

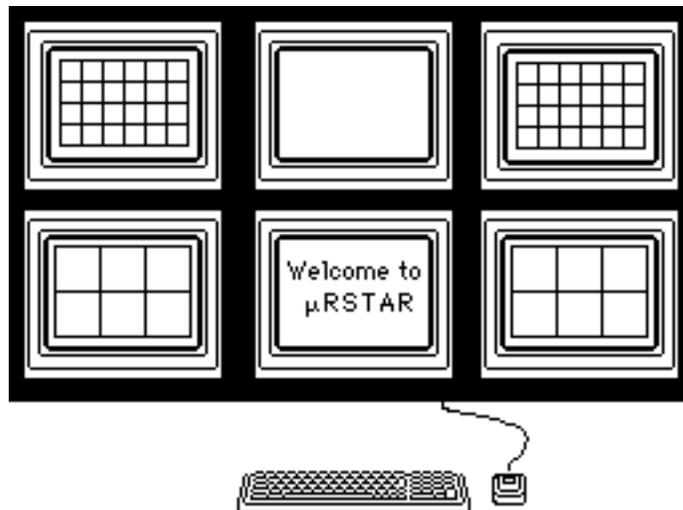
The Massachusetts General Hospital



Radiology Storage Transfer Analysis and Reporting

SYSTEM OVERVIEW

V1.01



AUGUST 24, 1988

μRSTAR OVERVIEW

The intent of this document is to provide a brief overview of the μRSTAR System.

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Overview of μRSTAR

μRSTAR (pronounced "micro-r-star"), Massachusetts General Hospital's computerized system for RADIOLOGY STORAGE, TRANSFER, ANALYSIS, AND REPORTING, is primarily a research-oriented medical image display-station and central archive for the acquisition, storage and display of radiological images from CT, MRI, Nuclear, PET and other devices. From any of the work-stations throughout the department, μRSTAR users may quickly and selectively search the central VAX computer for patient exams. The exams may then be viewed and manipulated at the work-station. In addition, images can be modified with sophisticated image processing algorithms.

Features and Capabilities

The following list indicates the features of μRSTAR.

- **Image Data Collection and Archiving**

The ability to collect and archive images from the following modalities: CT, MRI, Nuclear, PET, and Video Camera RS-170.

- **Demographic Data Collection and Archiving**

The ability to collect and archive demographic information about the patient, the exam and related images.

- **Clinical Exam Presentation Mode**

A fast case review mode that facilitates rapid presentation and display of selected exams.

- **Archive Searching Capabilities**

The ability to search for exams based on multiple keys, such as, patient name, exam date, radiologist, etc.

- **Image Formatting**

The ability to display multiple images per screen. The screens can have many different display formats and can simultaneously display images of different modalities, including cine-loops.

- **Image Moving**

The ability for the user to simply and quickly move images from screen to screen (grab and drag via the mouse).

- **Simple Image Manipulation**

The ability to perform simple image processing routines, such as, window and center, flip, rotate, invert, zoom, false color, etc.

- **Complex Image Manipulation**

The ability to perform complex image processing routines, such as, spatial, temporal, filtering, FFT, warping, etc.

- **Third Party Interface**

The ability to interface user written programs running on the VAX head-end to the μRSTAR System (TPI).

Screen Modes: Overview

Work-station functions performed by most users fall into five categories. For that reason, the user interface consists of five different modes, each having a distinct control screen representation.

- **Database Mode**

Execute a keyed database search and from the list of found exams choose the ones to view.

- **Image-Place Mode**

Place images upon the screens, select screen formats and move images from screen to screen.

- **Image-View and Manipulation Mode**

Perform various simple image manipulations locally and send complex image manipulations to the head-end for processing.

- **System Mode**

Set user defined system defaults.

- **Case Review Mode**

Automated mode that fetches a user's case load from the head-end archive and displays the exams on screens formatted to best suit the exam's modality.

Research Method vs. Clinical Method

In a department as large and diverse as MGH Radiology, μRSTAR must fill the needs of both clinicians and researchers. To that end, two different methods of operation are offered to the user.

- **Clinical Usage Mode**

A method by which the **work-station**, knowing a user's case load and work pattern, will execute a database search, fetch the relevant exams from the archive, and display the exams in manner best suited to their modality.

1. The user enters the Case Review Mode.

μRSTAR performs a predefined database search

(may search for read or unread exams).

μRSTAR makes the exams known to the work-station.

μRSTAR searches for relevant comparison exams.

μRSTAR displays the related images in a predetermined manner.

The user may perform various image processing operations.

- **Research Usage Mode**

A method by which the **user** has complete control over each step of the operation. The user executes a database search, chooses exams, places them on the screens and manipulates the images.

1. The user enters the Database Mode.

Executes a database search.

Makes the desired exams known to the work-station

(places them in the local work-station database).

2. The user enters the Image-Placement Mode.

Chooses screens formats.

Displays exams on the image screens.

3. The user enters the Image-View Mode.

Performs various image processing operations on the images.

Screen Modes: Detail

Database Mode

For greater speed and efficiency, each work-station contains its own local database which holds up to fifty exams with up to 200 related images. A user performs database look-ups on the main exam archive, at the head-end and from the list of found exams, chooses which exams to make known to the work-station (ie. place the exam demographics in the local work-station database). To prevent the work-station from being cluttered with extraneous exams, they may be forgotten. Forgetting an exam removes it from the local database only. A user cannot remove exams from the archive on the head-end.

Database of Exams and Related Images

At the head-end two archives exist. One contains image data from various modalities including CT, MRI, Nuclear, PET, and video camera capture. The other contains demographic information pertaining to patients, exams and images.

Database Searches

Multi-keyed database searches may be performed on the head-end demographic archive. Keys include: patient name, radiologist, exam date, exam code, date of birth, attending physician, review status, etc. A user may execute three levels of database searches: canned, simple, and complex.

- **Canned Searches**

Predefined by the user and available as menu items for easy execution. Clinically useful for physicians with predetermined case loads and teaching files.

- **Simple Searches**

A one or two key search from a list of predefined keys.

- **Complex Searches**

A totally user defined search that may be multi-keyed with many levels of logical dependencies (and, or, not). A research tool that allows for complicated database searches.

Image-Place Mode

Images are commanded to be displayed on the work-station screens in the Image-Place mode. Each work-station contains a total of ten screens made up of both real and virtual screens.

Real Screens

Real screens are those that are physically present, that is, capable of displaying an image. Each image screen can be formatted into various numbers of partitions. A partition is a rectangular location for one image.

Virtual Screens

Virtual screens are identical to image screens in every respect, except that there is no display monitor associated with them. Their usefulness comes from the fact that images can be placed upon them for future viewing and that they are a convenient place to temporarily store and manipulate images.

Image Grab-Drag-and-Select

Using the mouse, single images can be selectively moved from partition to partition and from screen to screen. Additionally, whole screen loads of images can be moved from screen to screen.

Image-View Mode

Images may be manipulated in the Image-View mode. Using the mouse, a user may select a single image, many images, or whole screen loads of images for processing.

Simple Image Processing

Simple image processing routines are performed locally at the work-station. Routines, such as, invert, flip, rotate, zoom, and false color are selected by choosing graphic-buttons with the mouse on the control screen. There are also two graphic sliders controlled by the mouse. The first one adjusts the window and center of images, and the second one adjusts the speed of the cine-loops.

Complex Image Processing

Because of the greater processing power of DEC VAX's, complex image processing routines are sent to the head-end for processing. Spatial and temporal filtering, FFT's, and warping are a few of the complex routines handled by the head-end. Information about a selected image is sent to the head-end with the request for processing. When completed, the head-end alerts the user of its completion. The processed image now resides in the head-end database and the user may bring it to the work-station for viewing.

Third Party Interface (TPI)

Using the Third Party Interface, users may write their own image processing routines to be executed on the head-end. TPI is a standardized method for interfacing user's code to the μRSTAR system. It allows for the development of new image processing routines without disrupting normal work-station operations. In a manner similar to complex image processing, image information is sent to the head-end with a request for processing, the manipulated image is placed in the database, and a completion message is sent to the user at the work-station.

Case Review Mode

Clinicians with a predetermined case load can quickly and efficiently view their exams. A built in expert system at the work-station performs database searches and displays the exams sequentially to the user.

Modality Specific Image Viewing

With the help of many physicians and researchers, the μRSTAR team has developed various screen formats best suited for exams of different modalities. This part of the expert system will be constantly upgraded as new modalities and new viewing formats are added to the work-station.

System Mode

The System Mode allows the user to set default conditions for operation. The work-station remembers the user's system defaults and implements them each time the user logs onto the system. In this way, a user may fine tune the work-station to best meet his needs and working patterns.

System Architecture

The μRSTAR work-station is primarily a research tool, with clinical applications, developed to investigate the form and function of PAC (Picture Archiving and Communications) systems in a Radiology department. Being the first of its kind in many respects, the decision was made to implement a low cost system for initial evaluation within the department. The work-station is IBM-AT based with a DEC VAX computer as the head-end. To the user, the work-station seems to be a control screen, a keyboard, and two to ten image screens; the connection to the head-end Image Storage and Archive is transparent. The work-station computer handles the main user interface and most of the simple image display and image manipulations. The head-end contains the exam and image data bases. Additionally, complex image processing routines are performed on the VAX.