ABSTRACT

APPLICATIONS OF THE SILICON TARGET STORAGE TUBE
IN TELEVISION FLUOROSCOPY

Michael George Ort

Under the supervision of Assistant Professor Charles A. Mistretta

The silicon target storage tube, a cathode ray device in which a video image can be stored and nondestructively read out, has been used for several different techniques in television fluoroscopy, including a new radiological procedure called Absorption Edge Fluoroscopy. After a brief review of the various methods for image storage in fluoroscopic procedures, the operation of the silicon target storage tube is discussed.

The storage tube was used for three techniques for reducing x-ray exposure in various fluoroscopic procedures. The first technique simply records (for instant video replay) the last fluoroscopic image on the TV monitor at the time a radiologist releases the x-ray switch during a fluoroscopic examination. This last image can then be studied without further irradiation. This has been useful for reducing x-ray exposure in teaching situations.

As an extension to this technique the storage tube has

been incorporated into a pulsed fluoroscopy system in which the x-rays are pulsed on for about 15 milliseconds, once a second, to write an image on the storage tube for instant display to the radiologist in a manner similar to a slide show presentation. This system was found useful in reducing x-ray exposure in a slowly varying scene in which maximum contrast and resolution were not needed.

A system for subtracting a live television fluoroscopic image from a stored fluoroscopic image to help the radiologist performing selective catheterizations was developed and evaluated. An image stored immediately after injecting a small amount of radiopaque dye into an artery to be catheterized serves as a "road map" when electrically superposed over the negative live fluoroscopic TV image. This aids the radiologist in determining the exact location of the catheter. This subtraction fluoroscopy technique was found to be of particular value in the angiography of transplanted kidneys and the performance of lower extremity angiography from the opposite side.

While implementing these relatively straightforward video storage techniques, which have been previously done using video discs and tape, a new high accuracy two stage video subtraction technique was developed. The technique uses a conventional silicon target storage tube and a second type of storage tube whose anode consists of a solid dielectric layer

over a conducting substrate. The details of the operation of this tube and the method in which the two tubes are used together are discussed.

In addition, the application of this two stage video subtraction technique to a new radiological procedure called Absorption Edge Fluoroscopy, in which it is possible to image, in vivo, very small concentrations of certain elements having K absorption edges in the diagnostic x-ray energy range is discussed. By alternate placement of two different filters in a conventional fluoroscopic x-ray beam it is possible to produce quasi-monoenergetic photon beams above and below the K absorption energy of an element to be imaged (such as iodine or xenon). Using a conventional image intensifier-TV chain it is possible to detect small brightness changes, corresponding to the concentration of the element of interest, as the filters are interchanged. This brightness change can be imaged using the two stage subtraction apparatus. Using this system a concentration of 1 mg/cm^2 of non-radioactive iodine in a 15 cm soft tissue equivalent phantom has been imaged. Because this concentration corresponds to the amount of iodine naturally found in the human thyroid, it is felt that the technique could be used to image the thyroid. In addition, the application of the technique to the imaging of the lungs using non-radioactive xenon is considered.