Flying-Spot Scanner with Omni-Directional Scanning for Two-Dimensional Processing of Radioisotope Images

N. Nohara, E. Tanaka and T. Tomitani

National Institute of Radiological Sciences, Chiba

A flying-spot scanner adopting a special scanning method has been developed for purpose of two-dimensional processing of radioisotope images. By application of two triangular signals of different frequencies $X_0(t)$ and $Y_0(t)$ to X and Y deflection electrodes of the flying-spot CRT, the spot on the CRT moves rapidly back and forth in two orthogonal directions, which results in anasynchronous Lissajous pattern. By application of rotation of angle ωt to $X^0(t)$ and $Y^0(t)$ (where angular velocity ω is small compared to both frequencies of $X_0(t)$ and $Y_0(t)$), the coordinates of the flying-spot is given below.

$$X(t)=X^0(t)\cos\omega t-Y_0(t)\sin\omega t$$
$$Y(t)=X_0(t)\sin\omega t-Y_0(t)\cos\omega t$$

The spot on the CRT is focused onto a 35 mm film and the density of the film is converted to video signal by measuring transmitted light with a photomultiplier tube. Any point on the film is scanned uniformly in every direction and one can observe an image in superposition of the video signal along the omni-directional scan line.

By processing the video signal with an electric filter, one can realize two-dimensional image processing such as deblurring, differentiation and low frequency cut-off, etc.

Smoothing is performed by defocusing the flying-spot tube. Two slide systems are provided in order to correct non-uniformity in sensitivity of the imaging device by taking the ratio of two video signals.

Various display modes are provided such as shaded image, bird's eye view, cross sectional view at any line and contour map.

Digital Simulation of RI Image Processing

F. Kajiya, H. Nishimura and T. Sakaguchi

Department of Electronics, Faculty of Engineering

K. Kimura, H. Inada, T. Furukawa and H. Abe

First Department of Internal Medicine, Faculty of Medicine, Osaka University, Osaka

Paper phantoms have been used to evaluate the efficiency of computer processing techniques in radioisotope scintigraphy.

In this paper, a "digital phantom" method was proposed for the evaluation. The merits of this method are those; 1. phantoms are able to be made with absolute accuracy and without trouble of unexpected unevenness of radioisotope distribution that often occur in paper phantoms, 2. the original patterns are precisely known beforehand and the effectiveness of the processing are easily compared and evaluated by both vision and mathematical analysis.

Simulating the scintigram-formation process, the digital phantoms were constructed by following three steps; 1. design of original pattern as a two-dimensional array of numbers that represent the concentration of radioisotope in some source organ. The four classes of numbers, i.e., 2, 10, 20, 30, were assigned to the array. 2. Modulation by Poisson's random numbers, the averages of which are the assigned numbers. 3. Blurring by point spread function which was obtained by scanning a point source and which consists of 7×7 elements of 3×3 mm square.

Assuming this "digital phantom" as starting data, an image restorating procedure of the iterative approximation by convolution integral with point spread function was examined and the series of patterns were demonstrated.

By smoothing with 9 points moving averages, the valley parts of the image were imbedded and the peaks were cut down. After iterative approximation of 3~10 times, the vally parts were restored but the restoration of the peaks were not satisfactory. Without smoothing process, noise in the image was increased after 2~3 times iteration.

Conclusion: 1. This digital phantom method is useful in the evaluation of image restoration methods. 2. The iterative approximation is an effective technique but the slope with point spread function transfers in series of iterative patterns so that step-functional images were not restored.

Digital Simulation of Radioisotope Imaging Process

T. A. IINUMA and K. FUKUHISA

National Institute of Radiological Sciences, Chiba

In an attempt to evaluate effects of various factors in R.I. imaging process upon the image quality, a method to simulate the imaging process is investigated using an online digital computer. As an image object, a phantom of a square defect in a uniform background source was employed. Position, size and contrast of a defect in the phantom was generated by a uniform random number. For the point spread function of an image detector, a two-dimensional Gaussian distribution was assumed. A simulated R.I. image was synthesized by convoluting the point spread function with the phantom and then by generating the noise of Poissonian distribution.

Thus, 30 simulated images that contain a defect of various configuration were generated by the computer simulation mentioned above. Then, 14 persons were asked to judge whether or not there was a defect in the 30 simulated images. From the result of the answer, the defects were classified into three categories: (1) "Detected" which is such a defect that all persons can recognize its presence, (2) "Not Detected" which is such a defect that all persons can not recognize its presence and (3) "Not Easily Detected" which is such a defect that some persons can recognize its presence, but others can not.

In order to estimate human detectability of the defect quantitatively, a signal-to-noise ratio (S/N) was defined by the maximum count in defect depth after convolution of PSF divided by square root of background count in an image cell. The defects of "Not Easily Detected" category have a S/N value of about 1.0 which is not dependent upon the size and background count.

From this finding, we have been able to derive the relationship between S/N and other parameters of imaging system which can be applicable to the clinical situation. The detail will be described elsewhere.