READS: A Radiology-Oriented Electronic Analysis and Display Station

Bradley J. Erickson, William J. Ryan, and Dale G. Gehring

READS is a picture archiving and communications system (PACS) display program that is tailored to allow a radiologist to efficiently perform image review tasks. In this study, the image review process was observed and functional patterns were identified. These were used to define a design that was considered to represent the optimal balance of compromises for a low-cost review station that also allowed easy addition of new functionality. As a result, a program was designed and implemented that has been found to be acceptable for image review and for special image processing function development.

KEY WORDS: PACS, image processing, image display.

DIGITAL IMAGES comprise an ever increasing fraction of the images interpreted by radiologists. They routinely are generated today by computed tomography (CT), magnetic resonance (MR) imaging, and nuclear medicine. Digital images are beginning to replace analog methods in ultrasonography, computed radiography (CR), and fluoroscopy. This movement to digital images presents challenges and opportunities. We present a method for displaying archived digital images in a fashion that facilitates easy review and permits easy integration of new image processing functions.

METHODS

It was determined from observation of practicing radiologists that selecting the next or previous image constituted 62% of interactions and that adjusting the window settings (width and level) constituted another 35% of interactions at physician consoles attached to CT and MR imaging scanners during the initial image review and comparison process. Choosing the image set and making measurements on images constituted most of the remaining 3%. Because the majority of interactions consisted of either requesting the next or previous image or adjusting the contrast of the displayed image, it was determined that performing these function should be possible at any time with a single action with either the keyboard or the mouse. These observations have been noted previously.[1]

In this software implementation, continuous adjustment of contrast and brightness is performed by dragging the right mouse button or by using the keyboard. Standard CT settings (such as bone, soft tissue, lung, or brain) can be achieved by clicking the correspondingly labeled button or by hitting a function key. The width and level settings for each is specified in the user profile database. For other images, the initial window setting for each series is calculated by an algorithm designed to match contrast settings typically chosen by a technician for filming a case.[2] Different display formats are easily selected using "radio button" style pushbuttons. The application is shown in Fig 1.

Added special functions can be accessed by clicking the "Functions" button. The list of available special functions comes from the user profile and, therefore, is tailored to meet the individual needs of each radiologist. Some functions are built into the application (such as printing a film, making 35-mm slides, or picking zoom algorithms); READS assumes that any other functions are separate programs that are to be started by READS.

RESULTS

A measure of success of READS is the replacement of old films with electronic display. Although there was initially some concern about this, most radiologists have felt comfortable with electronic display for purposes of comparing the new study with old ones. Training effort has been minimal—fewer than 15 minutes of one-on-one training generally has been sufficient to get users to the point of being able to review images.

Another measure of success is the number of special functions that have been added to READS—27 at last count. The added functions range from teaching file functions to three-dimensional automated image segmentation and classification. It has been adapted as a test bed for testing DICOM connectivity and has operated under six different operating systems.

READS also has been modified to allow capture of images as they are reconstructed to provide immediate remote review capability on low-cost computers. It also has been developed for teleradiology by integrating a communications module and special image compression.

DISCUSSION

READS currently is used in our department for reviewing old studies in clinical practice. READS

From the Departments of Radiology (BJE) and Information Services (WJR, DGG), Mayo Foundation, Rochester, MN.

Address reprint requests to Bradley J Erickson, MD, PhD, Department of Radiology, Mayo Foundation, 200 First Street SW, Rochester, MN 55905.

0897-1889/97/1003-1026$3.00/0

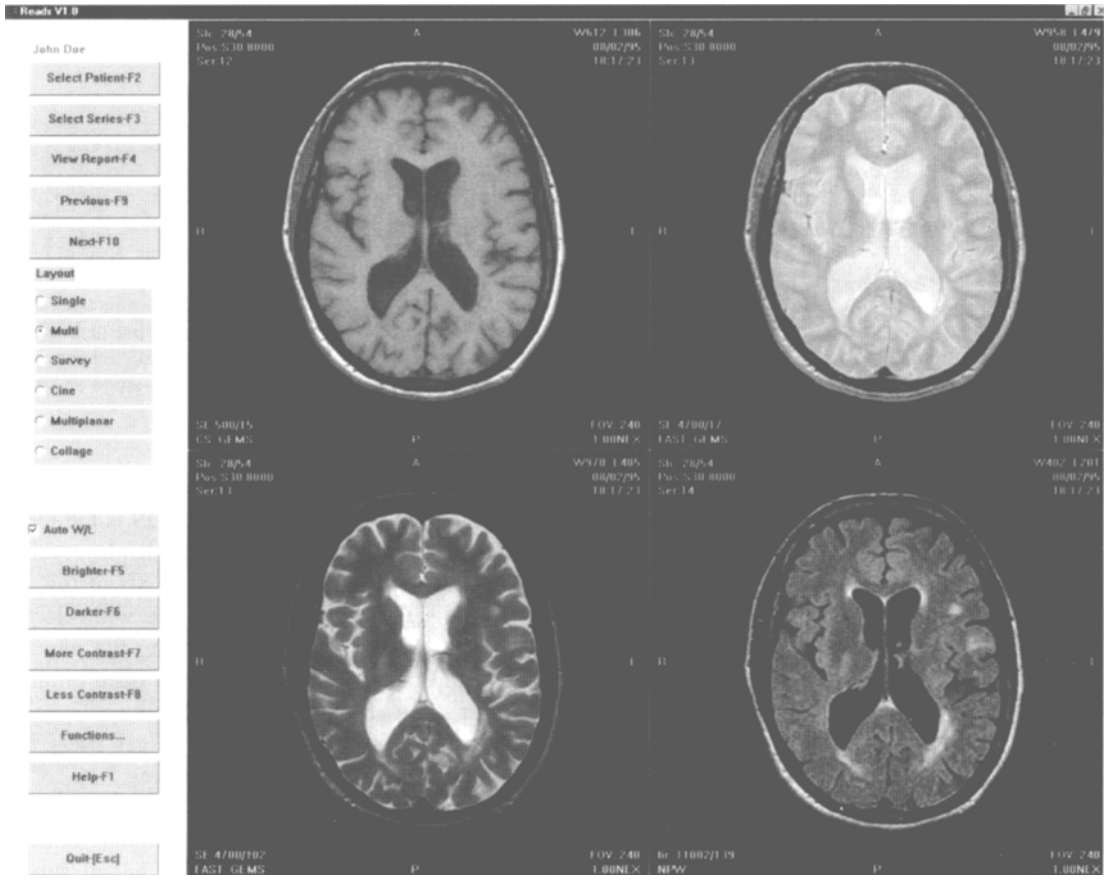

Fig 1. The READS application interface.

has been found to be easy to learn and use, and can obviate the need for retrieving old studies. At present, most staff do not yet feel comfortable with interpreting CT and MR imaging studies using any PACS workstation, particularly for complex MR imaging cases. Never-the-less, by reducing the need for transporting old studies, READS and PACS have reduced the costs of operating the department. READS also is used for viewing and printing studies performed at remote sites (studies are sent to a central location using Wide Area Network technology), teleradiology, for remote consultation, immediate review of modality images, and for educational and research purposes. Modules also have been developed for READS for performing quality control on MR imaging and CT scanners.

Another important value is the ability to view images on inexpensive and ubiquitous workstations, which allows for remote consultation and remote interpretation. It also eliminates competition for films among clinicians, because the same study can be viewed simultaneously at any number of locations.

The addition of DICOM receive capabilities has allowed READS to be deployed as a workstation for monitoring scanners. Because these are available in all CT and MR imaging reading areas, and because creating the DICOM association between the scanner and any READS station is straightforward, great flexibility in staffing options is permitted.

By adding telecommunications and image compression,[3] READS has become a mean of providing high-quality image review in the homes of radiologists.

The design of READS allows for the integration of more sophisticated functions with the press of a button. This has allowed clinical deployment of many special image processing functions that now have become a vital part of clinical practice. It likely will encourage the continued development

and application of more sophisticated image processing techniques in everyday practice. This, in turn, may improve the accuracy and speed of interpretation of radiological images.

READS has become an important "toolbox" in our department, and as our department image management system changes, READS has and will change to meet specific needs. It serves as an important bridge between systems when transitions are made, and serves as a familiar common application.

A derivative version of READS is now under development for clinicians. This version will have reduced functionality but will be integrated into the electronic medical record at our institition. We believe this might be an effective way to distribute images to clinicians for such purposes as review with patients and basic educational needs.

Electronic display of medical images has been performed for more than 20 years, but film media is still the accepted display method for image interpretation. Part of the reasons for preferring film are the ability to see many images simultaneously and the high quality of image rendition. But electronic display permits adjustment of contrast and brightness, cinematic viewing of images, accurate measurement of the image, and electronic transmission and storage. Advances in computer technology make electronic display a competitive alternative to film, and we foresee a time when the advantages of electronic display will surpass film. Until then, review of images on electronic displays still will be essential.

CONCLUSIONS

READS is an efficient program for reviewing CT and MR images on electronic displays. It allows many images to be displayed simultaneously with independent contrast adjustment, while also permitting cinematic display and three-dimensional reformatting. It provides a mechanism to implement experimental image processing algorithms, have subsequently have become a part of clinical practice.

REFERENCES

1. Ho BKT, Ratib O, Horii SC: PACS Workstation Design. Computerized Medical Imaging and Graphics 15:147-155, 1991

2. Ryan WJ, Avula RT, Erickson BJ, et al: Automated width and level calculation for MR images. Radiology 197:447, 1995 (suppl)

3. Manduca A, Said A: Wavelet compression of medical images with set partitioning in hierarchical trees. Medical Imaging 1996: Image Display. Proc SPIE 2707:192-200, 1996