to measure various characteristics as an image and to extract several features which are useful for automatic diagnosis.

We think the first step is more important at the present stage, since the doctor is getting diagnostic information by viewing the R.I. image.

Our effort has been concentrated on the software for the display of R.I. image on a CRT unit, a line printer and a curve plotter. For the routine diagnosis, we found an on-line CRT display is most useful because it is easily changed interactively between doctor and computer. Various programs for improvement of image quality are being developed which include many kinds of smoothing and restoration. These are being tested on the phantom image and also on the clinical images. In the near future, we will complete the on-line R.I. imaging system starting from digital data acquistion and image quality improvement to final image display on the CRT unit.

Furthermore, we will challenge to a difficult but rewarding task of pattern regonition of radioisotope images.

Applications of a Digital Computer for Radioisotope Image Processing (Use of the Clinical Data Analyzer CDS-4096)

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Scintillation camera and scanner are being used for obtaining radioisotope images, and processing of radioisotope image data was studied by coupling a computer with them.

[I] Use of a digital computer to scintillation camera

In radioisotope images obtained by scintillation canera, the counts in each picture element are statistically random and influenced by the limitation of the resolving power of its detector. In order to process digitally the data with a computer to improve and analyze them, the clinical data analyzer CDS-4096 (made by Nuclear-Chicago Inc.) was connected to the scintillation camera PHOGAMMA III. The analyzer consists of memory capacities of 4 kilowords (64 × 64 matrix) and is said a wired program mini-computer. According to the built-in programs the data manipulation is performed just by switching selectors or pushing buttons the results can be obtained on a CRT, a paper tape puncher or a typewriter at real time. For the purpose of processing other htan the built-in programs, the image data is transfered to the small general purpose computer NEAC-2230 and results are displayed on a CRT of the CDS-4096 after feedback from NEAC-2230 by the medium of paper tape.

A) On-line data processing programs

In the CDS-4096 some programs are incorporated as hardware. They are the functions of differentiation/integration, addition/subtraction of constants and so on.

In addition, data threshold, smoothing and isocount display manuplations are possible. Results are reported on the phantom with defects of the plastic spheres, the bar phantom arrayed lead bars and a few clinical data.

a) Data threshold

Continously varied cut off levels are permitted. As in a certain cut off level the variation of counts was enhanced, we could obtain the emphasized image, but the quality of the image was not always satisfactory.

b) Smoothing

This operation is to decrease statistical fluctuations of image data by operating a simple averaging of points neighbouring to

each other. Many points smoothing image is obtained at real time when this operation is carried out repeatedly on X and Y axes. Images of good quality were attained by three or four operations.

c) Differentiating

It was reported that differentiating was effective to show the contour of an organ. But this procedure on the CDS-4096 was not useful in obtaining the outline of an organ because decrement of points of an image was effective for time histogram curves in other purpose.

d) Subtraction

In the radioistope image by ^{75}Se-selenomethionine, the position of the liver and pancreas might be overlapped, and high count rate of the liver may mask the pancreas image of low count rate even if images of the liver and panceras are separate. So after storing counts due to ^{75}Se-selenomethionine as many as posible, the liver data by ^{198}Au colloid was subtracted from the data stored and the image of the pancreas alone could be obtained. As another application of subtraction mode, after storing a constant value in all channels, we subtracted the observed image data from it. As a result of this operation the intensified image was obtained on a CRT display which was helpful in determining an area of decreased radioactivity.

B) Off-line data processing programs

As the CDS-4096 can not do complicated operations, off-line programs are constructed.

a) Correcting the non-uniformity of sensitivity

The sensitivity of photomultipliers used in the detector of scinti-camera is much varied by a supplied voltage, temperature and humidity, so an image is influenced by them. Its adjustment is very troublesome. So we designed and constructed the scan mechanics of ^{241}Am band source to give the uniform exposure to camera head, and corrected the clinical image data according to the data of uniform exposure by ^{241}Am source.

b) Off-line smoothing (nine points method)

Using the method reported by Iinuma et al., comparison was made between this and the previously mentioned built-in program smoothing. Both gave almost the same result but off-line smoothing could eliminate the shortcoming of shift of position which is seen in the built-in program smoothing.

c) Focusing image

The blurred image was tried to be focussed by using a spread function of a point source which was simple exponential function in a small region because of small memory capacities and shortening of computing times. But the result was not good enough against our expectation.

d) Enhancement of an area showing great difference count rate

Using variable-sized matrices fo a weight coefficient, abnormal portion of image was enhanced in proportion to an area showing great changes of counting rate. This was an aid to observe the shape of an organ and area of abnormal counts. Furthermore we made the programs to change the format of output e) real-sized display f) character display and so on.

[II] Use of the CDS-4096 to our isosensitive scanner

Using the CDS-4096 processing of the data was desired at real time from scinti-scanner with two opposed position detectors to be uniform sensitive in depth. The interface was made between the scanner and the CDS-4096. This interface consists of the impedance changing and pulse shaping curcuits used field effect transisters each of X, Y and Z signals. By such a way the stored data of the scanner were processed as the same as in the scinti-camera.