Taking X-ray Images to the Web, the process and use in Radiography Education

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Abstract

Radiography students learn human radiographic pathology more efficiently by studying imaging and supplementary material on the Internet. The main reason is access, which allows instructional delivery and learning to take place when the student desires; 24/7. At Western Wisconsin Technical College, the traditional course delivery method was modified to include web enhanced delivery strategies for Fall 2000.

Taking analog radiographic images to the web and incorporating their use in instruction requires several steps, which are described in the paper. Useful images are first digitized with a clinical grade film digitizer, stripped of patient data, then converted to a file format recognized by web browsers and presentation application software. The images with accompanying information are then placed on a web site.

An online evaluation asks specific questions related to image access and quality, download time, and relevance to the learning objectives. The results of these questions are stated in the paper.

Introduction

Radiography students can learn human radiographic pathology more efficiently by studying imaging and supplementary material on the Internet. The main reason is access, which in effect allows instructional delivery and learning to take place when the student desires, 24 hours a day, 7 days a week. This is opposed to the more conventional approach of learning that takes place only when the laboratory or classroom is open. For the fall semester of 2000 at Western Wisconsin Technical College, in LaCrosse, Wisconsin, the traditional course delivery method was modified to include web enhanced delivery strategies.

While radiography students do not diagnose disease, they do need to understand the image qualities that allow physicians to make accurate diagnoses. Certain pathological conditions may require adjustment in imaging exposure values, and patient positioning strategies. Additionally, the ability to recognize various disease patterns on an image makes occupational tasks more interesting and rewarding.

Course competencies, performance statements, and learning objectives and learning activities are written to guide student learning. Learning assessment strategies that measure performance can include in-class and online examinations, both of which can include images.

To facilitate online learning, a desired course strategy is to take selected analog radiographic images, convert them to web friendly files (digitizing), and place them on the WEB, or convert them to a picture format that is accepted by presentation software such as PowerPoint. Placing these images on the web and incorporating their use in instruction requires several steps. Most radiographs chosen for placement on the Internet are targeted to specific diseases.

The Process

Select radiograph

As interesting and relevant radiologic images (plain film x-rays) are seen in the clinical setting, they are identified for placement in the web site database of pathology images. Images from the college lab's pathology file are also used. Pertinent information such as diagnosis or radiologic findings, patient symptoms or history is recorded. This data will accompany the radio logic image on the web site. No patient specific data such a patient name and patient number is used.

Figure1: Select radiograph

Background

Background for the use of digitizing images in the hospital follows. In the clinical (hospital) setting, for real time patient care, plain film images are often digitized with a film digitizer or scanner for electronic reading by the radiologist for special purposes. For example, in-hospital digitized readings are often used when the hard copy films are sent immediately to other departments. During off hours, images are sent to the on-call radiologists' homes via regular phone lines, using a modem. The term used to describe this process is called teleradiology. In this way, immediate diagnostic readings can be used for patient care. The digitized image produced is a DICOM (Digital Imaging and Communications in Medicine) image; a proprietary format in which the image is encrypted and compressed prior to transferring patient data over the Internet. The image reading workstation on the receiving end decodes the data in order for it to be viewed.

When a patient becomes ill, they receive treatment for disease or condition based upon a myriad of diagnostic tests results. The original tests and test results are the property of the hospital or clinic. The patient can purchase copies of these radiology tests and results, however the cost is high. From an instructional perspective, the challenges in obtaining and using images are threefold. When radiological images are used for instructional purposes, absolute patient confidentiality has to be maintained. This is especially true when images are displayed over the Internet. Local medical institutions will not permit transmission of images to non-medical instructional servers, even though the ability to strip patient data is available. It should be realized however, there are thousands of web sites containing possibly millions of radiological images. Most of these web sites are residing on hospitals, clinics, and university web servers throughout the world. However, are thousands of radiological images available for viewing by the public on the Internet (http://www.western.tec.wi.us/rad/wsrtlinks.htm#med%20resources) . See medical and radiology resources.

Second, in order to place images on the college server from other Internet sites, permission has to be obtained from the site author. This is logistically cumbersome, and the images cannot be edited or manipulated because of the ownership issue. The quality of images varies greatly from site to site, some being very good, to others, which are very bad.

Third, the technical process to convert plain films to web friendly images is tedious.

Currently however, the only way to obtain digital images for instruction to be placed over the Internet is by manually digitizing each film.

Scanning the radiograph

Chosen plain film x-rays are scanned with a clinical grade x-ray film digitizer. One of two Lumisys 75 digitizers driven by Pentium level computers is used. The 2 PC's are configured as such; one has Windows 3.1 for Workgroups, the other has Windows NT. Both have large hard drives, 1.44 MB floppy drives, a CD Rom., and a 15 or 17-inch monitor. The scanning software is Access Framewave 3.0. by Emed.

The scanners digitize and convert the image to a proprietary format that can only be read by a specifically configured film reader workstation. The scanner and reader workstation do not have the capability to convert the DICOM image to a web friendly file format. Therefore a different method of digitizing had to be found.

Figure 2: Film digitizer

As the computer software vendor specifically configures the machine to be used with the scanner, the vendor can perform maintenance on the machine remotely. Therefore, only vendor-approved software can be loaded and approved hardware used. I had hoped a work-around could be found. Communication with the software company proved futile, although the company would sell me the reader software for about $3,000. I still had no way to obtain the DICOM images. After discussion with the manufacturer of the film scanner, it was discovered that radiographs could be digitized, and the image saved in the TIF (tagged image file) format. This file could then be easily converted to a JPEG (joint photographic expert group) format that could be used in a web page or inserted into PowerPoint presentations.

To accomplish the conversion, several challenges are faced. The Framewave scanning software is first closed down. Next, through DOS, yes, good old DOS, an application program called Scanfile, which calls the driver to perform a scan, and saves it to file is activated. This software does not run under MS Windows, so the individual commands have to be entered. Also, there is no image editing software installed on the computers. And of course, there is the ever-present concern of "what if I lock up the system? As the system is used for real-time patient care, computer and digitizer down time would certainly not foster good public relations between the clinical site and myself, at the least!

Another challenge encountered is that the only removable storage device available is the 1.4 MB floppy drive.

What would be helpful on the computers driving the film digitizer are the following; image editing software and a ZIP™ drive.

To digitize films the following parameters are used. The images are scanned at a pixel depth (pd) of 8 bits/pixel. This provides a gray scale of 256 shades of gray, which seems to display images quite adequately over the Internet and in PowerPoint. Pixels per line (ppl) of 512 or 1024 can be used. The larger the pixels per line value, the greater the image resolution. Both formats are used. However, a ppl of 512 seems adequate for most images. For large films, 14X17 inches, scanning at pd:8, and ppl:512 provides an image file that can be stored on a 1.44 MB floppy disk. Voila! The scanner reads the whole film, not just the blackened image on the film; therefore image size can be quite large. To put this in perspective, to scan an image in the native format, using the proprietary Framewave software, a typical chest x-ray on a 14X 17 film contains about 10 MB of data. Scanning the same chest x-ray in the DOS mode with "scanfile", produces the image in the TIF format, and contains a little less than 1MB of data. The image would be of little diagnostic value, as the data set is so small. However, the image is of surprisingly good quality.

The command to digitize is: scanfile /pd:8   /pp:212 /tif f:filename.tif
The .tif file is now stored on the hard drive of the computer controlling the digitizer. I've tried to write a batch file to automate this, but do not believe this is easily accomplished. I suspect this may be because of the need to change the filename for each film scanned.

Copy image on floppy disk

The file can now be copied from the hard drive to the floppy disk, using the simple copy command. At this point, success is not assured.

Copy image file to PC and Edit image

After the file has been copied to the floppy, the file is now copied to another PC with image editing software installed. This is sometimes done on a laptop brought on site. The image editing software is Paint Shop Pro (PSP) v6.0. PSP, available off the shelf, is cost effective and fairly easy to use. Opening the file in PSP, the image is manipulated as needed. In the first step, patient data is removed by writing over or cutting out that part of the image. The image is then saved in the TIF format, containing essentially the same information as the scanned file, but minus the patient identification data. This is essential to maintain patient confidentiality. Also, the TIF format serves as the archival image for permanent storage. Next the image is further manipulated; it may need to be turned, lightened or darkened, contrast changed and finally cropped, to reduce file size. Once satisfied, the TIF image is saved as a JPEG. A compression ratio of about 10% is used.

File size is reduced somewhat, but image quality is maintained at an acceptable level. Typically, the file sizes range somewhere between 20 KB to 100 KB.

Figure 3: JEPG chest x-ray

After the image editing has been complete, the TIF file on the digitizer's computer is deleted.

A separate folder is kept on the editing computer storing the JPEG and TIF files. This allows for easy access to all the images. A copy of these files is also kept on a ZIP disk. Eventually, a third storage facility, such as a CD RW may be used as a backup. This would allow for adding images over time.

An additional note regarding file format follows. A JPEG file is a lossy compression. JPEG is a standard format for presenting radio logic images over the Internet. However, some data is lost. Therefore, new formats may be on the horizon. The PNG (portable network graphics) may be a possibility, as this format uses a lossless compression, in which data is not lost. At this point in time, PNG files are not fully supported by common web browsers.

Build web page

The last part to the project is to write the web page, insert the image and accompanying descriptive information, and publish to the web. FrontPage 2000 is used as the HTML editor, as it is easy to use, and allows for fairly good site management.

| | **Pneumothorax with subcutaneous emphysema**
 Dx: right pneumothorax
 Hx: not available
 Findings: subcutaneous and interstitial emphysema of upper torso secondary to right pneumothorax. Note chest tube in right lung.

 ACR # 60.73 |

Figure 4: sample image from web page.

Inserting radiographic images, saved, as JPEG's into PowerPoint presentation software is quite easy. The quality of images when presented in class over a presentation projector is marginal, mostly due to the resolution capability of the projector. When the same PowerPoint presentation is displayed over the Internet, the image quality is acceptable on most modern displays with the recommended settings of 16 bit color or higher and a screen area of 800 X 600 pixels.

The student learning plans have activities directing viewing of the web presented images. The images can be viewed online at http://learn.western.tec.wi.us/pathology. Choose image-teaching file.

Online Course Evaluation

To aid in improving instruction using online strategies, an online evaluation tool was developed and implemented. The complete tool can be accessed on the web at (place web address here). The evaluation tool, of 42 questions covered a wide range of topics relating to the course. The numbers in the right hand column refer to the number of students responding to each question. Total number of students responding to the evaluation was 13, out of 16 students. The rating scale follows.

SA Strongly agree
A   Agree with statement
D   Disagree with statement
SD Strongly disagree with statement
NA Not applicable

Table 1: Questions relating to image use in online instruction

Subject Content The teaching files (pathology images) are presented adequately. Comments: a. Not a big variety or numerous pictures	2- Strongly agree 10- Agree 1- Disagree
Class Management My experience as a computer user is:	1- Very experienced 8- Some experience 3- Very little experience 1- Have not used computers before taking this course
I am usually accessing the course web site:	7- from home using a phone modem, 56K

	or slower 1- from home using a cable modem (high speed access) 0- from home using a DSL modem (high speed access) 5- WWTC or HSC college computer labs
The web site graphics are appealing. Comments: a. Imaging of films were very hard to see b. They were okay-when I could access them.	11- Agree 2- Disagree
The radiographic pathology images on the web site are of good quality. If you disagree, please indicate your monitor settings if known. i.e., 16 colors, 256 colors, 16 or 24 bit color. Comments: a. No clue b. Don't know. c. You can't tell what your looking at & and when using images for quiz it's really hard –I got some wrong because I couldn't tell what I was looking at – school computers. d. I'm sure they would be appealing if my computer displayed them more clearly. e. (Strongly Disagree)- 256 colors	7- Agree 5- Disagree 1- Strongly disagree
The radiographic images on the web site are meaningful to my learning. Comments: a. Sometimes to small or could not tell what we were looking for. b. Couldn't get much from them. c. Very helpful. d. Would be more meaningful if they were clearer on my PC.	12- Agree 1- Disagree
The written information accompanying the radiographic pathology images is helpful. Comments: a. That helped me figure out the images.	1- Strongly agree 12- Agree

The radiographic images loaded in a reasonable amount of time. **If you disagree**, please indicate your computer modem speed, computer processor, and RAM if known. i.e. 28K or 56K modem, Pentium II 400 MHz, 64 MB RAM, etc. Comments: a. Some things took some time. I don't know exactly what I have. b. They loaded okay, just not clear.	12-Agree 1-Disagree

Conclusion

In reviewing the results from the course evaluation tool, the following can be gleaned. Overall the online strategy was fairly effective in its goal to provide learning by students at a time convenient to there needs. For the most part, the online radiologic images were well received. This method provided image availability for diseases not included in the text or as supplemental images to the text. Descriptive information with each image provides useful detail. These images were and continue to be available 24 hours a day, 7 days a week. Several images were placed into the online PowerPoint presentations. These same radiologic images were used in the online exams. Most students recognized these, and chose the correct response, possibly indicating success. Other students felt the online images were of poor quality. My next version of the online quiz will use larger sized radiologic images, even though this will increase download time.

There were some challenges. The in-school computer lab did not open as scheduled; it was about 17 weeks behind schedule. Therefore, students that did not have computer access in their homes had to use facilities across campus. Some students had limited computer experience. These students not only had to learn the material, but also learn the technology. Students choosing Internet access from home had mixed results with online image quality and download speed. This was mainly because of modem speed and their computer display.

The technique of producing the radiologic images for the web is extremely cumbersome and time consuming, given the currently available equipment. Hopefully, as more students express the need for this type of learning strategy, more dollars will be awarded for integrated film scanning/digitizing equipment purchase. The current cost for a complete system is a little under $20,000 and can be shared between several departments within the college building.

References

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