Development of the SONIALVISION G4 A New R/F System

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1. Introduction

Since Shimadzu began selling its SONIALVISION safire Series, a flagship model of the SONIALVISION Series of R/F systems equipped with a large field-of-view and high image quality FPD, the performance of the SONIALVISION safire Series and its tomosynthesis features have been held in high regard. Shimadzu has developed a new addition to the SONIALVISION Series of R/F systems, the SONIALVISION G4. The SONIALVISION G4 is a best-in-class base level R/F system suited to the fluoroscopy room. It inherits the base functions of the conventional SONIALVISION Series models while offering practical performance improvements in areas of multipurpose functionality, examination efficiency, exposure reduction, and space saving. The SONIALVISION G4 is described below.

Fig. 1 External View of R/F Table

Fig. 2 External View of Remote Console

2. System Advantages

2.1. Multipurpose Functionality

R/F systems are required to perform in an ever more diverse range of applications, a single system being used for a variety of treatments and examinations from conventional gastrointestinal radiography to endoscopic procedures, swallowing radiography, and angiography. In recent years, there has been increasing market demand for R/F systems capable of performing roles in a variety of clinical fields that were previously filled by dedicated systems, including for urologic, pediatric, and orthopedic examinations in addition to gastrointestinal examinations.

(1) Wide area fluoroscopy

The degree of longitudinal travel in the imaging system has been increased by 55 mm up to 1605 mm, creating a longitudinal radiographic range of 2025 mm at the maximum stroke of the imagining system without table movement. The distance from the end of the table to the field-of-view has also been shortened, an important feature for urologic examinations. The table is also constructed with a full-flat design and frame does not avoid the field-of-view. A full 17 × 17 inch field-of-view can also be utilized along the full lateral range of motion of the table.

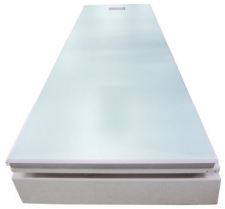


Fig. 3 Frame-Free Full Flat Table

(2) Optimum positioning for a given procedure

For times during urologic or other examinations when the table must be tilted, a control mode (URO mode) has been added that allows the table to tilt while maintaining a constant height at the end of the table where the operator performs procedures. The angle of incline on the table can be adjusted and held to provide the optimum orientation for an ongoing procedure.

Fig. 4 URO Mode

2.2. High-Quality Fluoroscopic and Radiographic Images (SUREengine-Advance)

Fluoroscopy SURE has been improved by the insertion of a frequency-separating recursive filter, which gives reductions in both noise and afterimages compared to previous models. Furthermore, needle tips and fine structures have been made easily observable by adding an HD fluoroscopy mode (high-definition fluoroscopy mode) using an expanded view of a 6-inch field-of-view.

Radiography SURE also optimizes processing parameters for the new FPD, achieving noise reductions and contrast enhancements and making the system suitable for use in gastrointestinal tract-related examinations.

Fig. 5 Example Examination of the Gastrointestinal Tract: Good Contrast

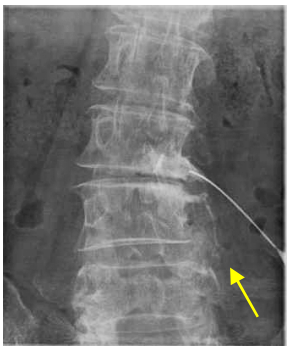


Fig. 6 Example Nerve Root Contrast Imagining: Good Contrast and Easily Observable Contrast Medium and Needle Point

2.3. Reduced Exposure

(1) Reduced exposure using detachable grid

Grid attachment/removal can be selected based on the location of the area to be examined and patient condition. This allows radiography to be performed with the optimum X-ray exposure conditions for each particular examination.

Grid status is shown on the control screen so the operator can easily determine whether the grid is attached or removed. Also, if grid status differs from pre-set conditions, the operator will be notified so as to prevent radiographic examinations performed with incorrect conditions.

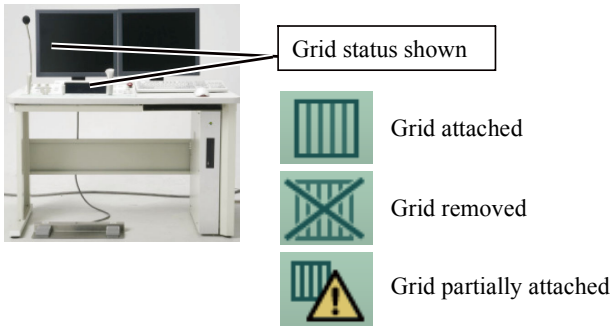


Fig. 7 Display Showing Grid Removal/Attachment

(2) Reduced exposure using an autofilter

An autofilter function was added to the collimator to select automatically the optimum filter for fluoroscopy or radiography so as to reduce soft X-rays that play no meaningful role in imaging the examination region.

Fig. 8 Auxiliary Filter Selection Screen

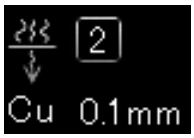


Fig. 9 Auxiliary Filter Status View

(3) Reduced exposure using a virtual collimator

Previously, setting the collimation area required adjustment using fluoroscopic confirmation of the area. In this model of system, the fluoroscopic image held by the last image hold feature is used together with a virtual collimator to set the collimation area via the monitor display. What was before performed in real time during fluoroscopy can be performed in a way that requires fluoroscopy for only a short period of time, reducing the exposure that occurs while setting an appropriate irradiation area.

(4) Asymmetric collimator / iris collimation

An asymmetric collimator is placed on the collimator in a direction lateral to table length that is used to screen the areas of the body such as urinary organs and orthopedic areas like the upper and lower extremities, that are outside the region of interest. This protects them from X-rays that would not contribute meaningfully to the image. The iris collimation can be used to cut X-ray exposure in regions outside the area of interest such as during the fluoroscopic examination of fingers.

Fig. 10 Example Use of an Asymmetric collimator (Screening Around the Upper Part of the Left Arm)

2.4. Improved Examination Efficiency

Examination efficiency has been improved by reducing operation procedures and improving operability.

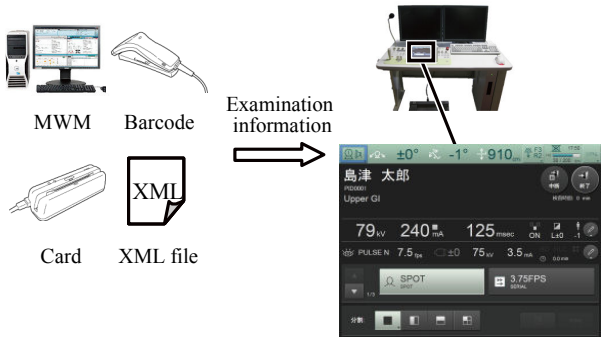
(1) Integrated touchscreen panel console

The control console is fitted with a centered 10.4-inch touchscreen LCD panel that displays information on X-ray conditions, the R/F table, and parameter presets in a single location. The buttons used to manipulate X-ray conditions are located around the touchscreen panel itself to minimize operator eye movements and reduce examination times. Adopting a touchscreen panel also means changes to presets and other manipulations that must be performed

during an examination can be completed at the operator's fingertips.

Fig. 11 Integrated Console

(2) Additional methods for entering patient information
Patient information entry can now be performed using a barcode and XML file in addition to the existing MWM and ID card. Whatever method of entering patient information is used, the function is equipped to automatically start an examination once information entry has been completed. Furthermore, when examination information is acquired via MWM, a search is performed using the patient ID read with the barcode reader and if matching patient information is found, patient information is registered automatically so examination can begin. This means that the registration of patient information and assisting the patient in preparing for an examination can occur in parallel.



(Simple mode screen example)

Fig. 12 Examination Workflow

2.5. System Design

(1) R/F table design
The R/F table follows the design concept employed with the SONIALVISION safire Series, with all cables routed internally in the driving unit through the X-ray tube to the column, creating a clean outer appearance that is non-intimidating to the patient and improving cleaning efficiency.

Fig. 13 "Cable-Less" Design

(2) Control unit design
A new design has been created that combines the local console with the monitor cart, using an aluminum column for the console cart and an uncluttered overall design.

Fig. 14 Mini Local Console and Monitor Cart

Fig. 15 Combined Console and Monitor Cart

3. System Specifications

Major system specifications are outlined below.

Component	Specifications
R/F Table	Imaging system longitudinal stroke: 1605 mm Lateral tabletop movement: 250 mm Distance between table end and detection area: 95 mm (closest) Tabletop height: 470 to 1100 mm Table tilting angle: -90° to +90° SID: 1100 mm, 1200 mm, 1500 mm X-ray oblique projection angle: -40° to +40°
X-Ray Flat Panel Detector (FPD)	X-ray conversion: CsI Pixel pitch: 139 μm Maximum effective number of pixels: 3032 × 3032 Density resolution: 16 bit
Image Processing Unit	Field of view sizes: 17" × 17", 15" × 15", 12" × 12", 9" × 9", 6" × 6" Fluoroscopy: Pulsed fluoroscopy (30/15/7.5/3.75 fps) Fluoroscopy image storage: 1000 frames max. Radiography: SPOT radiography, division radiography, serial radiography, DSA radiography Image processing: SUREengine-advance (fluoroscopic and radiographic multi-frequency processing) External equipment: DICOM MWM/MPPS, PRINT, STORAGE (RF/XA), card reader, barcode reader
High Voltage Generator	Max. output rating: 80 kW Generator type: Inverter
X-Ray Tube	Maximum anode heat capacity: 750 kHU Focal size: 0.7/1.2 mm

Table 1 Major Specifications

4. Conclusion

The new SONIALVISION G4 model R/F system is able to contribute to the efficient conduct of diagnosis and treatment in various clinical fields, including radiography, urology, orthopedics, and pediatrics. Looking forward, we intend to develop R/F systems with further reduced exposure doses and improved functionality, operability and image quality for more applications in more general radiographic roles and to meet ever more diverse market needs.

I would like to express my sincere gratitude to Nihon Koukan Hospital for providing a significant amount of clinical data.