Our Path to a Filmless Future

Luther Adair II · Eric Ledermann

Published online: 12 July 2011
© Society for Imaging Informatics in Medicine 2011

Abstract Film-based radiographs are still being used to teach in a conference format, which presents several viewing challenges amongst other problems. In the age of cloud computing, which enables the use of online server storage space, this information could be used more effectively if it were digitized. However, digitizing film-based radiographs and making them available for use in the cloud is not as easy as it seems. In order to address the issue of digitizing the film-based radiograph libraries in our radiology department, we looked at several options. The option that we chose was a consumer-grade scanner, and this decision was based on price, resolution, shades of gray, built-in transparency function, and its physical attributes. Our goal was to digitize the film-based radiograph teaching files so they could be stored in a digital file locker such as Google Picassa for organization and quick access later. These files would constantly be updated in a Google document by residents, and this document would be called the “Living Document” based on its continuous expandability. This method would allow even the smallest radiology department to benefit from the use of modern technology to gain access to valuable information stored in film-based radiographs and give every resident the opportunity to benefit from it.

Keywords Teaching · Radiology teaching files · Radiography · Internship and residency · Internet technology · Image libraries · Digital radiography · Digital libraries · Digital imaging · Digital image processing · Digital image management · Clinical image viewing

Abbreviations

TIFF	Tagged image file format
DICOM	Digital imaging and communications in medicine
BMP	Bitmap image file format
JPEG	Joint photographic experts group
US \$	United States dollars
DPI	Dots per inch
PACS	Picture archiving and communications system

Manuscript

As we arrive in the second decade of the twenty-first century, the fact remains that smaller radiology departments are still not completely filmless. Film-based radiographs are still produced for fluoroscopy studies, mammography studies, and in some cases there are radiographs that were saved historically as teaching files that have never been digitized. Presenting teaching files in a traditional film-based format in case conferences can present particular challenges, such as space limitations around the view box for participants, degraded film quality, and in some cases, findings may be difficult to see. Such dilemmas can be overcome by converting to a filmless environment so that all images can be presented on a projector or in digital media that each individual can access via their mobile devices or personal

L. Adair II (✉) · E. Ledermann
Department of Radiology, Long Island College Hospital,
339 Hicks Street,
Brooklyn, NY 11233, USA
e-mail: ladair01@gmail.com

E. Ledermann
e-mail: zygote007@aol.com

computers [3]. Furthermore, once teaching files are digital they can be stored in digital file lockers such as Google Picassa for organization and quick access later.

We tried to explore options for digitizing our teaching files and found that this was easier said than done. First, we looked into purchasing a professional grade large format scanner. This was expensive as some of the scanners that we found cost up to US \$20,000. Second, we called around to larger universities and professional scanning companies to attempt to borrow their commercial grade large format scanners or pay them to scan our images. This request was met with disdain mostly, and the companies that provided this service were few and expensive costing up to US \$5 per film. Third, we attempted to photograph individual radiographs using a consumer-grade digital camera and crop the images. These results were suboptimal, and the effort doing so was timely. We needed to efficiently scan a 17×14 in. radiograph. Finally, after further research we found an article by Davidson et al. in the *Journal of Digital Imaging* that summarized their research on film digitization.

Davidson et al. discussed their experience evaluating a consumer-grade digital camera, a commercial digital camera, a consumer-grade scanner, and a commercial scanner [1]. After performing both subjective evaluation by radiologists in their hospital and objective evaluation of the optical density response using grayscale test patterns, they noted that the best results were obtained with a commercial scanner, followed closely by a consumer-grade scanner and a commercial digital camera. The biggest drop in quality came from the consumer-grade digital camera which is what we used initially.

After exploring the options of consumer-grade scanners, we found that certain specifications needed to be met in order to achieve optimization when archiving. Many scanners use a feed-based system in which a belt or cylinder drags the image across the scanning surface in order to capture the image. This method was found to be suboptimal for scanning because it had limitations with regard to the size and thickness of images being scanned. Therefore, we narrowed the scope of our search to a flatbed type, large format scanner which would enable use of

additional freedoms in this area. Additional considerations needed to be made with regard to dots per inch (DPI) to ensure high-quality image preservation. This was not a significant issue as most current scanners are easily capable of an optical resolution greater than 300 DPI. Gray scale depth, also an important feature in the scanning process when evaluating radiographs, was evaluated because optimization of this product specification will enable higher detail when viewing the black to white spectrum. Most scanners feature 8-bit gray scale depths, which translate into 256 shades of gray. Three scanners we explored featured 16-bit gray scale depths, which translated into 65,536 shades of gray (Epson Expression 10000XL, Plustek 271-BBM21-C OpticBook, and Microtek ScanMaker 1000XL Pro). When viewing radiographs for diagnostic purposes the increased number of gray shades allows for better image quality aiding in better interpretability. For further evaluation, see the chart for comparison (Table 1).

Next, we looked for a scanner with transparency scanning adapters which are required in order to scan radiographs effectively [2]. This feature was not built into most scanners and required an adapter. We elected to only use scanners with this feature built in to save on cost and potential hardware conflicts. Finally, we needed to consider a reasonable price point in order to enable smaller departments the budget to purchase one of these units. After careful examination, the EPSON Expression 10000XLPH, 10000XL seemed to meet all of the above requirements and also remained competitively priced at about US \$3,000. Given the cost of digitizing individual radiographs for US \$5 each, the break even cost would be 600 total images. With this scanner, smaller institutions would be able to create an affordable, diagnostic quality, and easily organized digitized teaching file in a reasonable amount of time.

The quality of the film being scanned was judged using some of the most common practices in grading. The scale ranged from mint and near mint (near perfect), excellent plus (lies perfectly flat and nearly no flaw to the human eye), excellent (minimal visible wear and lies near flat), extremely good (slight wear to distract the eye), very good (noticeable wear), good plus (noticeable wear, may not lie flat), good (heavy wear), fair (wear becomes distracting),

Table 1 This figure outlines some of the features of consumer grade scanners that are able to scan radiographs

Scanner name	Price	Grayscale depth	Resolution	Size	Transparency
Epson Expression 10000XL	US \$2,200–3,000	16 bit	2,400 DPI	12.2×17.2 in. (12.2×16.5 in., transparency size)	Yes
Plustek 271-BBM21-C OpticBook	US \$1,500–2,200	16 bit	600 DPI	12×17 in.	No
Microtek ScanMaker 1000XL Pro	US \$2,200–2,500	16 bit	600 DPI	12×17 in. (12×16 in., transparency size)	Yes
HP ScanJet 8390	US \$1,200–1,800	8 bit	4,800 DPI	8.5×14 in.	Yes

The Epson was our choice based on price, resolution, shades of gray, built-in transparency function, and the physical attributes of the scanner

poor (uninterpretable). Most of the films scanned during this project would fall into the extremely good to good plus category. Most of the film that fell below this threshold was not selected for digitization.

Once the film-based radiograph libraries in our department are completely digitized, we plan to upload them to a digital file locker such as Google Picassa using joint photographic experts group (JPEG) format, which is one of several image formats that can be used. Some of the other basic formats are TIFF, digital imaging and communications in medicine (DICOM), BMP, and JPEG. Most people are familiar with these particular subsets due to their popularity in windows and internet imaging. While DICOM is the standard for radiological images, one may choose to convert these images to JPEG before uploading to protect the anonymity of the patient data. This can be done simply by removing the patient data from the images that you would like to download using your PACS anonymizing features and downloading the images as JPEG files. Converting back from JPEG to DICOM will require lossy compression, which means there is an alteration in the original data set. However, this usually results in minimal effect on the image quality and interpretability. If this is desired, one of the best options includes a single license user converter program that can be found at <http://www.pacsplus.com>.

After images are uploaded to Google Picassa and organized by pathology, they will be linked to short descriptions of their pathology in a Google document, which can be updated with information over time. These documents can be easily accessed in a mobile format and shared with each resident that goes through the rotation with certain residents being given the key responsibility of maintaining the accuracy of the information within the teaching files. This concept is called the “Living Document.” Once the “Living Document” is

functional, it can be viewed from any location and manipulated to form board reviews as well as didactic lectures.

In summary, digitizing historical film libraries was a problem over a decade ago and still remains a challenge for some smaller academic radiology facilities. Purchasing a consumer-grade large format scanner may solve this challenge in the most efficient way. Once film libraries are digitized, the opportunity for utilizing teaching cases with optimal viewing equipment and providing access to the cases anywhere becomes more tangible. Some interesting and useful cases remain buried in the traditional film libraries throughout many radiology departments. It is time to make this information readily available to all who could benefit from it.

Acknowledgments We would like to thank Dr. Nardi for his assistance with this project and the use of his teaching files. We would also like to thank medical students Pallavi Cherukuri and Rachel Gold for their assistance with the digitization of the films.

Disclosures There are no financial disclosures to make.

References

1. Davidson HC, Johnston DJ, Christian ME, Harnsberger HR: Comparison of radiographic image quality from four digitization devices as viewed on computer monitors. *Journal of Digital Imaging* 14(1):24–9, 2001
2. Christian ME, Davidson HC, Wiggins 3rd, RH, Berges G, Cannon G, Jackson G, Chapman B, Harnsberger HR: Digital processing of radiographic images from PACS to publishing. *Journal of Digital Imaging* 14(1):14–7, 2001
3. Dzingle D, May GA, Garland HT: Digital radiography and film scanners: automating the transition to filmless radiology. *Journal of Digital Imaging* 14(2 Suppl 1):128–30, 2001