Using Commercially Available Off-the-Shelf Software and Hardware to Develop an Intranet-Based Hypertext Markup Language Teaching File

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This presentation describes the technical details of implementing a process to create digital teaching files stressing the use of commercial off-the-shelf (COTS) software and hardware and standard hypertext markup language (HTML) to keep development costs to a minimum.

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THE WIDESPREAD implementation of high-speed campus-wide networks at the majority of teaching institutions makes an intranet-based hypertext markup language (HTML) teaching file a viable method to present radiology images for educational purposes. The practice of teaching from slides is adequate for the actual lecture, but it fails to allow students to preview materials before class to prepare for the lecture, and it does not allow review after the lecture to help reinforce the concepts presented during the lecture. In addition, when hard-copy archiving is used for teaching files, the good cases are often sequestered away in a staff office and are not readily available for resident review.

There have been articles written on digital teaching file creation in a picture archiving and communications system (PACS) environment¹; however, this is still not a common environment. Obtaining digital images in a non-PACS environment has traditionally involved the filming and subsequent digitizing of images. This is not optimal, as it often results in large files with limited bit depth and is labor-intensive.

This presentation describes the technical details of implementing a process to create digital teaching files stressing the use of commercial off-the-shelf (COTS) software and hardware and standard HTML to keep development costs to a minimum. This approach uses commercially available software on a personal computer (PC) or Mac (Apple Com-

puter, Cupertino, CA) platform to allow direct transfer of images from a Digital Imaging and Communications in Medicine (DICOM) modality to a PC. The images are then edited and saved in a standard file format for use in presentations. This eliminates the need to film and then redigitize images and preserves the full bit depth of the original modality. Additionally, instructional cases can be kept on a file server for use by all personnel and the images are not lost if someone removes the film from the department.

SYSTEM DESCRIPTION

An IBM PC (Boca Raton, FL) running Windows NT (Microsoft Corp, Redmond, WA) was configured as a DICOM server using a program called Digital Jacket from DesAcc Inc, Chicago, IL (<http://www.desacc.com>). This permitted direct DICOM transfer from computed radiography (CR), angiography, computed tomography (CT), and magnetic resonance imaging (MRI) scanners after appropriate configuration changes. The modalities all came equipped with DICOM transfer capabilities and were connected to a switched 10/100 MB ethernet network using the standard Transmission Control Protocol/Internet Protocol (TCP/IP). Configuration of the modalities involved entering the IP address of the NT server, and the port (DICOM standard of 104 was used) for the DICOM service. The images are then stored in a standard Windows file system using the patient name or medical record number for the initial directory and then creating subdirectories for each examination. Each image is stored as a separate DICOM file (.dcm extension) in the subdirectory.

The images were converted to standard graphic interchange format (GIF) or Joint Photographic Expert Group (JPEG) formats using standard PC-MAC-based image editing and conversion software. There are multiple software packages available to read DICOM files, some are listed here.

- NIH Image, National Institute of Health, <http://rsb.info.nih.gov/nih-image>, is an application written for the MAC platform that reads and writes multiple file formats. There is also a

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version of this for the PC and a platform independent version written in JAVA, Image/J, information is available at the same site. These programs are free but support is limited.

- OSIRIS, from the University Hospital of Geneva, <http://expasy.hcuge.ch/www/UIN/UIN.html>, it is an image manipulation and analysis software package that runs on multiple Windows and UNIX platforms. The program is available for free at the web site. An additional benefit of this package is its ability to handle static and dynamic image sets (series) using an extended format called Papyrus. This is a DICOM-compliant format that accommodates multiple images in a single file. This is useful on a PC with a National Television Standards Committee (NTSC) or super VHS (SVHS) video output to allow projection and recording of cine sequences.
- DICOMAccess, from DesAcc Inc, Chicago, IL, <http://www.desacc.com> is a Photoshop, Adobe Systems, San Jose, CA, plug-in that enables Photoshop to read and write DICOM files. This program has the advantage of relatively seamless integration with Photoshop so users familiar with the program don't have to learn another program. The program is available for \$449 or \$2,799 for a 20-license version from DesAcc; demonstration copies are available on their web site.

Once saved in a standard GIF or JPEG format, the images can be used in standard presentation software and be made available on an intranet server prior to lectures. We currently use PowerPoint, Microsoft Corp, Redmond, WA, for slide- or web-based presentations, and FrontPage, Microsoft Corp, to edit HTML documents.

DISCUSSION

COTS software and inexpensive PC hardware make a digital teaching file a viable option even in a non-PACS environment. Teaching files and other lectures could be rapidly developed using this approach, eliminating intermediate filming steps. As an added advantage, the presentations can be prepared rapidly and are easily presented in a conference room that is equipped with a projection system to enhance instructional effectiveness and are easily converted to HTML format to allow

web-based review. The availability of images for review before and after the presentation was given strong positive ratings in course evaluations where this approach has been used. In addition, the digital good case file is available at all times for staff and residents to use for review, conferences and other presentations without having to check out cases from the file room and subsequently select and photograph images. This system is available to all staff and residents in the radiology department, it has been used most extensively in the neuroradiology section, where there are more than 1,200 teaching file cases on line.

There are several limitations to this approach; some may be severe enough to make this a non-viable solution for some departments.

- Modalities must be equipped with DICOM capabilities and a network connection; if this is not the case, costs could be prohibitive (the cost for a DICOM upgrade for one angiography room was \$15,000).
- The department needs to be equipped with a robust network that can handle the additional traffic generated and there must be a sufficient number PCs or Macs that are adequately equipped to view and edit the images.
- Once the images are stored in a DICOM format, there is still manual intervention required to window and level the images, convert them to a standard format, and create a HTML file with the images and associated text. To address this limitation, we keep all teaching files in DICOM format for internal use and use hourly student help to create HTML files for cases that will be used outside of the department.

In our department, the advantages far outweigh the limitations. The majority of our modalities were equipped with DICOM transfer capabilities and the network and computer infrastructure was in place. Our incremental cost to add this capability was \$2,200 for the digital jacket software and \$2,000 for disk drives to add an additional 46 GB of storage to the server.

REFERENCES

1. Tellis WM, Andriole KP, Arvin DE, et al: Web technology in the integration of a digital teaching file at the diagnostic workstation. *J Digit Imaging* 11:117-119, 1998 (suppl 1)