A MICROCOMPUTER BASED DIGITAL RADIOTHERAPY SIMULATOR AT CHULALONGKORN UNIVERSITY

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ABSTRACT

To enhance quality and readiness of radiotherapy simulation at division of radiation oncology, Chulalongkorn University, we have assembled an in-house microcomputer based digital radiotherapy simulator, which consists of a conventional simulator, analog to digital video converter, microcomputer, laser printer and image processing and archiving software. We selected Scion Image for Windows as an image processing and archiving software. Scion Image for Windows is the Windows version of Scion Image, which is in turn a version of the popular Macintosh program, NIH Image, written at the US. National Institutes of Health. Scion Image may be used to capture, display, analyze, enhance, measure, annotate, and output images. The high-resolution digital images are processed and displayed in about 1 sec, as opposed to a minimum of approximately 15-min for film. The images have been captured and stored in a server computer, so they can be easily reviewed and reprinted from any computer in our division. Because of the advantages of short image acquisition and display times, they were observed in all cases, so this system reduces radiation exposure to the patients.

INTRODUCTION

Traditional film screen imaging is more and more being replaced by digital imaging using various technologies in converting traditional images into digital images. Digital imaging offers various new possibilities in image processing, storage and transmission. This may yield additional diagnostic information, dose reduction and fast availability of images. Images will be taken without film cassettes and will be directly displayed on monitors for reporting. Digital imaging provides greater flexibility in processing, transmitting and displaying images. It is powerful and relatively inexpensive, microcomputers have been available for many years. With the development of icon-based windowing operating systems and hardware optimized for graphics, they have enable us to assemble the low cost digital radiotherapy simulator. We describe a microcomputer based digital radiotherapy simulator, which consists of a conventional simulator, analog to digital video converter and image processing and archiving software. This low cost system is designed to produce digital simulation images from radiotherapy simulator. The system is based upon a standard microcomputer and operates using the simulator's image intensifier as the source of video signal for analog to digital video converter.

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MATERIAL AND METHOD

Hardware

1. Conventional simulator.
2. ASUS® V3800 TVR display card, which can convert analog video signal to digital video signal.
3. A personal computer bases upon Intel Pentium processor series with network capability.
4. Local area network.
5. Laser image printer.

Our simulator is Ximatron CX simulator from Varian Medical System,Inc.. It is a conventional simulator with fluoroscopy. It includes a built-in charged-couple (CCD) device camera, which views the x-ray image optically transmitted from a conventional phosphor screen. The image is sent to a monitor for on-line viewing. After proper simulation image is seen on a monitor, a hard copy image on photographic film is produced for every patient. To convert analog video signal to digital form, the video signal of simulation image is diverted to ASUS® V3800 TVR display card within a personal microcomputer from fluoroscopic monitor (Fig.1). The computer is one of the computers in radiation oncology network at King Chulalongkorn Memorial Hospital.

Software

1. Microsoft® Window 95.
2. ASUS® live video captures software.
3. Scion Image for Windows.

We chose ASUS® live video capture driver and Scion Image for Windows as a digital video capture software and image processing software respectively. They need Microsoft® Window 95 to be operated. Microsoft® Window 95 is operating system that is widely used and consists of many powerful tools. The ASUS® live video capture driver follows Microsoft Video for Windows standard and can open up to a capture window size of 704 x 480 pixels, 30 frames/second. Video Snapshot function of the driver lets us capture video stream data as single images and then show these images on desktop almost simultaneously through the image viewer selected. It supports any plug-in image-processing program, Scion Image for Windows. Scion Image for Windows is the Windows version of Scion Image, which is in turn a version of the popular Macintosh program, NIH Image, written at the National Institutes of Health. Scion Image may be used to capture, display, analyze, enhance, measure, annotate, and output images. Scion Image extensively supports all Scion frame grabber boards, and provides a powerful and complete image acquisition environment. Scion Image for Windows supports color and grayscale image capture with Scion frame grabbers. It includes advanced capturing capabilities such as frame averaging and summation, frame sequence capture, and on-chip integration support. All current features of NIH Image have been included.[1] This program is available free of charge. Scion provides full technical support to users of Scion Image.

RESULTS AND DISCUSSION

The high-resolution digital images are processed and displayed in about 1 sec, as opposed to a minimum of approximately 15-min for film In fact, we do not have film-processing unit in our division. Digital images of various radiation fields have been done with good resolution. Figures 2-4 show different sites of treatment fields.

These digital radiographs provided permanent high-resolution images as required in most cases for verification of treatment fields. All of the images have been stored in our division server computer, and Scion Image for Windows can be installed on any remote computer in the computer network, so the physicians can access and review the images from any computers in the division. Apart from acquiring and displaying the images, Scion Image can edit, enhance, analyze and animate images. It reads and writes TIFF, PICT, PICS and MacPaint files, providing compatibility with many other applications, including programs for scanning, processing, editing, publishing and analyzing images. It supports many standard image processing functions, including contrast enhancement, density profiling, smoothing, sharpening, edge detection, median filtering, and spatial convolution with user defined kernels which found to be very useful for image enhancement. Scion Image can be used to measure area, mean, centroid, perimeter, etc. of user defined regions of interest. It also performs automated particle analysis and provides tools for measuring path lengths and angles. Spatial calibration is supported to provide real world area and length measurements. Density calibration can be done against radiation or optical density standards using user-specified units. Results can be printed, exported to text files, or copied to the Clipboard. A tool palette supports editing of color and gray scale images, including the ability to draw lines, rectangles and text. It can flip, rotate, invert and scale selections. It supports multiple windows and 8 levels of magnification. All editing, filtering, and measurement functions operate at any level of magnification and are undoable. Many features of Scion Image were found to be very useful for imaging in regions of different density, such as lung and soft tissue, in the same radiograph.

There are some limitations of this approach. First, the quality of image is influenced by many factors such as quality of simulator's phosphor screen and CCD device camera that produce analog video image, display card resolution and laser printer quality. Second, there are some distortions of the images that may cause by CCD camera. Straight line is not exactly straight. It is slightly curved. Third, the maximum field size is about 16 by 16 centimeters that is the maximum field of view of CCD camera. If we need simulation images with radiation portal more than 16 by 16 centimeters we have to take more than one image at different ends of portal, so the physicians could see all of the boundaries of the portal. (Figure 5)

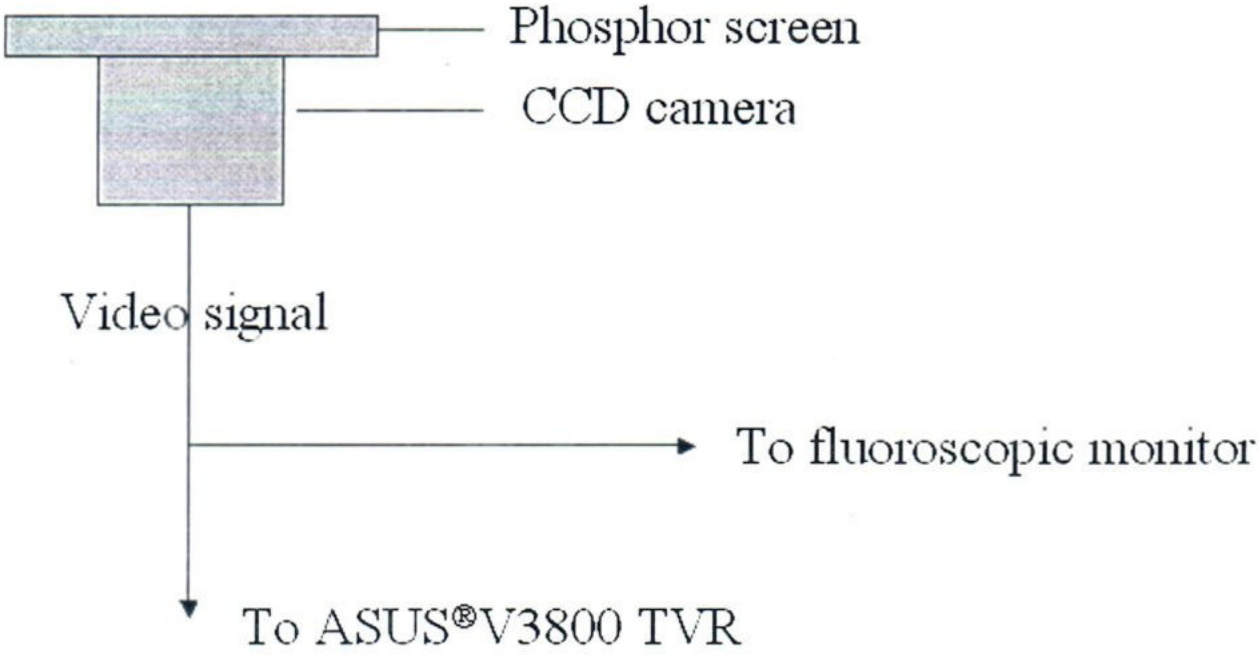

Fig.1 Diverting of analog video signal from CCD camera to ASUS® V3800 TVR

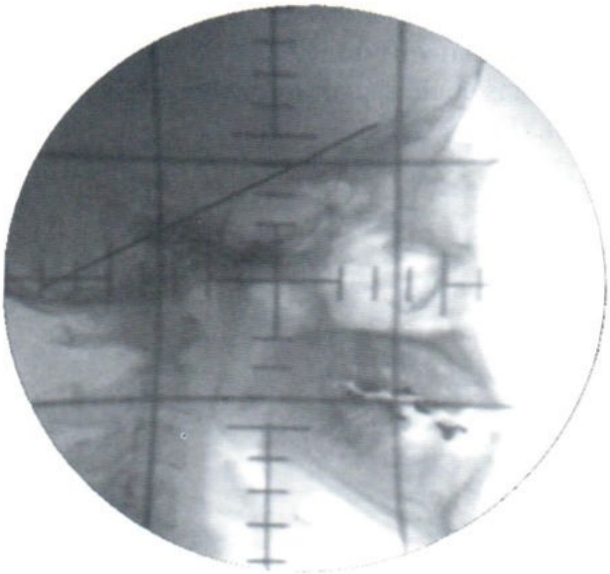

Fig. 2 Radiation portal at nasopharynx.

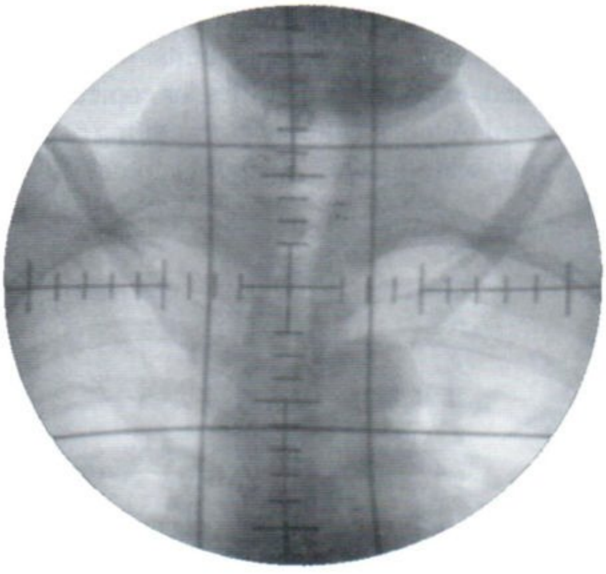

Fig. 3 Radiation portal at thoracic area.

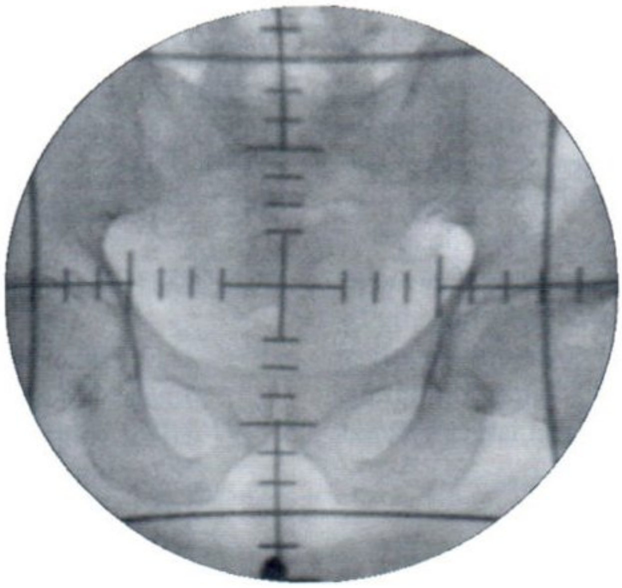

Fig. 4 Radiation portal at pelvis.

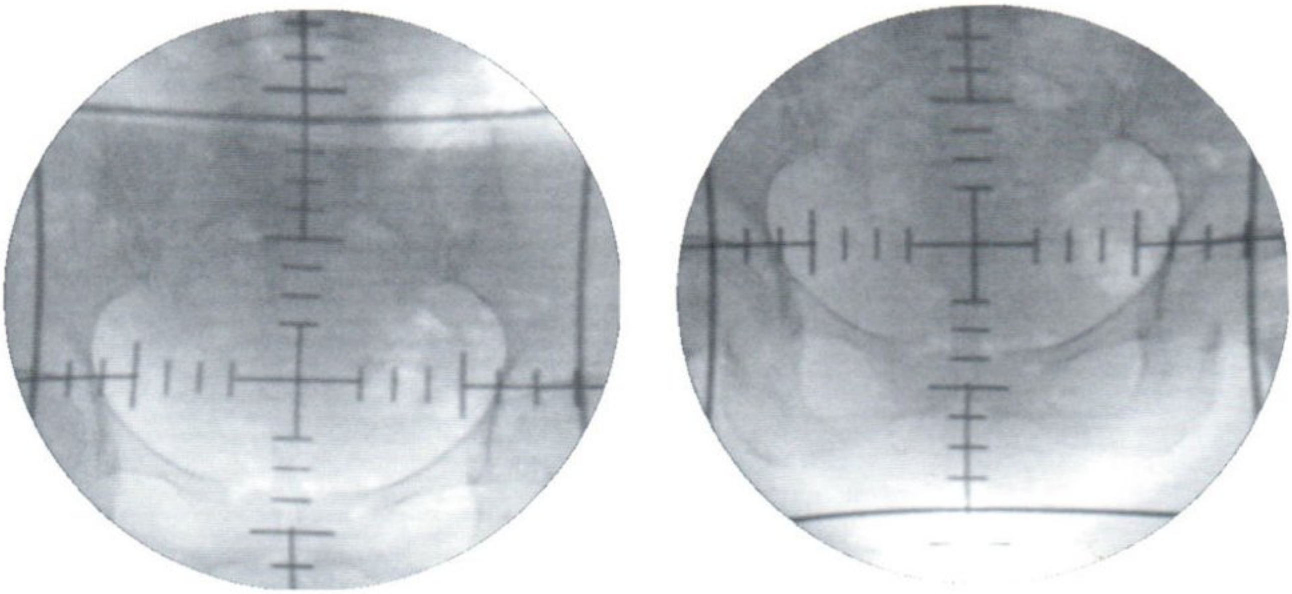

Fig. 5 Image at upper end (right) and lower end (left) of radiation field.

Because it require only 1 second per image for processing and displaying, the advantages of short image acquisition and display times were observed in all cases. So this approach also enables a new method of simulation to be considered which reduces patient dose and prolongs the useful working life of the X-ray tube. However, this trend is influenced technically by the advent of more efficient detectors, improved image processing methods, faster computers, brighter and sharper displays and larger systems for image storage and archiving.

CONCLUSION

A microcomputer based digital radiotherapy simulator enables a new method of simulation, which enables fast image display processing; archiving and reduction of patient radiation dose and prolongs the useful working life of the X-ray tube.

REFERENCE

1. U.S. National Institutes of Health . NIH Image Manual (V1.61). Available from: URL: http://rsb.info.nih.gov/nih-image/index.html