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DESIGNING AND PRODUCING A SIMULATION MODEL OF MULTISLICE CT-SCANNER

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Abstract

Multislice CT Scanner is a high-tech medical complex. It is equipped in all major hospitals. The system is implemented simultaneously emitting and receiving X-ray signals; put the body of the patient at the right position to capture and handle in time, and then it reproduce the images which are not only the structure but also the function of examination parts. A simulation model of multi slice CT - Scanner in training is imperative. In this paper we describe the design and produce a simulation model of CT-Scanner for training engineers, doctors and technicians

1. Introduction

Multislice CT-Scanner is a modern medical, high-tech complex and a necessary equipment in the Faculty of diagnostic imaging in big hospitals though the price is very expensive (about $ 150,000 to $ 2,000,000). There are 85 systems [1] in Vietnam. In addition, it cannot be used to practice repairs or operation, since for every hour of downtime, hospitals will loss 800,000 VND x 4 cases = 3,600,000 VND. On the other hand, for every CT scanner it needs at least 1 technician, 2 doctors and one maintenance repairing engineer. Thus the demand of operator training and operating these machines is very large.

Key words: Multislice CT Scanner, rotary and tilting gantry structure, DICOM image processing.

2. Design Concept

System design includes parts and meets the following requirements [2, 3, 4, 5, 6]:

Gantry:

- Rotating gantry and control, stabilizing rotation speed.
- Tilting gantry and controlling tilting angle.
- Simulating the operation of lights, including the field of array of scanner (FOV), slice thickness (ST) for simulation mode 1, 2, 3, 4 slices.
- Controlling the lights in position by 4 switches.

Patient table:

- Lifting table by hydraulic system and controlling 3 positions of height.
- Moving table by stepping motors with different speeds and controlling position of the table.
- There are controlling position sensors, and switchs to disconnect the system when a problem happened.
- Synchronize table and gantry operation to demonstrate Scanogram, Standard, and Helical shooting modes.

Controlling Software:

- Controlling the operation from computer systems, through the RS232 interface;
- Controlling the Scanogram, Standard, and Helical selected mode by choosing mode parameters, taken part, taken time, FOV, ST...
- Showing the synchronization with the mechanical operations of the system in the display of Scangram, Standard, Helical photos corresponding to modes, number of slices, ST and the part of body taken.
- There are programs to view DICOM image processing after the shooting or from some folders.

3. Results and Discussion

Completed result System (Fig.1) resolves the issues raised with the complete model as follows:

The system can synchronously operate [7, 8] with the activities of the gantry and the table and show Scanogram shooting modes, in Standard or Helical, according to the rotary and tilting gantry structure.

Gantry system is designed for two modes of operations: rotation of the gantry to move lights to the desired location in Scanogram, Standard or Helical modes; tilting movement of the gantry to capture some special positions of body parts.

The rotation of the gantry (Fig.2) is operated by DC - motor system encoder. The rotational speed is determined and controlled via encoder mounted

Fig.1: Model simulation computer tomography system multi-slice

on motor shaft. The gantry rotation speeds are 1cycle/s, 2 cycles/s and 3 cycles/s.

Fig.2: Structure Gantry running back in round 3 speed 1cycle / s, 2 cycles / s and 3 cycles / s

The cruise control switches to control gantry position at positions 1, 2, 3, 4 corresponding to positions $0^0, 90^0, 180^0, 270^0$ of gantry.

The tilt movement of the gantry is done by a DC motor system shifting in the direction as shown in Fig.3 and the encoder system mounted on motor shaft determines the position and angle to move. Angular displacement limit: $+25^o$ to -25^o.

The rotation of the gantry is driven only by a certain rotation, clockwise (as often seen in the CT of Toshiba, Hitachi using a broom).

Moreover, in two ends of mechanical systems there are 2 switches to disconnect cruise tilt system, to guarantee tilt levels in safety by the sensor to control the height and angle of inclination (Fig.4, Fig.5)

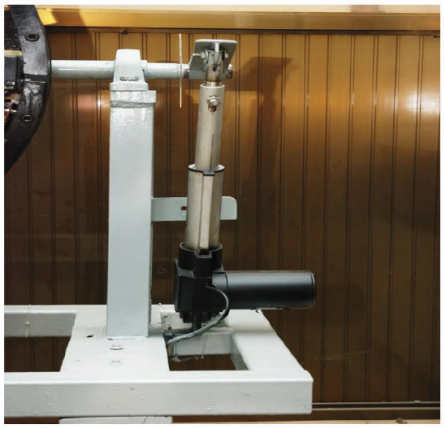

Fig. 3: Structure of tilt from -25^o to $+25^o$

Patient table system is designed for two basic modes of an operation: moving up - down and moving in-out the table. Moving the table up - down is done by the system with oil pump and hydraulic cylinder. A hydraulic pump operates in two modes: pump discharge through relay switching by VDK, its height is determined and controlled via the encoder position. The safety position is controlled by the cruise control switch.

The position height settings: 64, 77, 85cm.

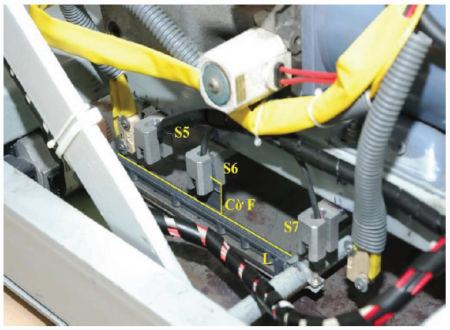

Fig.4: Optical sensor determined high of patient table

The sensors S5, S6, S7, are placed respectively at the location as shown in Fig.4. They are used to control the positions, including:

- Sensor S5, S7 corresponding to the maximum and minimum height of the table.

- Sensor S6 corresponding to the height of the center of gantry. Tables are in this position during shooting.

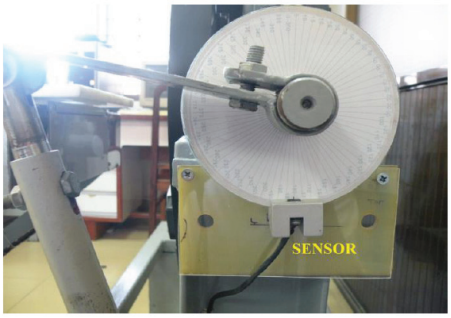

Fig.5: Sensor determined angle 0^0

Motions in-out of the table is controlled by the structure vitme-step motor. Shift position is determined and controlled via encoder. The safety position is controlled by the cruise control switches.

The sensors S1, S2, S3, S4, are located in the following locations:

- Sensor S1, S4 corresponding to the maximum location of the table.
- Sensor S2, S3 corresponding to the position of the table are moved slowly before stopping at two limit positions

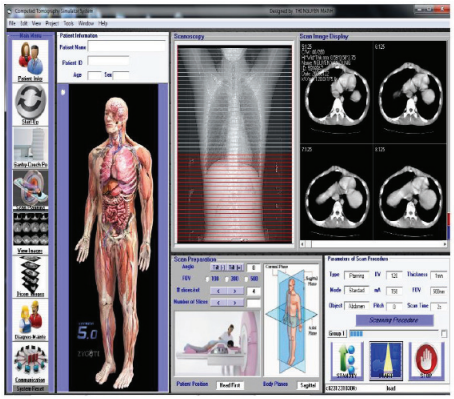

Fig. 6: The main control interface

Crucial part in this model is the central control system [7, 8], the operational lights model and simulating detector in mode 2, 3, 4 slices. The driver software of the computer is designed to interface closely with the Protocol of the actual machine. It can be demonstrated the ability to control flexibly from computer:

- Tables of patients are moved up and down or in and out to gantry corresponding to each control mode.
- Having ability to adjust gantry tilt left and right with the scales of 20.

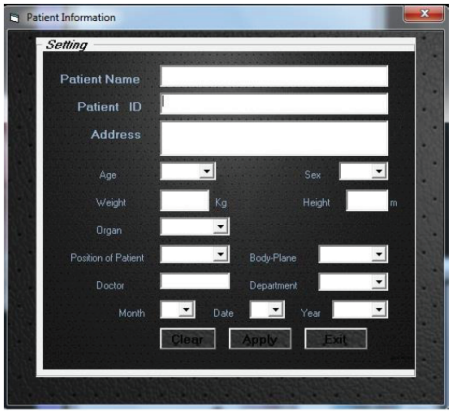

Fig. 7: Interface patient information

- Especially, photo viewer software is capable to process Dicom image and Medical image, in general including the most basic functions of a medical image viewer program (Fig.8).

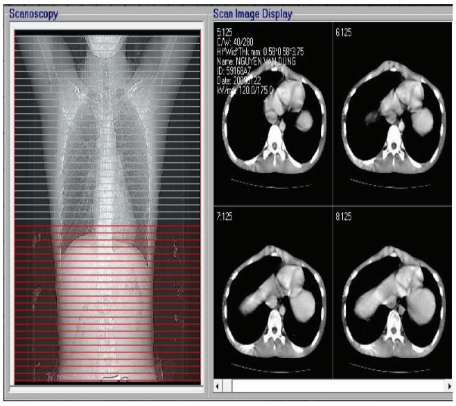

Fig. 8: The standard DICOM image viewer and Medical Image Processing

The system completes the task and set out to become a learning tool, a practice of computer modern tomography system at laboratory of physics biomedical engineering Department of Applied Sciences, Ho Chi Minh City University of Technology.

However, it would be better if we can add adequate shooting modes, including the cases that the head goes in first or the foot first, the emergency mode. The diagnostic helps to find out the problem, and examine the errors of the whole system.

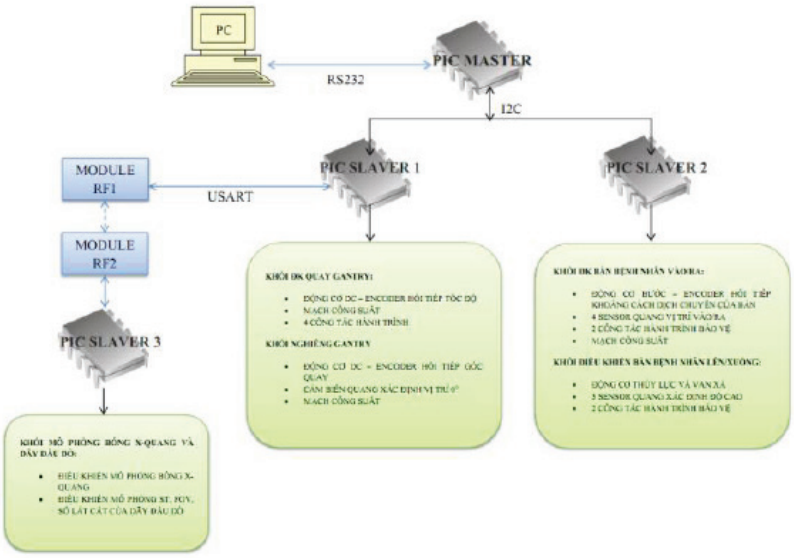

Fig. 9: Block diagram of control software algorithms

4. Conclusion

Based on the objectives and requirements, the system satisfies all of the following: - As a visual teaching tool for teaching the principles of operation and structure of the CT - Scanner.

- Simulating the full operation of computer tomography system in Scanogram mode, Standard, Helical modes according to actual operations, including operation of the software, the operation of the patient table, the tilt rotation of the gantry - and simulation of collected X-ray generator. The system can operate in modes 1, 2, 3, 4 slices simultaneously.

- Completing instructions from the system and using it to create all experiments to train technicians and medical students to operate a system of practical computer tomography as well as multi- slice CT imaging to examine DICOM format and utilization of CT images.

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