Programs for the R.I. Image Display by Means of Computer-controlled Display Units

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One of the purposes of our R.I. imaging system is to display R.I. images of the best quality, since various image processing such as sumoothing and enhancement is no use without good display. In this paper, several software for the image display are described employing CRT unit, line printer and curve plotter that are I/O peripherals of NIRS on-line computer system.

(1) C.R.T. display unit

Characteristics of our CRT unit are as follows: effective area is 80 × 80 mm, resolving power is 1024 × 1024 points over effective area. If the image data (counts/picture cell) are converted to the display data (X and Y cordinates and brightness level/picture cell) by the software, the picture is displayed either as a pattern of brightness modulation or as a volumetric pattern. The brightness levels can be assigned to 5 levels including blank level, and each level corresponds to a certain count in a picture cell which can be set by an I/O typewriter. When the image must be displayed during the data accumulation, an interrupt signal called "Trigger" is used. It calls a program for converting image data into display data and transfers the latter to the display area at 2 second intervals.

(2) Display by a line printer

A program has been developed to print various characters (including numbers, alphabet and special characters) corresponding to X and Y co-ordinates and counts of each picture cell of a R.I. image. The character includes multi-print of up to 6 characters which can be pre-assigned in the program.

(3) Display by a curve plotter

A program has been developed to discrive a pattern in volumetric display using a curve plotter. The program uses various subroutines which are supplied with the on-line system. The potter draws a one-dimensional curve by reading image data as a function of X co-ordinate for a fixed Y co-ordinate. When one curve is drawn, the plotter starts again by incrementing one to the Y co-ordinate. Size of X and Y direction and a viewing angle are arbitrarily changed, and type of the data (integer or real) can be assigned. The size of the picture is made up to 34 cm (X direction) by 25 cm (Y direction) and the smallest distance of the plot is 0.2 mm. The various examples of the display methods mentioned above are shown.

Analogue Processing of RI Image in Scintiscanning

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RI image obtained by a scintiscanner is deteriorated because of a finite geometrical resolution of a focused collimator used and statistical fluctuation in count rate. In order to improve the deteriorated RI image an analogue technique is proposed for smoothing and enhancement using a system comprising an operational count rate-meter with two RC circuits, a 4-channel data recorder and an X-Y recorder.

The ouput signal from the scanner is recorded on one of 4 channels of a magnetic recording tape through an ordinary count rate meter with a short time constant. X and Y signals representing the detector position are obtained by two herical potentiometers, and these signals are also recorded on another channel after being mixed. The recorded count signal is reproduced for enhancement using the operational count rate-meter with suitable parameters so as to have a frequency response of under-damping. The output of the operational count rate-meter is recorded again on one of the other channels while the above processing is done.

The disadvantage in this enhancement is that the impulse response of the enhancer is not symmetric. This asymmetric response can be avoided by using the serial bi-directional enhancing technique. To realize this, the same processing as the first one is carried out again about the one way processed signal but in the reverse direction. Finally the enhanced RI image is obtained on the X-Y recorder as a bird's-eye view by the bi-directionally processed signal and the X-Y signal.

Basic experiments using this system have been carried out with a line source, a filiform source and a thyroid phantom of ^{131}I. It has been found that the spatial resolution of the response (FWHM) for the line source can be improved by about 20% with overshoot less than 20%.

A Mathematical Consideration of Radioisotope Scan Image Processing Least Square Deconvolution Method

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Since "differential operator method" (Nagai, Fukuda and Iinuma) of deconvolution effectively multiplies image spectra by a complex polynomial in frequency, high frequency noise is very strongly enhanced, and noise smoothing procedures must be chosen to efficiently suppress high frequency noise without counteracting resolution enhancement effects of the deconvolution procedure.

Concerning the signal to noise ratio (S/N) of scan image, through analysis in frequency space has been reported by various workers. On the other hand, mathematical analysis of the average frequency arising from noise has not yet been reported.

In this note, at first this subject was investigated both from theoretical and experimental points of view.

Probability that arbitrary channel is local maximum in stationary Poisson process was proved to converge to one third as average channel count goes to infinity. On the same line of thought, one can calculate the average noise frequency as a function of average channel count. Such data may be useful for estimation of cut-off frequency in Fourier smoothing and optimum filter methods.

Second, maximum likelyhood method of deconvolution of radioistotpe image which is essentially stochastic process was considered.

When non-stationary Poisson process is supposed as image process, conventional discrete convolution equation is derived by the maximum likelyhood method. While, when Gaussian process is supposed, the maximum likelyhood method is equivalent to the least square method from which one can derive normal equation with respect to effective object.

Applying the differential operator method to approximately solve this normal equation, reasonable enhancement of resolution of image obtained by scanning ^{131}I parallel lines source was performed.

This method is practically nothing but application of differential operator method by using twofold moment of collimator response function to matched filtered scan image.