RADspeed safire Digital General Radiography System Equipped with New Direct-Conversion FPD

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1. Introduction

General radiography is a basic examination that accounts for 70 percent of diagnostic imaging. Many kinds of procedures, such as chest radiography, abdominal radiography, and orthopedic radiography, are performed in a single room. Consequently, patients require low exposure levels and short waiting and examination times, whereas medical staff require reliable images with high diagnostic performance, reduction in labor provided by ease of operation, network compatibility, and linkage between operations. In addition, there is a strong demand for displaying images immediately to allow accurate examinations.

To meet these requirements, Shimadzu released the RADIOTEX safire general radiography system equipped with a direct-conversion flat panel detector (FPD) in October 2004, which has been highly evaluated by customers.

To achieve an even higher level of image quality and even lower exposure dosages, Shimadzu has now developed the RADspeed safire system equipped with an advanced direct-conversion FPD, and new digital image processing unit. This new system is also equipped with an auto-positioning feature for higher operability.

2. System Features

2.1. System Configuration and Key Specifications

Table 1 shows the RADspeed safire system configuration and key specifications. Fig. 1 shows the system appearance. The RADspeed safire system includes a new direct-conversion 16-bit FPD, which offers outstanding detection performance, a high-performance digital image processing unit, which takes advantage of the high-definition data provided by the FPD to generate images with high diagnostic performance, and an X-ray tube support equipped with an auto-positioning feature for superior operability.

RADspeed safire	Key Specifications
FPD	Direct-conversion FPD, 16-bit grayscale (65,536 shades), 2880 x 2880 effective pixels, 432 mm x 432 mm effective field of view, and 150 µm pixel pitch
Image Processing Unit	Radiographic image display: approx. 3 seconds after exposure Monitor: 15-inch color LCD touch panel Functions: Auto density correction, grayscale processing, multi-frequency processing, noise reduction DICOM 3.0 Compatibility: Print, Storage, MWM, and MPPS
X-Ray Tube Support	Vertical stroke: 160 cm Control panel: 9-inch color LCD Linkage with X-ray tube vertical movement and rotation Auto-positioning
Variable Aperture	Auto collimator (auto/manual switchable)
X-Ray High-Voltage Generator	Rated output: 80 kW Tube voltage: 40 kV to 150 kV
Bucky Stand	Vertical movement: 38 cm to 178 cm (center height) Detector surface inclination: -20 to 90 degrees
Bucky Table	Table elevation range: 39 cm to 94 cm Longitudinal travel linked with X-ray tube
X-Ray Tube Unit	0.6/1.2 mm focal point, 400 kHU, 12-degree target angle, 1-second startup time

Table 1 RADspeed safire System Configuration and Key Specifications

Fig.1 RADspeed safire System

2.2. 16-Bit Direct-Conversion FPD

Fig. 2 illustrates the principle of the direct-conversion FPD[1]. Incident X-rays are directly converted to electron-hole pairs in the amorphous selenium (a-Se) layer and accumulated at the pixel electrode. Accu-

mulated electrical charges are collected as analog data, converted to 16-bit digital data, and sent to the image processor. Unlike cassette radiography or indirect-conversion FPDs, direct-conversion FPDs do not need to convert X-rays to light. Therefore, the obtained images are less likely to blur even in detailed regions. Consequently, they can clearly show even fine structural details, such as micro bone fracture lines or bone trabeculae.

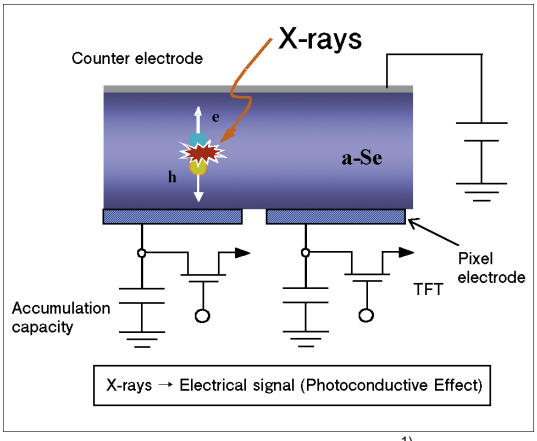


Fig. 2 Principle of Direct-Conversion FPD[1)]

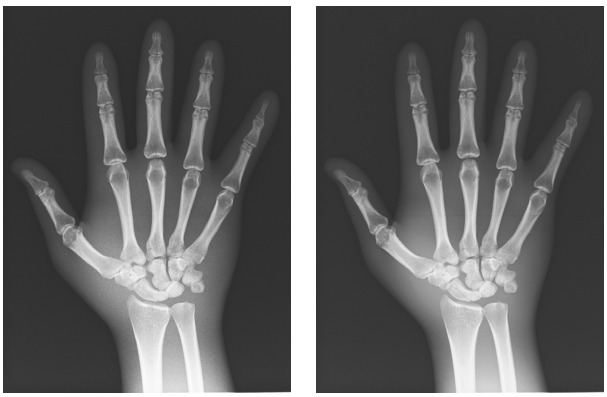
2.3. Image Processing Unit

The image processing unit that processes data collected from the high-performance FPD and displays and outputs the results offers superior operability, a wide variety of image processing functions and highly stable image quality (Fig. 3).

Fig. 3 Control Console

(1) Auto Sensitivity Adjustment

Images acquired by the direct-conversion FPD are subjected to histogram analysis for each exposure region, so that they are automatically output with the optimal density contrast, even if the subjects or dosages differ. Fig. 4 shows radiographic images of a hand obtained using significantly different dosage levels, but the images are displayed with appropriate levels of density. This eliminates variability in image density between images obtained by different operators, and also significantly improves examination workflow.



(a) 0.5 mAs (b) 5 mAs

Fig. 4 Effect of Auto Sensitivity Adjustment (hand joints at 50 kV and 100 cm)

(2) Multi-Frequency Processing

Multi-frequency processing includes frequency enhancement and dynamic range compression. Approximate levels of enhancement are applied to individual frequency bands of images where density contrast has been adjusted by automatic sensitivity adjustment, to create images optimized for the object of interest or diagnostic objective.

Fig. 5 shows how even areas that were previously difficult to express well at the same time are shown with good contrast, such as the mediastinum and the lungs in the chest image (a), or the area between the thoracic and lumbar vertebrae, fifth lumbar vertebra to sacral bone, and processus spinosus in the lateral lumbar image (b).

(a) Anterior Chest Image (120 kV, 2.5 mAs, 180 cm)

(b) Lateral Lumbar Image (80 kV, 40 mAs, 120 cm)

Fig. 5 Images Subjected to Multi-Frequency Processing

The image processing unit also provides the following features to achieve the ease of use required for general radiology systems used for large numbers of examinations.

- The touch panel screen provides an easy-to-see graphical user interface for outstanding operability.
- Automatically processes orders taken from the work list.
- Automatically specifies exposure conditions and irradiation field.
- Displays reference images approximately 3 seconds after exposure.
- Automatically advances to next menu item after exposure.
- Automatically sends images to a printer or image server after examinations are completed.

2.4. Auto-Positioning

Previous systems required manual operations for X-ray tube positioning whenever the SID was changed or when the patient position was changed from standing to supine. However, moving the heavy X-ray tube or positioning the tube at a high location required considerable effort. Therefore, customers were demanding an instrument that would allow improving the workflow.

In response, Shimadzu developed an auto-positioning feature, which moves the X-ray tube to a specified location, in synchronization with the radiography menu. This feature allows using a remote control unit to change from a standing to a supine position, change the SID, tilt the imaging angle, or move to a parking position. This feature eliminates the need of installing two X-ray tubes in an examination room - one for the standing position and the other for the supine position, allowing more effective use of the space in the examination room. This also helps patients feel more relaxed, and reduces the costs for installing the equipment.[2)]

3. Summary

Shimadzu has developed a new digital general radiography system, the RADspeed safire, based on the concept of lower dosages, higher image quality, and higher operability. In this new system, the 16-bit direct-conversion FPD and high-performance digital image processing unit are effectively combined to create high quality images, and the auto-positioning and other features realize outstanding operability. Furthermore, as an X-ray system manufacturer, we designed the entire system to achieve a significant improvement in the total workflow of general radiography. Please look for new applications proposed by Shimadzu for the system, which take advantage of the FPDs characteristics or synchronized functionality.

References:

1) Susumu Adachi et al.: Development of 17-inch Direct-Conversion Dynamic Flat panel X-Ray Detector (FPD), MEDICAL NOW, No. 53, pp. 20 to 21, 2004

2) Masahiro Kawano et al.: Development of Auto-Positioning System for X-ray General Radiography, Shimadzu Review, Vol. 63, No. 3・No. 4, pp. 155 to 160, 2007