calculated within seconds. This facilitates the clinical usefulness of this method under any collimator application such as pine-hole or diversing.

When compared to more complicated data processing application photo-equidensitometry analysis is found to have many practical advantages especially in its ease in filing and quickness of bandling data for contrast enhaneement, measurement of size or area and construction of contour images.