Creating a Digital Video-Based Teaching File for Interventional Procedures Using CT Fluoroscopy

Thorsten L. Krebs, KC Hisley, Barry Daly, Jade J. Wong-You-Cheong, and David M. Perlmutter

A computerized radiology education teaching file application, MRW (Multimedia Radiology Workstation), was produced in our department as a collaboration of faculty, fellows and a doctoral student. This inexpensive and flexible system is novice-programmable and is capable of capturing images from multiple modalities (including still and cine image) and organizing them into individual electronic teaching cases. Help and tutorial functions support the main case display functions.

Copyright © 1998 by W.B. Saunders Company

AN INNOVATIVE third-generation CT scanner (Xpress SX, Toshiba Corp., Tokyo, Japan) currently in use at the University of Maryland, Department of Radiology permits near real-time reconstruction of CT Fluoroscopy (CTF) to aid in the performance of interventional procedures. We have created MRW (Multimedia Radiology Workstation) to be capable of using a variety of imaging resources, including CTF, as an alternative to standard teaching file methods. MRW consists of three components: a search engine, a case library and a media file collection. The search engine allows case selection by organ system/body region, modality and pathology. The case library consists of a hard disk directory containing individual case projects. Supporting data (diagnostic, patient history and modality information) can be added for each case. The media file collection consists of a directory containing digitized imaging media files obtained from CT, CT fluoroscopy, MRI, US, plain film, and nuclear medicine. Thus, MRW is a database application containing potentially hundreds of unique cross-indexed cases designed to allow efficient access/viewing in an intuitive, user-friendly manner.

We have drawn on the radiology literature and five years of multimedia creation experience to make MRW. Since the initial learning task involved

the viewing of interventional techniques and dynamic guidewire/catheter placement, the work of Kuszyk et al¹ was useful. Their system uses a similar hardware/software platform as ours but was predominantly focused on hepatic anatomy. D'Alessandro et al² studied the effectiveness of multimedia teaching methods versus existing lectures and found that computer-based systems were more efficient in repetitive drill learning. Both of these reported systems stressed ease-of-use and the attractiveness of interactive media. Other efforts investigated cross-platform on-line hypertext documentation,³ the use of game interfaces to increase multimedia information retention⁴ and multimedia authoring by radiologists without professional assistance.⁵

MATERIALS AND METHODS

Media Requirements

Our experience with over 300 interventional procedures utilizing CTF forms the basis of the teaching collection. Although time-based cine studies are the core of this potential library MRW can use many multimedia file formats. Useful visualization methods including animation and three-dimensional models can also be incorporated. Since these media formats must be digital, analog image sources must undergo analog-to-digital conversion either by NTSC video capture, digital camera, or flatbed scanner. Resulting media digital formats are saved in standard formats such as PICT, TIFF (standard formats for still images) or QuickTime (a standard digital multi-track movie format). Images may also be transferred in native DICOM digital file formats and avoid image degradation associated with the analog-to-digital conversion process. Since these files have lengthy headers, the image must be extracted and saved in one of the standard formats mentioned above.

Hardware/Software Considerations

Video output from the CTF scanner is captured by a Micromotion DC30 digital video capture card (Miro Corp., Palo Alto, CA) on a 210 MHZ Macintosh clone (PowerCenter Pro, PowerComputing Corp., San Antonio, TX) computer. High quality digital still images were obtained by using a Kodak DCS 420 digital camera (Eastman Kodak, Rochester, NY). A Two 4 gigabyte interleaved RAID hard drive serves as a large rapidly addressable archive for the cases. The multimedia software used was SuperCard (Allegiant Corp., Palo Alto, CA) which is a flexible multiwindow-based authoring tool with capabilities for the design and programming of color-based background, controls (icon/text buttons), text fields, and QuickTime movie display.

Software Design Concepts

A general functional system overview diagram is shown in Fig 1. The basic design concept for MRW centers on three basic

From the Department of Radiology, University of Maryland Medical School, Baltimore, MD.

This effort is being supported in part by a grant from Toshiba America Medical Systems, Inc.

Address reprint requests to Thorsten L. Krebs, MD, Department of Radiology, 22 South Greene Street, University of Maryland Medical School, Baltimore, MD, 21201.

*Copyright © 1998 by W.B. Saunders Company
0897-1889/98/1103-1036\$8.00/0*

LEGEND:

User-Accessed SuperCard Projects

Case SuperCard Projects Awaiting Access

Media Files

Users, DB Administrators
Case Constructors

Fig 1. MRX functional system overview.

Fig 2. Database search/access. (1) search/viewing execution controls. (2) search parameter selection menus. (3) accessed cases list.

functions: case construction, access and viewing. Central to the design is a consistent viewing frame with a changeable arrangement of control buttons arranged by functional class. The case access function (Fig 2) is implemented in one main window and case construction/viewing is implemented in the other. Case construction consists of image and text media sets inserted into an existing case window template (Fig 3). Image media icons arranged by modality are linked to a given media file. Supporting text data is imported or directly keyed into text frame overlays. The entire case template is saved as a SuperCard project. Case media viewing (Fig 4) is accomplished simply by clicking on the desired image icon button with the mouse.

The case access function window (Fig 2) allows the user to browse the case project library by Boolean logic. The database is searchable by organ system, imaging modality and pathology. The retrieved case set may then be viewed individually by clicking with the mouse directly in the text list field or by clicking a button to display the entire target set sequentially. Database maintenance is accomplished by adding, changing or removing case projects from the case database folder.

Support functions are useful to the beginning student. A help display window provides a global view of MRW usage while the

tutorial window gives brief lessons. Existing SuperCard animation/QuickTime functions are used to describe the CT Fluoroscopy procedure in a step-by-step manner.

RESULTS

MRW initial prototyping development occurred over a six week period. The initial access-viewer functional design concept was refined with daily experimentation with test cases. Sessions with faculty and residents produced a number of design improvements. There was an initial challenge in successfully integrating hardware and software from multiple vendors. The overall design and functionality was examined by faculty and residents with satisfactory results. Users were able to use the library access and viewing capabilities within several minutes of being introduced to MRW. The spatial and temporal resolution of the

Fig 3. Case construction/indexing. (1) case indexing matrix. (2) patient information controls. (3) case image viewer controls by modality. (4) case execution controls.

Fig 4. Media viewing/control. (1) general image/cine window controls. (2) patient information controls. (3) case execution controls. (4) specific cine controls.

cine display images compares favorably to the source images.

DISCUSSION

This project appears to validate inexpensive object-oriented rapid prototyping in the design of software useful in a radiology teaching environment. Limited resources require a minimum of detailed programming, testing and debugging. SuperCard appears to be a fast and reliable method for creating a working database which fulfills the requirements of the project. The main disadvantage of this software package is that it is currently not available for the Windows operating system.

In Phase II of the MRW project is planned to port the tested design either to the Windows operating

system or to JAVA which is operating system independent.

REFERENCES

1. Kuszyk B, Calhoun P, Soyer P, et al: An Interactive Computer-Based Tool for Teaching the Segmental Anatomy of the Liver. *AJR Am J Roentgenol* 169:631-634, 1997
2. D'Alessandro M: The Instructional Effectiveness of a Radiology Multimedia Textbook (HyperLung) versus a Standard Lecture. *Investigative Radiology* 28:643-8, 1993
3. Cooper JA, McCandless BK: Development of cross-platform computer-based tutorials. *Radiographics* 16:1489-94, 1996
4. Calhoun PS, Fishman EK: Interactive multimedia program for imaging the spleen: Concept, design and development. *Radiographics* 14:1407-14, 1994
5. Baxter AB, Klein JS, Oesterle EV: RadNotes: A novel software development tool for radiology education. *Radiographics* 17:761-7, 1997