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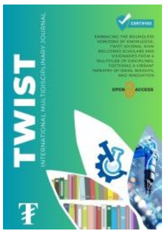

The Advantages of Digital Radiography: Recent Advances in Imaging and X-ray

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Abstract

Digital radiographs are composed of a set of numbers arranged as a grid of rows and columns. The dentist can perform mathematical operations on these numbers to create a new image in which certain characteristics are enhanced, thus making interpretation of the image easier. The dentist also can correct, to some extent, overexposed or underexposed images and can optimize contrast and brightness for specific diagnostic procedures, such as caries detection and bone level assessment. Using advanced image capture and computer technology, radiographic images are viewed on a computer monitor. This is advantageous because radiographic images can be adjusted using dedicated computer software to maximize diagnostic image quality. Digital images can be accessed at computer workstations throughout the hospital, instantly retrieved from computer archives, and transmitted via the internet for consultation or case referral. Digital radiographic data can also be incorporated into a hospital information system, making record keeping an entirely paperless process. the more promising existing and experimental detector technologies which may be suitable for digital radiography will be considered. Devices that can be employed in full-area detectors and also those more appropriate for scanning x-ray systems will be discussed. These include various approaches based on phosphor x-ray converters, where light quanta are produced as an intermediate stage, as well as direct x-ray-to-charge conversion materials such as zinc cadmium telluride, amorphous selenium and crystalline silicon.

Keywords

digital radiography, Radiographs, Scanning X-ray, Devices

INTRODUCTION

Digital radiography or computed radiography by use of reusable storage phosphor screens, offers a convenient and reliable way to replace film. In addition to the reduced cost on consumables, the return on investment of computed radiography systems is strongly determined by savings in exposure time, processing times and archival times. Furthermore, intangible costs like plant shutdown, environment safety and longer usability of isotopes are increasingly important when considering replacing film by storage phosphor systems. More and more applications can be covered by improving the image quality of digital radiography systems. Digital images offer a lot of advantages in terms of image manipulation and workflow. Film scanning, Computed Radiography and Direct Radiography by using different kind of flat panel detectors all have their specific application fields. Utilizing this process, the image is captured directly on the flat plate and the image is transmitted directly to the computer. No intermediate steps or additional processes are required to capture the image. Process provides a direct feed from panel to imaging workstation. Direct Digital Capture is suitable for applications where medium and finer grain film is employed. The extended diagnostic imaging chain also includes a number of other important elements. The ultimate outcome for a patient referred for an imaging procedure depends only in part on the quality of the imaging system. The outcome depends even more on the quality of the diagnosis and on the resultant management or treatment decisions. Finally, this diagnostic chain is embedded in a clinical, technical, operational, and socioeconomic context that strongly influences its internal work flow and data flow. Thus, although the focus of this chapter is on digital image acquisition with a specific technology, one must always keep in mind the bigger picture that determines the ultimate use and usefulness of the acquisition system.

the acquired digital image must be processed to produce a new digital image suitable for human viewing. This optimized image must also be reproduced on some analog output medium or device (eg, film from a laser printer, soft-copy display) with which a human being can interact. In the case of machine vision (eg, computer-aided detection or diagnosis. the image processing extracts useful diagnostic information directly from the digital image data without necessarily producing an image as output. There must also be a means to manage the image data, for example, to store them and distribute them among the various components that make up the complete digital imaging system. the acquired digital image must be processed to produce a new digital image suitable for human viewing. This optimized image must also be reproduced on some analog output medium or device (eg, film from a laser printer, soft-copy display) with which a human being can interact. In the case of machine vision (eg, computer-aided detection or diagnosis. the image processing extracts useful diagnostic information directly from the digital image data without necessarily producing an image as output. There must also be a means to manage the image data, for example, to store them and distribute them among the various components that make up the complete digital imaging system.

The image quality of digital radiography detectors including CR can be evaluated using a toolkit of physical parameters such as: dynamic range, spatial resolution, and DQE. These parameters have the advantage of treating an imaging system as a "black box", requiring measurement of physical characteristics at the input and output alone. In theory, a detailed knowledge of the inner workings of the system is not required. Importantly, these parameters are transportable across to other x-ray.

Standard CR imaging

This plate contains photo sensitive storage phosphors which retain the latent image. When the imaging plate is scanned with a laser beam in the digitizer, the latent image information is released as visible light. This light is captured and converted into a digital stream to compute the digital image. A key consideration in the use of flexible storage phosphor plates and CR systems is that any exposure source that can be used with conventional X-ray films can also be used with this filmless technology. The flexible storage phosphor imaging plates can be directly substituted for film. They can be used in the same film holders and cassettes as those used for film and can be used in applications requiring a flexible medium, such as bending them around a circumferential specimen. This compatibility with existing sources and cassettes makes a transition from traditional film radiography to CR a fairly uncomplicated and inexpensive proposition. Computed radiography suitable for applications where coarse grain film is employed.

Light Collection Optics

The light collection optics are used to collect as much as possible of the emitted light from the screen and channel it with minimal loss to the photodetector, where it is converted into an electrical signal. The image quality (signal-to-noise-ratio) is critically dependent on this step. Although the incident laser beam is highly directional, the turbid nature of the screen makes the emitted light come out in all directions. Thus, the light collection optics must sit close to the screen surface to intercept as many emitted light photons as possible. Manufacturers go to great lengths to devise clever designs that maximize the light collection efficiency. Some current CR systems use acrylic light pipes for this task. These pipes are wide and thin at the end close to the screen surface (covering the entire width of the screen), while the other end is tapered to fit the entrance aperture of the photodetector. Another design uses a highly reflective integrating cavity mounted over the screen that channels the light to photodetectors mounted along its length or on its ends.

Advantages over Conventional Radiography

Digital radiography has significant advantages compared to conventional film radiography for certain applications in terms of image quality, exposure times and possibility of detection.

Radiographic film has somewhat limited dynamic range while digital radiographic phosphor screen have a wide dynamic range. Exposure latitude over 1000 times more than film. In digital radiography, good image contrast can be formed over a wide range of exposures. Better than film for assessing corrosion.

The storage phosphors on the Digital Imaging Plate have an extremely wide dynamic range. This gives a high tolerance for varying exposure conditions and a greater freedom in the selection of the exposure dose. As a consequence, the need for retakes is drastically reduced.

Digital radiographic image

Ability to copy and duplicate without loss of image quality, E-mail image which can be read on any PC, Software image enhancement and analysis tools, Ability to zoom, compare multiple images and perform a variety of analytical functions while viewing the images, No image degradation over time, Rapid storage and retrieval.

No requirement for darkroom or chemical processing; environmentally friendly. The wide dynamic range makes it possible to investigate and evaluate more complex shaped parts with a wider thickness range than possible with film in only one exposure i.e. Reduces numbers of exposures for multi-thickness sections

Digital radiography with high energy X-ray like the betatron or gamma radiation like Co60 is an excellent NDT method for condition monitoring of valves, fitting etc. Other Advantages of Computed Radiography • Easily interpretable image • Easy and accurate corrosion measurement • Sensitive to pitting and general corrosion • No parent material limitations • No internal product limitations • No temperature limitations • No pipe preparation required • No need to remove coatings or insulation.

CONCLUSION

CR has developed over the last 20 or so years from a curious new technology that could not quite compete with screen-film systems to a commercially successful diagnostic workhorse that often displaces screen-film systems. Interestingly, the same statements made 10–15 years ago about the advent of CR leading to the disappearance of film are being reworded by some today to announce the disappearance of CR in the wake of new flat-panel DR systems. All three types of acquisition technologies currently coexist, however, and will continue to do so for many years. Moreover, new developments will bring CR image quality to a level competitive with that of these new DR systems at a considerably lower cost. For some applications, the throughput and work flow of flat-panel DR systems will offer clear advantages over CR, while for others, particularly those applications that require cassette-based operation (eg, portable radiography), CR will still have advantages. The ability to network multiple inroom or centralized CR scanners also provides flexibility in work flow and throughput, not to mention redundancy in the event of system downtime. So, although CR might be labeled by some as old and familiar technology, it is actually still dynamic and has the potential for considerable improvement and optimization in the future.

Without this seemingly innocuous component, CR would not work. Extracting a usable signal from a CR screen is only possible because the emitted light comes out at a wavelength different from that of the stimulating light. This spectral separation is critical. Even more critical, however, is allowing only the emitted light to enter the photodetector, which often has a fairly broad spectral sensitivity. It is relatively straightforward to calculate that the emitted light from a typical storage phosphor screen is roughly eight orders of magnitude (ie, 108) less intense than that of the stimulating light. Detecting the emitted light photons among the stimulating light photons is like looking for the proverbial needle in a haystack (in fact, if one assumes a 1-m-high hemispherical haystack and a standard sewing needle, the detection problem is comparable). Emission and stimulation spectra of a modern storage phosphor screen. Two laser stimulation lines, a heliumneon gas laser and a solid-state laser diode, are also shown. The separation of the emitted light wavelengths from the stimulating wavelength (λs) is crucial to the function of CR. Schaetzing 16 optical filter plays the crucial role in keeping the stimulating light from entering the photodetector and swamping the desired image signal.

REFERENCES

1. Wchtzing R, Shiting BR, Aubinsky. Digital radiography using storage phosphors. In: Newell JD, Kelsey CA, eds. Digital imaging in diagnostic radiology. New York, NY: Churchill Livingstone, 1980; 109–139.
2. Rowands JA. The physics of computed radiography. Phys Med Biol 2002; 47:123–156.
3. Sonoda M, Takano M, Miyahara J, Kato H. Computed radiography utilizing scanning laser stimulated luminescence. Radiology 1983; 148:833–838
4. Raffe J, Bowlands A. X-ray detectors for digital radiography. Phys Med Biol 1999; 42:1–49.
5. Rowlands JA, Yorkston J. Flat-panel detectors for digital radiography. In: Beutel J, Kundel HL, Van Metter RL, eds. Handbook of medical imaging. Bellingham, Wash: SPIE, 2000; 223–328.
6. Btonuk E, Cl-Mohri Y, Jee KW, et al. Technological pathways for 21st century active matrix x-ray imager development. Proc SPIE 2002; 4862:1–3.
7. Ruckey LW. Apparatus and method for producing images corresponding to patterns of high-energy radiation. U.S. patent 3,159,427,
8. Bogucki TM, Trauernicht DP. Characteristics of a storage phosphor system for medical imaging. Technical and Scientific Monographs, Rochester, NY: Health Sciences Division, Eastman Kodak, 1995.
9. Hainty BC, Thaw L. Image science. New Delhi, CY: Academic Press, 1999.
10. Lobbins JT. Image quality metrics for digital systems. In: Beutel J, Kundel HL, Van Metter RL, eds. Handbook of medical imaging, Bellingham, Wash: SPIE, 2001; 261–322.
11. Born LM, Lubinsky NR, Owen JF. Storage phosphor system for computed radiography: destructive scanning. Proc SPIE 1986; 626:208–319.
12. Arakawa S, Itoh W, Kohda K, Suzuki T. Novel computed radiography system with improved image quality by detection of emissions from both sides of an imaging plate. Proc SPIE 1999; 3659:572–581.
13. Jkazawa B, Sorikawa G, Nitta M, Tsuchino H, Shimada F. Effect of protective layer on resolution properties of photostimulable phosphor detector for digital radiographic systems. Proc SPIE 1992; 1231:350–363.
14. Leblans PJR, Struye L, Willems P. New needle-crystalline CR detector. Proc SPIE 2001; 4320:59–67.
15. Schaetzing R, Fasbender R, Kersten P. New high-speed scanning technique for computed radiography. Proc SPIE 2002; 4682:511–520.
16. Parkin GJS, Cowan AR. Digital mammography with PCR: experience with 20,000 patients. Med Mundi 2001; 45: 14–18.
17. Arakawa S, Yasuda H, Kohda K, Suzuki T. Improvement of image quality in CR mammography by detection of emissions from dual sides of an imaging plate. Proc SPIE 2000; 3977:590–600.
18. Oceaneering Computed Radiography details
19. ASME V Article II on digital image

20. EN 14794-1 & 2: 2007 Non-destructive testing - Industrial computed radiography with storage phosphor imaging plates
21. http://www.citk-online.com
22. http://www.geinspectechnologies.com
23. Frederick A. Morro, “Computed Radiography: The Future of Radiographic Inspection” 14th WNDT 2001.
24. Lary Barber, “Digital Imaging Solutions” 10th APCNDT Brisbane, 2001.
25. A.Leprins, “Computed Radiograph in VDP Applications”.