A TV Rescanning Method with a Combination of CCTV Camera and a Small Computer

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A simplified digital image processing of photoscintigrams was performed by data acquisition with CCTV re-scan and by data processing with a small computer. Scanned TV picture signals are sampled, digitalized, in sequence, and stored in the memory of the computer. Sampling pulses are generated by a time delay unit built in an oscilloscope. The timing of sampling pulses is controlled by the computer programs. Some of the fundamental characteristics of this method were examined by the use of a test chart. They were, a flatness of sensitivity and a linearity in gray scale of vidicon tube. When characteristics of a vidicon tube are measured, they could be compensated by computer processing. As the result of sampling, an image is divided into 70×50 or 3,500 points. After the compensation for a TV tube characteristics, various kinds of data processing were performed according to the diagnostic requirement.

Some of the result in the cases of thyroid and liver are presented. Digital image processing has much more flexibility than analog processing.

1. Introduction

As the result of remarkable increase in the number of nuclear medicine examinations, the necessity of efficient filing and image processing is increasing year by year.

Scintigrams, when they are converted into TV images, could be easily transmitted to any place and could be analyzed quantitatively by means of TV data processing devices. In this paper, the author introduced a simplified digital TV image processing system which is applicable to the data handling and analysis of scintigrams.

2. Method and Materials

The principle of the author's device for the TV data processing is shown in Fig. 1. Vertical synchronizing signals from the TV camera are fed to an analog to digital converter and trigger the sampling process. Horizontal synchronizing pulses, after certain steps of rate down according to the programmed interval for the vertical axis, are connected to the external trigger of an

oscilloscope. Delayed pulses generated in the time delay unit of the oscilloscope are used as sampling signals for the horizontal axis. They trigger a wait instruction terminal of the computer, and drive the sample hold unit, at the same time. Thus, TV picture signal are sampled, read and stored in sequence. Sampling is executed at one point for each selected horizontal scan and for one frame. In the next frame, the position of sampling on the horizontal scan is slightly shifted, and the sampling is repeated. Thus, a two dimensional digital data acquisition is performed. The number of matrix was decided as 70 on horizontal axis, 50 on vertical axis and 3,500 in total.

At first, a flatness characteristics of vidicon tube was examined, a special view box was designed for this purpose. The flatness of light source was kept less than 10% deviation. The film-camera distance was kept at 50 cm and target and beam current of vidicon tube were kept at constant. Specifications of TV camera and computer for this method were shown in Table 1.

Fig. 1 Block diagram of processing system.

Fig. 2 Timing chart for sampling of the video signal.

Fig. 3a shows a characteristics of TV camera before corrections. The correction for the flatness characteristics of vidicon tube was performed by hard or soft wares. The procedure of correction is as follows. Data of TV camera characteristics as shown in Fig. 3a are stored in the upper 8 bits each word up to about 3,500 words. Scanned data of scintigram image are stored in the lower 8 bits each word. The latter data are divided by the former data and are given a corrected digital image. Fig. 3b shows the flatness after the correction. Improvement of flatness is quiet remarkable as shown in this figure.

Next problem is a reproducibility of images. As regards this point, the TV camera used in this experiment showed fairly good quality, as shown in Fig. 4a and b. Distortions were within allowable range. The third problem is a linearity in the gray

Table 1 Specifications of sampling and processing devices

A. Television camera

Horizontal resolution	350 lines (Center)
Vertical resolution	300 lines (Center)
Frequency characteristics	1 kHz-7 MHz ± 3 dB
Signal to noise ratio	up to 38 dB

B. Computer

Memory capacity	4,096 words
Cycle time	5 μ sec
Word length	16 bits
System	stored program system

Input output device

Teletypewriter (ASR-33)

Photo tape reader	120 characters/sec
Paper tape puncher	30 characters/sec
Analogue to digital converter (2 channel)	
conversion time	4.5 μ sec
full scale	100 mV, 1V, and 10V
accuracy	$\pm 0.5\%$

C. Sample and hold circuit

aperture time	0.1 μ sec
acquisition time	3 μ sec
full power resp.	500 kHz
accuracy	$\pm 0.1\%$

scale. Gray scale test was carried out by a following method. A film test chart for gray scale was prepared of density was 0.5-2.5 (Fig. 5a). Digitalized images of this gray scale before and after the correction is shown in Fig. 5b and Fig. 5c. The result shows that this system has a fairly good linearity in the limited range of density.

Since the images of scintigram are composed of multi photo pulse, a relationship between the number of pulses and density of film or of digitalized image should be considered. Fig. 6a shows a film which was exposed to pulse rate from 12 to 150 cps with constant scanning speed 1 cm/sec. Digitalized images after the correction are shown in Fig. 6b. The relationship between the pulse rate and the film density obtained from the data of 6b is shown in Fig. 7. This result suggests that certain correction should be done by a soft ware according to the pulse

6a A film shows record of each pulse rate by the scanning.

6b Digital image.

Fig. 6 Calibration for density on the film and pulse density of the scanner.

rate or film density. Data acquisition time depends on the number of sampling points on a horizontal scan line. Since the sampling was done at the rate of one sampling point for every one horizontal scan, the rate of data acquisition is 60 point per second. The total length of data acquisition is given as number of sampling points. About two seconds are necessary for the computing process for the flatness correction. Examples of the

Fig. 7 The curve shows a characteristics of the pulse rate and digital levels of the computer.

8a Thyroid scintiphoto.

8b Digital image is displayed by 8 gray scales on the tele-typewriter.

Fig. 8 Case 1.

application of this method for the re-scanning of scintigrams are shown in Figs. 8~10. Various kinds of data processing were realized by using these digitalized image data.

In the case of liver and spleen scan, the following parameters are computed and estimated at iso-contour lines of Fig. 10c; area, diameter, location of maximum density, liver and spleen area ratio, and so on. Fig. 10c shows a contour plot of isodensity levels corresponding to 20% and 80% density respectively.

3. Discussion

Quantitative image analysis of scintigrams is important for the purpose of better interpretation of the scan. Rescanning of scintigrams, in the past, was only on the basis of quantitative or visual conversion. Computer processed TV digital rescanning method developed by the author have greatly improved the accuracy of quantitative analysis of radioisotope images. The merits of the method are summarized as follows.

- 1) Quantitative evaluation of scintigrams.
- 2) High speed rescanning.
- 3) Applicability to the filing retrieval and transmission of scintigrams.

Several technical problems to relating to the digital image acquisition and processing have to be studied. In this paper, the author shows that most problem could be solved by the combination of adequate hard and soft wares. In future, the TV system will be widely used for the purpose of medical image processing including the field of nuclear medicine. Data processing after the acquisition using TV system can be processed by a various sign of the computer system. In the case of scintigram images, on account of their relatively smaller number of picture elements, a mini-computer

with about 4k memory can be used efficiently. Further data processing on the digitalized data will extract many useful informations, and contribute greatly to the medical diagnosis.

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要 旨

TV カメラと小型 Computer を用いた RI Scintiphoto の digital re-scan 法

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工業用 TV カメラと、小型 computer を用いた、RI フォトシンチグラムのデジタルリスキャン法が試みられた。均一な面光源によって撮像された TV カメラの映像信号は、オシロスコープを用いた簡易なインターフェースによってサンプリングされる。オシロスコープ時間軸によって、data とすべき走査線の幅が決められ、また computer DA 変換器からの 8 ビットの電圧により、RI 像のサンプリング点が決められ、掃引される。digital matrix の大きさは 70×50 (3,500) ポイントである。TV カメラのもつ各種歪の補正が検討されたのち、甲状腺、肝シンチフォトのリスキャンが試みられ、また肝 RI 像の自動計測を実施できる可能性が示された。