DIGITAL RADIOGRAPHIC IMAGE PROCESSING AND MANIPULATION pdf

1: Digital image processing â€" UC Davis

Processing parameters and image manipulation controls are also similar for both systems. Preprocessing takes place in the computer where the algorithms determine the image histogram. Postprocessing is done by the technologist through various user functions.

Binary Representation[edit] Virtually all computers in use today are based on the manipulation of information which is coded in the form of binary numbers. A binary number can have only one of two values, i. When a piece of information is represented as a sequence of bits, the sequence is referred to as a word , and when the sequence contains eight bits, the word is referred to as a byte - the byte being widely used today as the basic unit for expressing amounts of binary-coded information. In addition, large volumes of coded information are generally expressed in terms of kilobytes , megabytes , gigabytes etc. It is important to note that the meanings of these prefixes differ slightly from their conventional meanings because of the binary nature of the information coding. As a result, kilo in computer jargon represents units - or being the nearest power of 2 to one thousand. Thus, 1 kbyte refers to bytes of information and 1 Mbyte represents times bytes, and so on. Binary coding of image information is needed in order to store images in a computer. Most imaging devices used in medicine however generate information which can assume a continuous range of values between preset limits, i. It is therefore necessary to convert this analogue information into the discrete form required for binary coding when images are input to a computer. The development of modern computers has been almost totally dependent on major developments in material science and digital electronics which have occurred in the latter half of the 20th century. These developments have allowed highly complex electronic circuitry to be compressed into small packages called integrated circuits. These packages contain tiny pieces of silicon or other semiconductor material which have been specially manufactured to perform complex electronic processes. These pieces of silicon are generally referred to as silicon chips or microchips. Within the circuitry of a chip, a high electronic voltage can be used to represent the digit 1 and a low voltage can be used to represent the binary digit 0. Thus the circuitry can be used to manipulate information which is coded in the form of binary numbers. An important feature of these electronic components is the very high speed at which the two voltage levels can be changed in different parts of the circuitry. This results in the ability of the computer to rapidly manipulate the binary information. Furthermore, the tiny size of modern integrated circuits has allowed the manufacture of computers which are very small physically and which do not generate excessive amounts of heat - previous generations of computers having occupied whole rooms, which required cooling because they were built using larger electronic components such as valves and transistors. Thus modern computers are capable of being mounted on a desk, for instance in an environment which does not require specific air-conditioning. It is worth noting that information in this chapter is likely to change by the time the chapter is read, given the ongoing, rapid developments in this field. The treatment here is therefore focused on general concepts - and the reader should note that current technologies and techniques may well differ from those described here. In addition, note that mention of any hardware or software product in this chapter does in no way intend support for such a product and its use in this discussion is purely for illustrative purposes. General-Purpose Computer[edit] The following figure shows a block diagram of the major hardware components of a general-purpose computer. The diagram illustrates that a computer consists of a central communication pathway, called a bus , to which dedicated electronic components are connected. Each of these components is briefly described below. Block diagram of components of a general-purpose computer. This is generally based on an integrated circuit called a microprocessor. Its function is to act as the brains of the computer where instructions are interpreted and executed, and where data is manipulated. The Control Unit is used for the interpretation of instructions which are contained in computer programs as well as the execution of such instructions. These instructions might be used, for example, to send information to other components of the computer and to control the operation of those devices. The ALU is primarily used for data manipulation using mathematical techniques - for example, the addition or multiplication of numbers - and for logical decision-making. This typically consists of a large number of integrated circuits which are used for the

storage of information which is currently required by the computer user. RAM is used for the short-term storage of information. It is a volatile form of memory since its information contents are lost when the electric power to the computer is switched off. Its contents can also be rapidly erased - and rapidly filled again with new information. This is used for the storage of information in permanent or erasable form for longer-term purposes, i. There are various types of devices used for secondary memory which include hard disks , CD-ROMs and flash drives. These are used for user-control of the computer and generally consist of a keyboard , visual display and printer. They also include devices, such as the mouse , joystick and trackpad , which are used to enhance user-interaction with the computer. This consists of a communication pathway for the components of the computer - its function being somewhat analogous to that of the central nervous system. The types of information communicated along the bus include that which specifies data, control instructions as well as the memory addresses where information is to be stored and retrieved. As might be anticipated, the speed at which a computer operates is dependent on the speed at which this communication link works. This speed must be compatible with that of other components, such as the CPU and main memory. There is a lot more to computer technology than just the electronic hardware. In order for the assembly of electronic components to operate, information in the form of data and computer instructions is required. This information is generally referred to as software. Computer instructions are generally contained within computer programs. Categories of computer program include: These packages include programs which are used for word-processing e. MS Word , spreadsheets e. MS Excel , databases e. FileMaker Pro , graphics e. Adobe Illustrator and digital image processing e. OsiriX - as well as the software used for operating specific digital image receptors; Programming packages: Examples of common computer languages which are used for writing programs are Fortran , C and Java. A number of additional pieces of software are required in order for such programs to be written. Digital Image Processor[edit] Computers used for digital image processing generally consist of a number of specialised components in addition to those used in a general-purpose computer. These specialised components are required because of the very large amount of information contained in images and the consequent need for high capacity storage media as well as very high speed communication and data manipulation capabilities. Block diagram of the components of a digital image processor. The yellowed components are those of a general-purpose computer. Digital image processing involves both the manipulation of image data and the analysis of such information. An example of image manipulation is the computer enhancement of images so that subtle features are displayed with greater clarity. An example of image analysis is the extraction of indices which express some functional aspect of an anatomical region under investigation. Most digital radiography systems provide extensive image manipulation capabilities with a limited range of image analysis features. A generalised digital image processor is shown in the following figure. The yellow components at the bottom of the diagram are those of a general-purpose computer which have been described above. The digital image processing components are those which are connected to the image data bus. Each of these additional components is briefly described below. This is the device which produces the primary image information, i. The image system is often physically separate from the other components of the image processor. Image information produced by the imaging system is fed to the image acquisition circuitry of the digital image processor. Connections from the digital image processor to the imaging system are generally also present, for controlling specific aspects of the operation of the imaging system, e. This circuitry is used to convert the analogue information produced by the imaging system so that it is coded in the form of binary numbers. The image acquisition device may also include circuitry for manipulating the digitised data so as to correct for any aberrations in the image data. The type of circuitry which can be used for this purpose is called an Input Look-Up Table. An example of this type of data manipulation is logarithmic image transformation in digital radiography. This device is used to convert digital images into a format which is suitable for display. The image display unit may also include circuitry for manipulating the displayed images so as to enhance their appearance. The type of circuitry which can be used for this purpose is called an Output Look-Up Table and examples of this type of data manipulation include windowing. Other forms of image processing provided by the image display component can include image magnification and the capability of displaying a number of images on the one screen. This typically consists of

a volume of RAM which is sufficient for the storage of a number of images which are of current interest to the user. This generally consists of magnetic disks of sufficient capacity to store large numbers of images which are not of current interest to the user and which may be transferred to image memory when required. This consists of an ALU designed specifically for handling image data. It is generally used for relatively straight-forward calculations, such as image subtraction in digital subtraction angiography DSA and the reduction of noise through averaging a sequence of images. This consists of circuitry designed for more complex manipulation of image data and at higher speeds than the Image ALU. It typically consists of an additional CPU as well as specialised high speed data communication and storage circuitry. It may be viewed as a separate special-purpose computer whose design has traded a loss of operational flexibility for enhanced computational speed. This enhanced speed is provided by the capability of manipulating data in a parallel fashion as opposed to sequential processing - which is the approach used in general-purpose computing - although this distinction is becoming redundant with developments such as multicore CPUs. This component is used, for example, for calculating Fast Fourier Transforms and for reconstruction calculations in cone-beam CT. This component consists of a very high speed communication link designed specifically for image data. Note that many of the functions described above have today been encapsulated in one device called graphics processing units GPUs and have been incorporated into many computer designs, e. Digital Images[edit] The digitisation of images generally consists of two concurrent processes - sampling and quantisation. These two processes generally happen concurrently and are described briefly below. Image sampling is the process used to digitise the spatial information in an image. It is typically achieved by dividing an image into a square or rectangular array of sampling points - see the following figure. Each of the sampling points is referred to as a picture element - or pixel to use computer jargon. Although in the context of DR image receptors, the term detector element, or del, is also used. Naturally, the larger the number of pixels or dels, the closer the spatial resolution of the digitised image approximates that of the radiation pattern transmitted through the patient â€” see the following figure , panels a and b.

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2: Digital Radiography and PACS | Radiology Key

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Image Processing and Display Elizabeth A. Krupinski, PhDa, Mark B. Anthony Seibert, PhDg This article on digital radiography image processing and display is the second of two articles written as part of an intersociety effort to establish image quality standards for digital and computed radiography. The topic of the other paper is digital radiography image acquisition. Increasingly, medical imaging and patient information are being managed using digital data during acquisition, transmission, storage, display, interpretation, and consultation. The management of data during each of these operations may have an impact on the quality of patient care. These articles describe what is known to improve image quality for digital and computed radiography and to make recommendations on optimal acquisition, processing, and display. The practice of digital radiography is a rapidly evolving technology that will require timely revision of any guidelines and standards. Digital radiography, image quality, image display, soft-copy display, image processing, work- station J Am Coll Radiol ;4: Image quality is affected by a number of factors, begin- This paper on image processing and the display of ning with the acquisition process and device and includ- digital radiography images, together with its companion ing the manner in which images are displayed. In digital paper on image acquisition, was developed with reference systems, the functions of acquisition and display are to information available in the peer-reviewed medical clearly separable, so that the evaluation and optimization literature. The companion paper on image acquisition of image quality can take place at both ends of this im- contains in its introduction a common definition of dig- aging continuum. The analysis of image quality also de- ital radiography that serves as a reference point for both pends on the particular type of imaging task []. Briefly, in this guideline, the term digital radiog- ital radiography is used in a wide variety of imaging tasks raphy refers to all types of digital radiographic systems, eg, chest, musculoskeletal, genitourinary , but there are including those historically termed computed radiography and those historically termed digital radiography. This guideline is applicable to the practice of cassette and a cassetteless digital radiography. A glossary of commonly used terminology ramento, CA ; e-mail: Secondary displays eg, those used by cli- nicians or technologists for radiographic images do not Specifications for equipment used in digital image data need to adhere to these guidelines as long as the images management will vary depending on the application and are not used for primary interpretation purposes. The minimum quality specifications are tion or secondary review. Compliance with the current summarized here. Digital Imaging and Communications in Medicine DICOM standard of the ACR and the National Elec- Matrix Size and Display Size trical Manufacturers Association especially part 14, on gray-scale displays [4] is strongly recommended for all Soft-copy displays should render images with sufficient new equipment acquisitions, and consideration of peri- pixel density to allow viewing of the whole image with odic upgrades incorporating the expanding features of sufficient spatial detail at a normal viewing distance of that standard should be part of ongoing quality control approximately 30 to 60 cm with eyeglasses specifically programs. Compliance with the Radiological Society of selected for this distance when required. For Healthcare Enterprise Consistent Presentation of Images those images, zooming and roaming display functions are [15]. Each provides guidance and tools for the accep- required to achieve a correspondence between the detec- tance and quality testing of medical display devices and tor element matrix and the display pixel matrix so that should be consulted if further detailed information is the resolution of the display monitor does not limit the desired. This is true for any size image for which the detector element matrix size exceeds the display pixel matrix size. The ratio of maximum luminance to aging, ultrasound, nuclear medicine, digital fluorogra- minimum luminance of a display device for images phy, and digital angiography and large matrix size eg, other than for mammography should be at least Smaller ranges could lead to inadequate large-matrix images. The present guidelines the contrast sensitivity of the human eye. Indirect and back- should be included in luminance measurement consider- light incandescent lights with dimmer switches rather ations, because some level of ambient light is always than fluorescent lights are

recommended. Luminance should be as uniform as possible clothing and laboratory coats can increase reflections and across the entire display. The intrinsic minimum luminance of a device The contrast response of a display should comply with should not be smaller than the ambient luminance min- the AAPM Task Group 18 recommendations [8]. A high imum luminance should be at least 2. Cathode ray tube CRT displays typically have level 0. Contrast response antiglare coatings that can help reduce these effects, but should not deviate from the DICOM Grayscale Stan- not eliminate them. Bit Depth Color Tint and Color Displays It is necessary for a soft-copy display device to render Both monochrome and color displays have a color tint image details with sufficient luminance quantification to that is a function of where the manufacturer sets the prevent the loss of contrast details or the appearance of white point. The tint of the display can affect the comfort contour artifacts. Thus, a minimum of 8-bit luminance of the user. The color tint of the display blue, gray, resolution bit depth is required. Nine-bit resolution or yellow, etc is based on user preference but should be higher is recommended if the for-processing image data uniform across the display area, and monitor pairs should are greater than 8-bit. In general, the higher the lumi- be matched from the same manufacturing batch. All monitors and corresponding video graphics cards There are currently no accepted standards or guidelines used for primary diagnosis or for image adjustment and available for calibrating color displays when viewing evaluation eg, a technologist review monitor must pro- gray-scale radiographic images, so care should be taken. Both require about 30 minutes of soft-copy display for interpreting medical images include warm-up time to reach maximum performance. Flat- the modulation transfer function and noise. A display parable for CRT displays and LCDs, but off-axis degra- device also should not add more than a third of the noise dations in contrast are still possible with many LCDs and of a typical image, limiting the display relative noise to should be taken into account when viewing images on 0. LCDs from nonorthogonal angles. If two displays are Desirable display calibration features include remote placed side by side for viewing images, it is recommended performance monitoring, calibration, and quality con- that they be tilted inward toward the viewer to minimize trol. Monitor set matching of contrast ratio, brightness, the impact of angular response variation. Glare and Reflections Secondary Displays Veiling glare or the spread of light within the display can reduce contrast, so the glare ratio should be greater than When the display systems are not used for the official for primary displays. If they are being used by a technologist to Most manufacturers apply processing algorithms judge image quality during acquisition, consideration which are often proprietary to optimize image quality, should be given to using a display as similar as possible to so it is necessary that the nature of these processing steps the diagnostic one in terms of maximum and minimum be made clear to users. The display resolution need not be the proprietary processing vs for-presentation ie, after some same as long as zoom and pan roaming are easily avail- processing has been applied data. Once the image data able to the user so that the full intrinsic resolution of the are transferred to the viewing workstation, they can be image can be viewed. Display workstations used for the official interpretation Computer-aided detection CAD and computer- of large-matrix systems should be capable of the follow- aided diagnostic tools for a variety of images and modal- ing: In general, these fast and easy navigation between new and old studies; tools have been shown to enhance the performance of rotating or flipping the images, provided that the labeling radiologists, although the effect may be lower for more of patient orientation is preserved; and accurately associ- experienced and specialized radiologists than for general- ating the patient and study demographic information ists. It is recommended that all CAD and computer- with the images of the study. Although many of the algorithms already do a significant amount they need not all be displayed simultaneously, the use of image processing. The for-presentation data may alter of dual monitors to display as many as possible is the effectiveness of the CAD algorithms. It is recom- desirable. Clinically relevant technical parameters of mended that radiologists using CAD understand what the acquired image data should be accessible eg, milli- the CAD and computer-aided diagnostic tools are capa- amperes, kilovolts, bit depth, exposure time, and ma- ble of doing, particularly with reference to their sensitiv- trix size. It is imperative that the exposure value be ity and specificity, so that they can better judge the va- displayed on the picture archiving and communica- lidity of the CAD prompts. Preset window and level settings eg, bone or influence not only the comfort and fatigue levels of radi- lung windows using set lookup-table transformations ologists but also interpretation

accuracy [20]. Viewing are recommended to increase the speed of user interac- conditions should be optimized by controlling reading tion with the display device. It is recommended that the room lighting to eliminate reflections on the monitor prior application of an irreversible compression ratio, and lowering the ambient lighting level as much as feasi- processing, or cropping be noted in the image record. Ambient lights should not be turned off completely Zoom magnification and pan roaming functions nor turned up completely. About 25 to 40 lux is generally capable of meeting guidelines for display at the originally sufficient to avoid most reflections and still provide suf- acquired spatial resolutions should be used rather than ficient light for the visual system to adapt to the sur- the user moving closer to the display. Calculating and rounding environment and the displays [21]. Incandes- displaying accurate linear measurements and pixel value cent lights with dimmer switches are recommended, determinations mean and standard deviation in values especially those with natural filters. Fluorescent lights are appropriate for the modality eg, Hounsfield units for not recommended. A combination of backlighting with computed tomographic [CT] images should be calcu- desk side lighting with focused or shielded light eg, for lated and displayed if those data are available and can be taking notes is recommended. If view boxes and film are calibrated to the acquisition device. If this is not possible, the cause they tend to drift more with age. It may be necessary, de- image, such as the SMPTE [8,22,23] test pattern or the pending on the particular environment, to have direct AAPM Task Group 18 pattern, should be captured, ventilation for each workstation that is controllable by transmitted, archived, retrieved, and displayed at appro- each user for personal comfort. Water-cooled computers priate intervals, to test the overall operation of the system should be considered. Avoid placing monitors in the under normal operating conditions. As a spatial resolu- same area as light boxes or alternators. If necessary, place tion test, at least 2. The overall SMPTE image appearance should be Noise considerations computers, fans, etc are also inspected to ensure the absence of gross artifacts eg, important to minimize with digital workstations. Water- blurring or bleeding of bright display areas into dark cooled computers should be considered because they are areas or aliasing of spatial resolution patterns. All display quieter than fan-cooled computers. Proper shielding eg, monitors used for primary interpretation should be via movable walls should be considered, especially to tested at least monthly. As a dynamic range test, both the isolate dictation systems from each other. Dictation tools, Internet access, Compression and other reference tools should be readily accessible and Data compression may be performed to facilitate trans- easy to use during image interpretation. Consider ergo- mission and storage. The type of medical image, modal- nomically designed input devices and alternatives to the ity, and the objective of the study will determine the more traditional mouse and trackball interfaces. If compression is used, algorithms ac- radiography device. Performance testing and monitoring cepted by the DICOM standard, including wavelet com- of digital display equipment should be maintained in pression methods such as JPEG, are generally rec- accordance with the equipment manufacturer specifica- ommended. The types and ratios of compression used for tions, applicable industry guidelines, and state and fed- different imaging studies transmitted and stored by the eral regulations. In the absence of adequate manufacturer system should be selected and periodically reviewed by procedures, guidelines, or standards, the recommenda- the responsible physician to ensure appropriate clinical tions for the performance evaluation of display devices image quality. Regulary bodies may require that the com- testing methods and frequencies contained in the AAPM pression ratio be indicated on the compressed image. It should be noted that CRT and LCD devices Transmission tend to have different characteristics and may not de- grade in the same ways or at the same rates. The same The environment in which the studies are to be transmit- holds true for color vs gray-scale devices. Devices from ted will determine the type and specifications of the different manufacturers may also degrade at different transmission devices used. In all cases, for official inter- rates. The transmission system Reliability and Redundancy shall have adequate error-checking capability. See the For facilities practicing electronic radiology, quality pa- Practice Guideline for Electronic Medical Information tient care depends on the stability and reliability of the Privacy and Security [27]. Written policies The DICOM Transmission and Storage Standard and procedures must be in place to ensure the continuity [28] should be referred to for best practice implementa- of care at a level consistent with those for hard-copy tion, especially the DICOM DX Image Information Ob- imaging studies and medical records within a facility or ject Definition. Optimally, all

vendors should use the institution. This should include internal redundancy sys- DX object. Images stored at either a transmitting or Digital radiology encompasses a number of modalities receiving site should meet the jurisdictional requirements and image interpretation tasks. The images are acquired of the acquisition and transmitting site. Images inter- at different resolutions, bit depths, and matrix sizes.

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List the functions of contrast enhancement parameters. State the Nyquist theorem. Describe the effects of improper algorithm application. Explain modulation transfer function. Discuss the purpose and function of image manipulation factors. Describe the major factors in image management. To avoid this, exposure data recognition processes only the optimal density exposure range. Finding collimation edges Eliminating scatter outside the collimation Failure of the system to find the collimation edges can result in incorrect data collection. Images may be too bright or too dark. Because information within the collimated area is the signal used for image data, the information is also the source for a vendor-specific exposure data indicator. Image location and orientation is determined. Size of the signal is determined. Value is placed on each pixel. Histogram identifies all densities on the imaging plate in the form of a graph: Y-axis displays the number of pixels for each exposure. Graphic representation appears as a series of peaks and valleys and has a pattern that varies for each body part. High energy kilovoltage peak gives a narrow histogram. Histogram shows the distribution of pixel values for any given exposure. Histogram shows the frequency of each of those values and actual number of values. Shape of the histogram stays fairly constant for each part exposed anatomy specific. Because sample is preprocessed by the computer immediately, signal loss is minimized but still occurs. Sampling occurs less than twice per cycle. Wraparound image is produced. Aliasing can be problematic because of the same effect occurring with grid errors. Automatic rescaling occurs in an effort to display the pixels for the area of interest. When too little exposure is used. When too much exposure is used, it will result in a loss of contrast and loss of distinct edges because of detector saturation. Rescaling is no substitute for appropriate technical factors. Danger exists of using higher than necessary mAs values to avoid quantum mottle. Used as a cross-reference to transform the raw information. Has a mapping function: Brightness density can be increased or decreased by moving the line up or down the y-axis. The greater exposure latitude is due to the higher dynamic range of the receptors. Spreading out of the light will always occur. Light spread reduces system efficiency. The more light spread, the lower the MTF. Brightness can be varied at the toe and shoulder of the curve, removing the extremely low and extremely high density values using a different parameter. No amount of adjustment takes the place of proper technical factor selection. It is possible to degrade image information if algorithms are improperly applied. Results from averaging of the frequency of each pixel with surrounding pixel values to remove high-frequency noise. Result is a reduction of noise and contrast. Low-pass filtering is useful for viewing small structures such as fine bone tissues. Controls the ratio of black to white, or contrast. User is able to manipulate quickly through use of the mouse. Movement of the mouse in one direction vertical or horizontal controls brightness, and the other direction controls contrast. This results in temporary white light blindness. Eye recovers quickly enough so that viewer recognizes only that the light is very bright. Glare is a great distraction that interferes with image reception by the eye. Reader must be informed of the orientation of the anatomy with respect to the reader. Technologist will have the ability to re-orient the image while preparing the image at the quality control workstation. Sometimes, special cassette holders are used and positioned vertically, corresponding to foot to hip or entire spine radiography. Images are processed in computer programs that nearly seamlessly join the anatomy. Computer displays one single image. Can be useful when such additional information is necessary. Overlay the image as bitmap images. May not transfer to picture archival and communication system PACS. Demographic information about the patient includes the following: Doe and is entered that way. Name must be entered that way for every other exam. If name is entered as Jane Doe, then system will save it as a different patient. Merging of files can be difficult. Suppose the patient gives a middle name on one visit but has multiple exams under his or her first name. Retrieval of previous files will be difficult. The right images must be placed in the correct data files. The manual send function allows the quality control technologist to select one or more local computers to receive images. Function allows retrieval of images from the PAC

system based on the following: Multiple combinations of query fields are possible: The histogram then undergoes an analysis. The plate is scanned, and the image location is determined. A value is place on each pixel, and the histogram is generated displaying the minimum and maximum diagnostic signal. The histogram is anatomic region specific and remains fairly constant from patient to patient. Automatic rescaling allows pixel display for the area of interest, regardless of the amount of exposure. There is no substitute for proper kilovoltage peak and milliamperesecond settings. Images cannot be created from nothing; that is, insufficient photons, insufficient penetration, or overpenetration will result in loss of diagnostic information that cannot be manufactured by manipulation of the image parameters. Contrast-enhancement parameters allow enhancement of the image by controlling the steepness of the exposure gradient, density variance, and contrast amount. Spatial frequency resolution is controlled by focal spot, object image distance, and computer algorithms. The Nyquist theorem is applied to digital images to ensure that sufficient signal sampling occurs so that maximum resolution is achieved. MTF refers to the contribution of all system components to total resolution. The closer the MTF value is to 1, the better the resolution. Edge enhancement is accomplished by limiting the number of pixels in a neighborhood of the matrix. Known area of interest frequencies can be amplified or high-pass filtered to increase contrast and edge enhancement. Suppression of frequencies of lesser importance, known as masking, can cause small detail loss. Contrast and noise are decreased, allowing small structures to be seen. Window and level parameters control pixel brightness and contrast. Shuttering is a process that removes or replaces the background in order to block distracting light surrounding a digital image. This does not take the place of proper collimation and can be removed to show proper collimation. Digital imaging cassettes are marked for orientation to the top and right sides. This ensures that images are displayed correctly. Image stitching is a computer program process that allows multiple images to be joined when the anatomy is too large for one exposure. The result is a nearly seamless, single image. Magnification techniques are available with digital systems that allow small area enlargement or whole image enlargement. Any alterations of patient demographics should be avoided unless absolute identification is possible. The manual send function allows images to be sent to one or more networked computers. Historical study of patient exams can be accomplished through the archive query function. Retrieval of radiographic studies can be specific as to patient name, date, and exam or broad such as date ranges and combinations of anatomic areas.

4: Digital Radiographic Image Processing and Manipulation | Radiology Key

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pre-processing the reader is to be informed as to what exam will be processed. So when you "flash" the cassette, or scan with a bar code reader or in DR, choose the patient and the examination and the views that are to be done HISTOGRAM Graphical representation of optimal densities collected by exposure data recognition.

6: Digital Image Processing

Digital Radiographic Image Processing and Manipulation Part III: Digital Image Acquisition 4. Photostimulable Phosphor Image Capture 5. Photostimulable Phosphor Image Capture 5. Flat Panel Array Image Acquisition 6.

7: Digital image processing.

Image processing or digital image manipulation is one of the greatest advantages of digital radiography (DR). Preprocessing depends on the modality and corrects for system irregularities such as differential light detection

efficiency, dead pixels, or dark noise.

8: Digital Radiography Image Quality: Image Processing and Display | Sisna Wati - www.enganchecubano

It includes tips on acquiring, processing, and producing clear radiographic images, performing advanced image processing and manipulation functions on CR/DR workstations, storing images with PACS workstations, and a guide to quality control and management.

9: Chapter 7 Digital Radiographic Image Processing and

This article on digital radiography image processing and display is the second of two articles written as part of an intersociety effort to establish image quality standards for digital and computed radiography.

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The horses of the Royal Canadian Mounted Police The Guide to Cooking Schools 2005 Poetic Healing: A Vietnam Veterans Journey Joseph Story and the American Constitution Sahlis Tuberculin Treatment: Including a Discussion of the Nature and . Families, work, and housework Foundations of Algorithms and Theory of Computation Years Best SF 11 (Years Best Sf) Great American Quilts (No. 7) Appendix V: Ingredients of a real estate loan submission Our Side of the Story Will drafting explained Political learning among the migrant poor Famous People in American History Digital integrated circuits Method in Unit Delimitation (Pericope) Gender and Trade Action Guide Correspondence Of James Fenimore Cooper Volume Ii Basins on the Atlantic Seaboard A. Principles of underfit streams. Collaborative case conceptualization Approaches to social archaeology Speech of the Right Hon. W. E. Gladstone, M.P. for the University of Oxford Alcoholic drinks recipe Math and literature. Pike Spanish America 1900 1970 (Paper) Computers in Railways X Ca-ching, ca-ching : the allowance lowdown Dialectic and Rhetoric Bakery shop business plan Downtown Black-Jewish DC: From the Library to the YMHA.38 Samrat ashok history in gujarati Theories of state formation in africa A second look at fundamentalism, the Scopes trial, and Inherit the wind Grammar and communication Outlines Highlights for Brief Calculus: An Applied Approach by Larson, ISBN Before After Garden Makeovers History of the qur anic text azami Shari Lewis presents 101 games and songs for kids to play and sing Butterfly life cycle book