Integrating Digital Teaching-File Systems With Off-the-Shelf Presentation Software to Facilitate Speaker-Led Conferences

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Objective: Develop methods for automated transfer of images and associated text from a teaching-file repository into presentation material for speaker-led conferences. **Materials/Methods:** Our institution uses a Microsoft Windows (Microsoft Corp, Redmond, WA) software application to maintain a digital teaching-file database that can store and retrieve content in a case-centric fashion. Virtually any number of images can be stored with any given case. Cases and their associated images can be retrieved via a module that supports searches by American College of Radiology (ACR) code and by free-text Boolean queries on the history, findings, diagnosis, and discussion components of a case. In addition to the software system serving directly as an interactive teaching tool, the digital teaching file itself serves as an image repository and resource for attending radiologists who create their own presentations and lectures. To better support this use, software modules were developed for interprocess communication and automated creation of Powerpoint slides. These modules are fully integrated with the teaching-file software application. A single image or a set of selected images can be automatically made into individual slides with two mouse clicks. Images are automatically centered and optimally sized. A slide title is automatically rendered from the user's preference of the case history or diagnosis (stored with the case), or via the entry of free-form text. We describe the programming techniques that are used, as well as how several features of the operating system and Powerpoint itself can be integrated with a customized software application to facilitate this objective. **Results:** The creation of presentation-ready Powerpoint slides is fully automated from within our teaching-file application, and the time required to create a presentation compared to the conventional method of manually seeking and inserting files from within Powerpoint itself, on a per-slide basis, is drastically reduced. The benefits are magnified by having all imagery stored within an organized and searchable database system so that desired images can be easily located. **Conclusion:** A digital teaching-file system can serve as a useful image repository for purposes ancillary to direct computerized instruction. Software that supports these uses, such

as the automated creation of presentation material for speaker-led conferences, facilitates the radiologist's role as an educator.

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AS RADIOLOGIC IMAGES are increasingly obtained and stored digitally, so too is educational material in radiology increasingly being acquired, stored, and presented using digital technology. A gradual migration is underway toward digital teaching files and presentation materials and away from "legacy" collections of hard-copy film and 35-mm slides. In this transition from the tangible to the electronic, certain capabilities need to be mirrored in the electronic world. For example, many radiologists have over the years devised techniques, however idiosyncratic, to efficiently add material to and retrieve material from their hard-copy or slide-based collection of educational imagery. In addition to serving as a convenient source of content for informal Socratic instruction, educators also typically use such a collection as a source of images for 35-mm or digital slides for didactic presentations. When such educational content is stored digitally, it quickly becomes apparent that new methods are needed to make this material conveniently accessible, searchable, and reusable. We describe some features of a knowledge-management and delivery system for the world wide web that is customized as a digital radiology teaching file application. The software facilitates the creation and management of a digital teaching file for radiology, has a robust search engine to expedite the retrieval of specific cases and associated imagery from the database, and automates the creation of Powerpoint (Microsoft, Redmond, WA) slides from such imagery to enable instantaneous generation of material for speaker-led conferences with minimal effort.

MATERIALS AND METHODS

The teaching file system was developed within Microsoft's Visual Studio software framework. Visual Foxpro, a database management application and member of the Visual Studio suite, served as the primary development tool. Some ancillary software libraries were created with Visual C++. The software

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0897-1889/01/1402-1022\$35.00/0

doi:10.1053/jdim.2001.23862

runs in the Microsoft Windows environment and is compatible with Windows 95, 98, Millenium Edition, and Windows 2000. The application is distributed as a self-installing executable file that can be downloaded via the Internet and installed as a stand-alone or local area network (LAN) application. Information is entered into the system in a case-centric fashion. That is, one record in the database typically represents one teaching file case. The software employs a variable-length, loosely structured record format that also facilitates its use for storing thematic material, as well as other formats of content. It is primarily the context in which the educator uses the application, and the way in which material is entered, that determines whether the content within will be case-centric, thematic, or otherwise.

The system stores discrete data such as the name of the case or patient, identification number, facility where performed, modalities used, contributor, reviewer, mechanism of establishing diagnosis, etc. The user interface employs the familiar parlance of "history," "findings," and "diagnosis" to reflect the more general concepts of "problem," "evidence," and "solution" that are represented within the underlying data model. An integrated coding module expedites the assignment of diagnostic codes to a case. An image management facility enables the integration of imagery with each case. The software is compatible with images of Windows Bitmap (BMP), Graphics Interchange (GIF), Joint Photographer Expert Group (JPEG), and Digital Imaging and Communications in Medicine (DICOM) formats. The image management module contains facilities for both interactive and batch mode functions such as zooming, sorting, renaming, cropping, resizing, watermarking, and reorienting images, as well as creating "thumbnail" images that correspond to their full-sized counterparts. Images are stored external to the database as individual graphic files within a folder hierarchy maintained by the software. References to image files are stored within each database record. The image management module can be configured to also automatically invoke and use commercially available image-editing software such as Photoshop or Paint Shop Pro. A built-in search engine supports menu-driven, Boolean combinations of natural-language queries that can encompass any or all elements of a record. In addition, but beyond the scope of this report, the software also supports (for intended delivery over the world wide web) the storage and choreography of several other types of content such as free-form stylized text and interactive multiple-choice or true-false questions accompanied by immediate feedback to the user.

Integrated with the software is the capability to automatically and instantly create a titled Powerpoint slide (or slides) from any image (or images) stored within the system. The user may rightclick upon any image or image file name displayed by the teaching file software. In response, the software presents a context-sensitive pop-up menu (Fig 1A). One of the choices is "Inject into Powerpoint" which, if selected, results in another pop-up menu requesting how to title the slide (Fig 1B). These two mouse clicks result in fully automated communication with Powerpoint (which is invoked as an automation server) and the generation of a new, titled Powerpoint slide (Fig 1C). By default (author's personal choice) background color for the

slide is set to black and font color is set to yellow. The software automatically calculates the font size for the title, as well as the image size on the slide, so that these are displayed correctly regardless of title length or original image size. The user does not need to manually start the Powerpoint application. If Powerpoint is already running with a presentation open, the new slide is appended to the active presentation. The user may also select several images at one time, eg, when viewing a panel of thumbnail images (Fig 2), and a new slide will be created for each selected image. Once created, any slide can be manipulated interactively within Powerpoint as if the user had created it manually.

RESULTS AND DISCUSSION

Most radiologists have encountered the frustration of trying to find a particular teaching-file case within their own or their department's collection of educational material, whether in hard-copy or digital format. This problem is magnified when images are stored digitally and are not directly tangible. The excitement of owning a digital camera or having newly available capabilities to download images from a picture archiving and communication system (PACS) can quickly fade when the radiologist discovers that dozens or hundreds of images residing on his or her computer system have little meaningful context as computer files. The capability to link the images with meaningful, searchable, case-based information is essential for the collection to be useful. Some approaches used to accomplish this have been discussed in recent publications.¹⁻³ Furthermore, the effort typically involved in finding an image file on one's computer (once there are several), transferring it into presentation media such as a Powerpoint slide, appropriately sizing and positioning the image, and optionally labeling it with a title, can be time-consuming and tedious when using Powerpoint alone.

The benefits of using an indexed and searchable digital teaching file system, in which images are stored outside the database but are linked to their related case(s) in the database, are manifold. Desired images can easily be located and displayed via free-form searches performed on any elements of information stored with the case, such as history, findings, diagnosis, American College of Radiology (ACR) code, etc. Images can be dragged-and-dropped from within the teaching file software to other applications such as an E-mail message. The database can be accessed via a web delivery technology (a capability we exploit) in which so-

Fig 1. (A) User rightclicks on image and is presented with a pop-up menu of choices that includes Powerpoint injection feature. (B) A subsequent pop-up menu lists choices for how slide should be titled. Here user chooses to use the case's diagnosis for the title. (C) Powerpoint is invoked and driven via its automation capabilities to generate a new slide with appropriately sized and positioned image and title.

phisticated, interactive delivery of case material on the web can be achieved by virtue of the images being stored within a hierarchical folder tree that is maintained by the software yet is accessible to the web delivery software. The creation of presenta-

tion-ready Powerpoint slides is fully automated from within our teaching-file application, and the time required to create a presentation compared to the conventional method of manually seeking and inserting image files from within Powerpoint itself, on a per-slide basis, is drastically reduced.

A relatively standard programming technique known as OLE automation is used to accomplish the creation of slides. The teaching-file software invokes Powerpoint and communicates with it using an object-oriented approach in which the slide presentation is exposed by Powerpoint as a programmatically accessible document. Using a relatively straightforward syntax available within Microsoft's software development environments (including Visual Basic and Visual Foxpro), one can manipulate properties that affect the appearance of each slide, as well as all items on each slide. Trivial changes to the software can modify slide properties such as background color, font

Fig 2. User may also create one or more slides from a panel of images associated with a case.

color, font face, etc. Software functions (known as methods) can be invoked within Powerpoint to execute specific actions such as adding an object (eg, slide, image, title), positioning it, etc. This programming technique is documented on Microsoft's web site at <http://msdn.microsoft.com/library/default.asp?URL=/library/officedev/office97/output/F1/D5/S5AE28.HTM>.

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