

Latest Image Processing Technology and Applications Used in X-Ray TV Systems

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1. Introduction

Flat panel detectors (FPDs) have attained a favorable reputation at medical facilities for the ultrahigh image quality that they afford. At the same time, however, recent advances in medical technology have been accompanied by a demand for the ability to observe moving images with even higher image quality, under difficult conditions such as a low S/N ratio or low contrast, particularly in fluoroscopic imaging performed at low X-ray doses.

In order to allow the superior performance of FPDs to be utilized effectively, I believe that it is important to develop applications that eliminate some of the effort required in daily examination work.

In this article, I describe two developments that were brought about in order to fully utilize the superior characteristics of direct-conversion FPDs. SUREengine is a high-speed real-time image processing function that has been modified specifically for use with R/F table systems and allows observation, particularly in examinations of the digestive tract, with even higher image quality than before. SLOT Radiography is a new application that is particularly useful in the field of orthopedics.



Fig. 1 SONIALVISION safire II: X-ray TV System Equipped with Direct-Conversion FPD

2. SUREengine: High-Speed Real-Time Image Processing Function

Using SUREengine to perform the image processes described below makes it possible to improve image quality without the decrease in frame rate and image lag that occurs with conventional processing, and thereby produce smoother images.

· Noise reduction processing (Fig. 2)

With conventional time-integration-based noise reduction, there is a trade off between improved S/N ratio and decreased image lag. It is difficult to simultaneously improve both the S/N ratio and time resolution.

With SUREengine, the noise elements and signal elements are separated for every single frame of moving images, and the noise elements are controlled independently. This makes it possible to reduce noise without image lag.

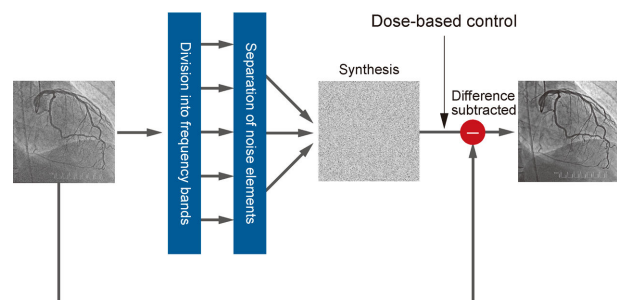


Fig. 2 Principle of Noise Reduction Processing

· Multi-frequency processing (Fig. 3)

Images are separated into multiple frequency bands and gradation processing is performed for each band. This makes it possible to suppress the contrast of parts with halation or black saturation, and thereby obtain images that are well balanced throughout, not just in the region of interest. It also enables the image quality to be adjusted to suit the examination region more precisely than is possible

with conventional single-frequency dynamic range compression or with contrast enhancement based on an LUT (look-up table).

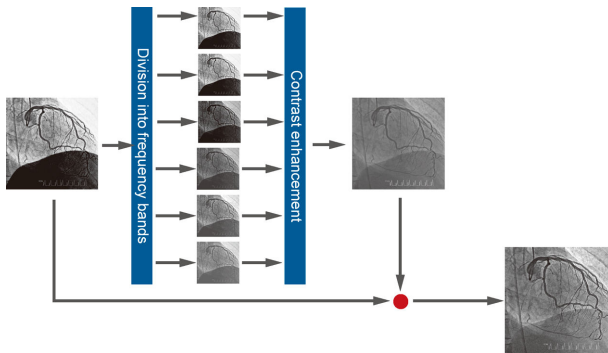


Fig. 3 Principle of Multi-Frequency Processing

With an X-ray TV system, in order to be able to observe various regions, SUREngine's image processing parameters must be adjusted to suit the application. Fig. 4 shows a fluoroscopic image of an IVH and Fig. 5 shows a fluoroscopic image of the lower gastrointestinal tract.

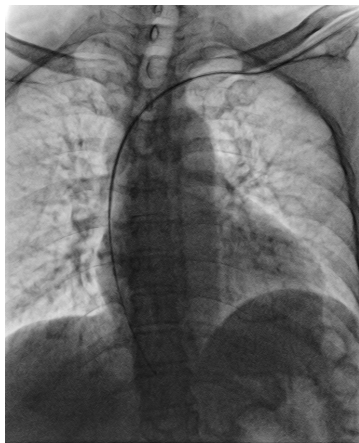


Fig. 4 Fluoroscopic Image of IVH

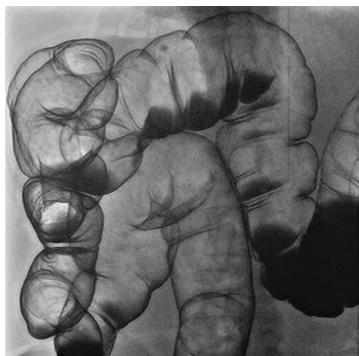


Fig. 5 Fluoroscopic Image of Lower Gastrointestinal Tract

3. SLOT Radiography: Effective Application for Orthopedics

Slot radiography is a technique used to obtain long images (e.g., of the entire spine). With the X-ray tube and FPD acting as a pair, the X-ray beam is

narrowed to a region with a width of a few cm (the slot width) running perpendicular to the axis of the body, and images are continuously taken while the imaging chain is moved over the body at a constant speed (Fig. 6).

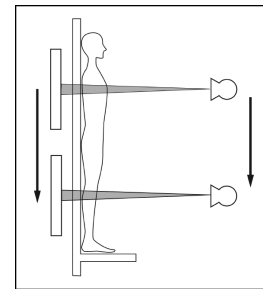


Fig. 6 Imaging Method

Information about the position of the imaging chain relative to the R/F table is used to combine the acquired images into a single long image (Fig. 7). With an FPD, a wide dynamic range with no distortion is available, and by performing dynamic range compression or by adjusting the gradation, it is possible to obtain an even image of the entire region containing the cervical spine, thoracic spine, and lumbar spine.

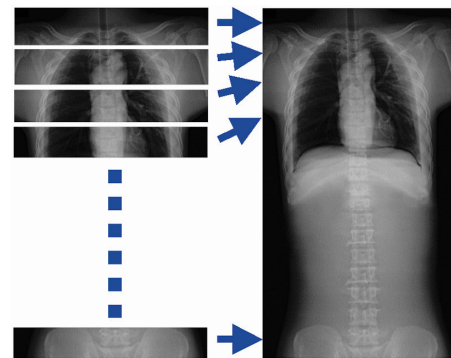


Fig. 7 Combining Slots

In comparison with conventional film-based longitudinal radiography, SLOT Radiography offers the advantages described below.

· Projection from infinity

The X-rays that reach the various parts of the body are almost perpendicular to them and so even peripheral areas appear clearly in the acquired images. Also, because the magnification factor in the direction of the axis of the body can almost be ignored, the measurement precision is extremely high.

· Low dose

FPD performance characteristics allow radiography to be performed with a lower dose than that required with film or CR. Also, narrowing the X-ray beam to a slit helps minimize scattered radiation.

- Improved operability

Radiography in the supine position, which is difficult to perform with conventional techniques, is possible, and it is easy to switch between the standing and supine positions by tilting the R/F table. Also, there is no need to set films or CR cassettes, and radiographic images are combined automatically, making it easy to observe and measure images on the monitor.



Fig. 8 Total Spine Radiography (Left) and Lower Limb Radiography

4. Summary

The direct-conversion FPD is an X-ray sensor that offers superior performance characteristics such as high resolution and high sensitivity.

Use in combination with SUREengine makes it possible to fully utilize the excellent characteristics of this sensor, and to attain the performance required in various examinations at an even higher level.

In addition to SLOT Radiography, FPDs have the potential to help realize more applications that can support difficult examinations in a variety of medical situations.

In the future, Shimadzu Corporation will continue to improve the performance of FPDs and develop useful applications.

References

- 1) K. Mori. "SUREengine High-Speed Real-Time Image Processing Engine". INNERVISION No. 206 (November), Safire (Supplement) Vol. 5, pp. 22-23, 2007.
- 2) T. Sakai. "SLOT Radiography: Application for X-Ray TV". INNERVISION No. 206 (November), Safire (Supplement) Vol. 5, pp. 24-25, 2007.