A Website for Teaching Digital Radiography Principles

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Abstract—**The physics properties of digital x-ray receptors are very different from that of film. In order to teach these principles for digital systems a web-based simulation was developed using images of a body phantom. The simulation shows example images while explaining these principles.**

Keywords— **Radiography, Digital, Image Quality**

I. Introduction

Film served the radiology community for over one hundred years in the triple role of acquisition, viewing, and archiving. The physics principles of image quality and the sensitometric response of film to radiation was straightforward and required knowledge for radiology residents and radiographers.

Over the last several decades radiography has migrated from film to various digital technologies, most notably computed radiology and digital radiology. Computed radiology (CR)[1] employs analog photostimulable cassettes which replaced film and which could be used with existing radiographic equipment. Digital radiology (DR) [1] uses an electronic receptor which can take the form of either a fixed structure or a cassette which can be placed in a conventional bucky.

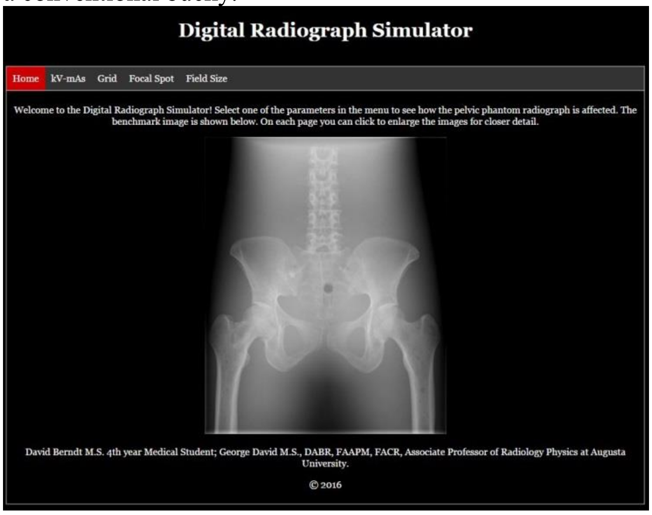

Fig 1. Digital Radiograph Simulator Home Page.

The sensitometric response of digital systems to radiation is very different from that of film. Image quality is a function not only of the digital system hardware but also software that renders the digital latent image into a readable radiograph. One of the challenges in transitioning from film to digital was that technique changes made when using film to address image quality or sensitometry cannot be applied to digital. Film has a well-defined response to radiation [2]. If an image is lighter than desired, an increase in radiation will make it darker. And if an image is too dark, the problem can be resolved by reducing radiation. Thus for a given film type and processing there was a "Goldilocks" dose that would result in a radiograph of optimal density, not too light and not too dark.

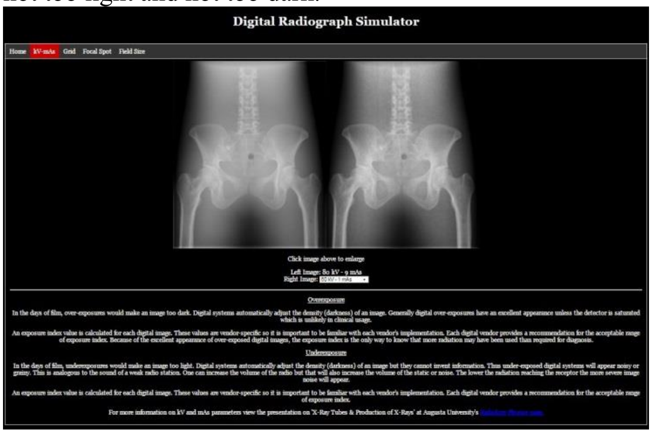

Fig 2. Comparison of Images Taken at Different Values of mAs.

The response of digital systems to radiation is completely different. Software is designed to optimize image density much as a radio's volume control can achieve any desired volume for both strong and weak stations. Thus image density is no longer a reliable indicator that the proper amount of radiation was used [3].

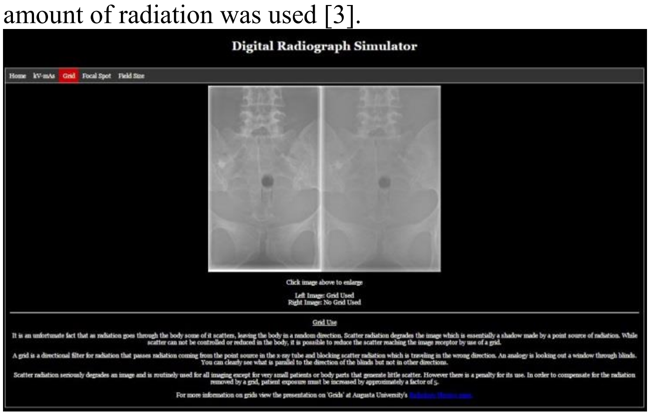

Fig 3. Comparison of Images Taken With and Without a Grid.

In both CR and DR digital systems, differing amounts of radiation will affect image noise. If too little radiation is used, image noise can mask subtle low contrast differences and may render images unreadable even though density appears correct. Too much radiation will reduce noise and improve the appearance of an image without darkening the image. Only if the detector is saturated will image quality degrade. However, detector saturation requires so much radiation it is unlikely to occur clinically. Since image density is controlled by software and since the amount of noise that can be tolerated for a particular study is subjective, there is no longer a correct or “Goldilocks” amount of radiation based on density.

Vendors provide feedback in the form of a quantitative dose index for each CR or DR image [4]. The calculation of dose index is vendor-specific, although there is an industry-wide effort to standardize it [2,3]. Software attempts to isolate anatomy from collimated areas and areas of raw radiation. Receptor dose is then averaged only for these anatomic areas. While serving as a useful metric, dose index can be influenced by the software’s identification of anatomy which can be affected by positioning or the choice of study or views.

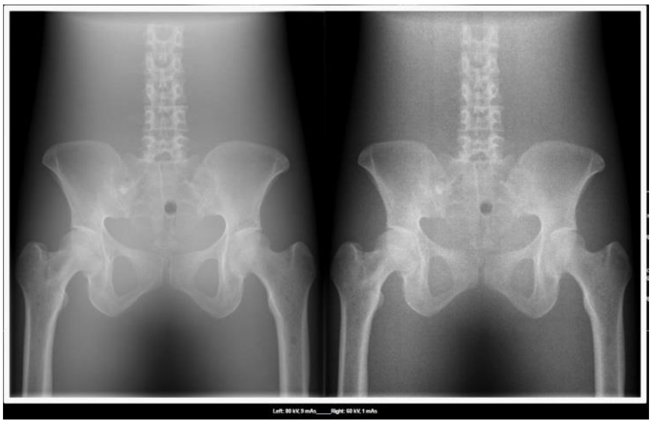

Fig 4. Enlarged Comparison Images.

Radiology residents and radiographers are tested on the differences in response between film and digital receptors. We felt we could enhance the teaching of these principles by making example radiographs using a body phantom changing one technical parameter at a time, something that would be impossible using clinical images. A web page was developed to providing example images along with descriptions of the underlying physics.

II. DISCUSSION

A web site was written to enhance the teaching of digital imaging physics. The web site allows users to view the result of various changes by putting images side by side. All images were made on a Philips Digital Diagnost 4 radiographic unit using a SkyPlate digital radiography system[5].

First a phototimed reference image of a Lucite abdomen/pelvis phantom was acquired using the machine’s clinical protocol. A series of images using identical positioning was made at several combinations of kVp and mAs. Images were also made using both focal spots, three field sizes, and with and without a grid.

A web page was then written (Figure 1) allowing the user to select an image to compare with the reference image. An explanation of the difference is displayed just below the image pair. For example, the user can view images taken at various kVp / mAs combinations along side the reference image (Figure 2) or an image made without a grid along side the reference image which was taken with a grid (Figure 3). Both figures show the text description of the principle demonstrated by the pair of images. One can also enlarge the image pair to better discern the differences in image quality (Figure 4).

The goal of the web site development was to create a simulation where a user can make single changes to technique and observe the effect of that change while reading an accompanying text of the underlying principles.

The website described here can be accessed at the following link:

http://medicalphysics.augusta.edu/DRSim/

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