E-LEARNING OF FUNCTIONING PRINCIPLES MEDICAL INTRASCOPY SYSTEMS

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Abstract: The questions of creation of virtual educational technical systems are considered as facility of imitation experiment. These virtual systems are usable for teaching of medical intrascopy systems functioning. The virtual educational technical systems allow guarantee the goodness technical training.

Keywords: medical intrascopy systems, virtual technical systems, imitation experiment.

ACM Classification Keywords: K.3.2 Computer and Information Science Education — e-Learning Systems

Introduction

Medical intrascopy systems are up-to-day technical systems, which allow get information about internal structure of human body. Principles of organization and functioning of this equipment are the barest necessity for biomedical engineers. These systems based at high technology of physics, electronics, applied mathematics and computer science. Moreover, these systems are unique, expensive and require radiation safety therefore engineer's training requires tentative explanation of principal modes of operation at simple virtual analogs. As virtual analog e-learning means can be used, because kernel of any intrascopy system is computer. The main difference between e-learning means and real technical system is availability of detector. E-learning means have the virtual detector of certain type. The type of virtual detector is determined by physical phenomena (ultrasound, x-ray etc). On conditions that virtual detector is adequate, then virtual intrascopy system' rest parts are similar to real system.

Objective

There are the main principles of creation of virtual intrascopy systems for educational purposes. The aim is working up of block diagram and their computer-based realization.

Materials and methods

The simulation of bio-object structure allowed creation the object phantom. Also the virtual source built up. The simulation of interaction of phantom and virtual source was used for creation of virtual detector. Finally the synthesis of block diagrams was realized for different e-learning virtual intrascopy systems. E-learning virtual intrascopy systems created as computer systems. The programming environment Borland Delphi 6 and API OpenGL used for creation of special-purpose software.

Design projects and main results

The virtual intrascopy systems are software, which allow have relative structure of the technical system and investigate the process into this system. These virtual systems allow imitation experiments. Such experiments are used for learning: sequence of operations, instrument settings, parameters of malfunction.

There was analyzed, that next consecution of actions was common for all virtual intrascopy systems:

– forming of source;

– interaction of source with the bio-object;

– detection the result of interaction;

– images' reconstruction and visualization.

In compliance with foregoing there were created: virtual ultrasound system, virtual X-ray computer tomograph (CT), virtual radioisotope system.

The virtual ultrasound system. This system is destined for imitation of functioning of ultrasound scanner at A- and B- modes. The block diagram of this system is shown at fig.1.
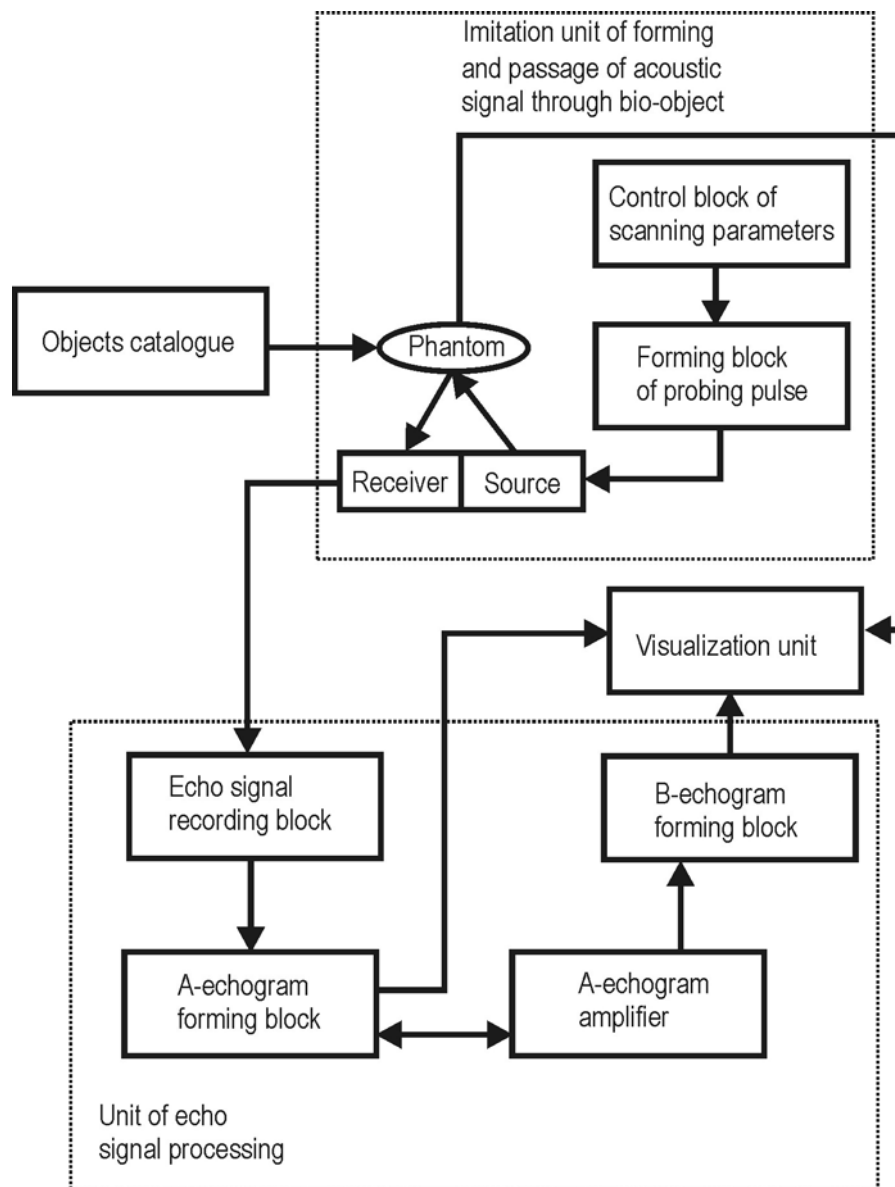
Fig. 1 The block diagram of virtual US-scanner

Objects catalogue. There are the graphic files of phantom slices. The phantom simulates heterogeneous object, where tissues of object have different acoustic impedance. One presented by gray scale.

Imitation unit of forming and passage of acoustic signal through bio-object.. As the virtual source and receiver the linear 1D acoustic grid is used. The dimension of grid element is variable. This unit allows imitate process of acoustic radiation, passage and reflection of one with following detection of reflected acoustic ray. The forming part of this unit allows operate by probing pulse interval and periodicity.

Unit of echo signal processing. There are following parts of this unit: echo signal recording block, A-echogram forming block, A-echogram amplifier, B-echogram forming block.

Visualization unit.. This unit allows visualize A- and B-echograms as at real US-scanner. Moreover virtual US-scanner allows show imitated real-time process.

The virtual CT. This system is destined for imitation of functioning CT of different generations (fig. 2).

Objects catalogue. There are the graphic files of phantom slices. The phantom simulates heterogeneous object, where tissues of object have different density. One presented by gray scale as at X-ray image.
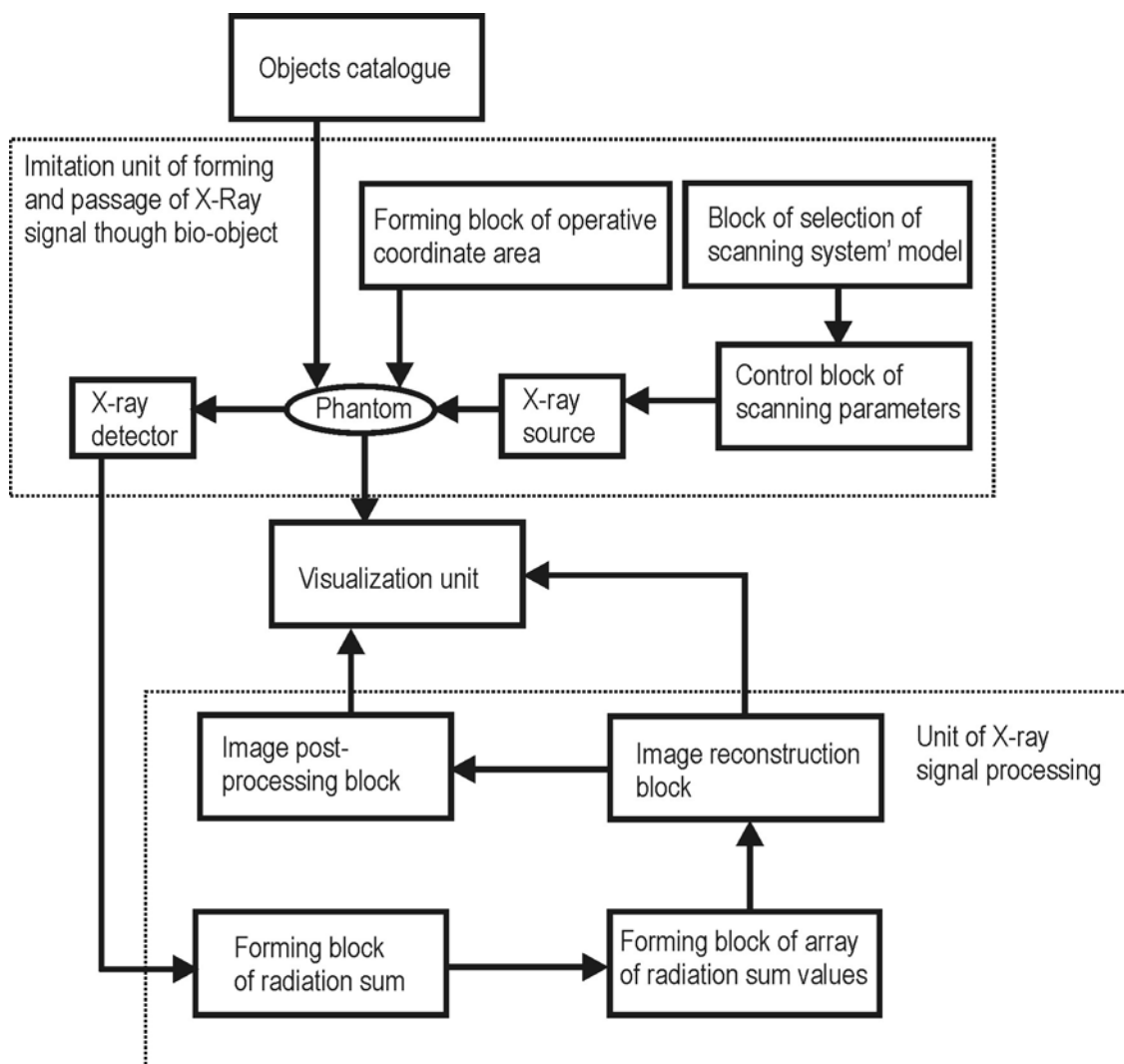

Fig. 2 The block diagram of virtual CT

Imitation unit of forming and passage of X-ray through bio-object.. The forming X-ray block is used as the virtual X-ray source. The kinds of X-ray source (single or fan beam) and detector (single or detector matrix) are selected in accordance with CT generations (block of selection of scanning system' model). The control block of scanning

parameters allows adjust the scanning step and range. The forming block of operative co-ordinates area allows imitate reference of coordinates space to the object.

Unit of X-ray signal processing. There are following parts of this unit: the forming block of radiation sum, the forming block of array of radiation sum values, image reconstruction block (the back projection method), image post-processing block (low-frequency filtering and threshold processing).

Visualization unit.. This unit allows visualize X-ray passage through the object and result of image reconstruction and post-processing.

The virtual radioisotope intrascopy system. This system is destined for imitation of data processing at the radioisotope intrascopy system (fig. 3). As distinct from others intrascopy systems this system is lack imitating units of virtual source and detector. There are two units only: the unit of γ-image processing and visualization unit.
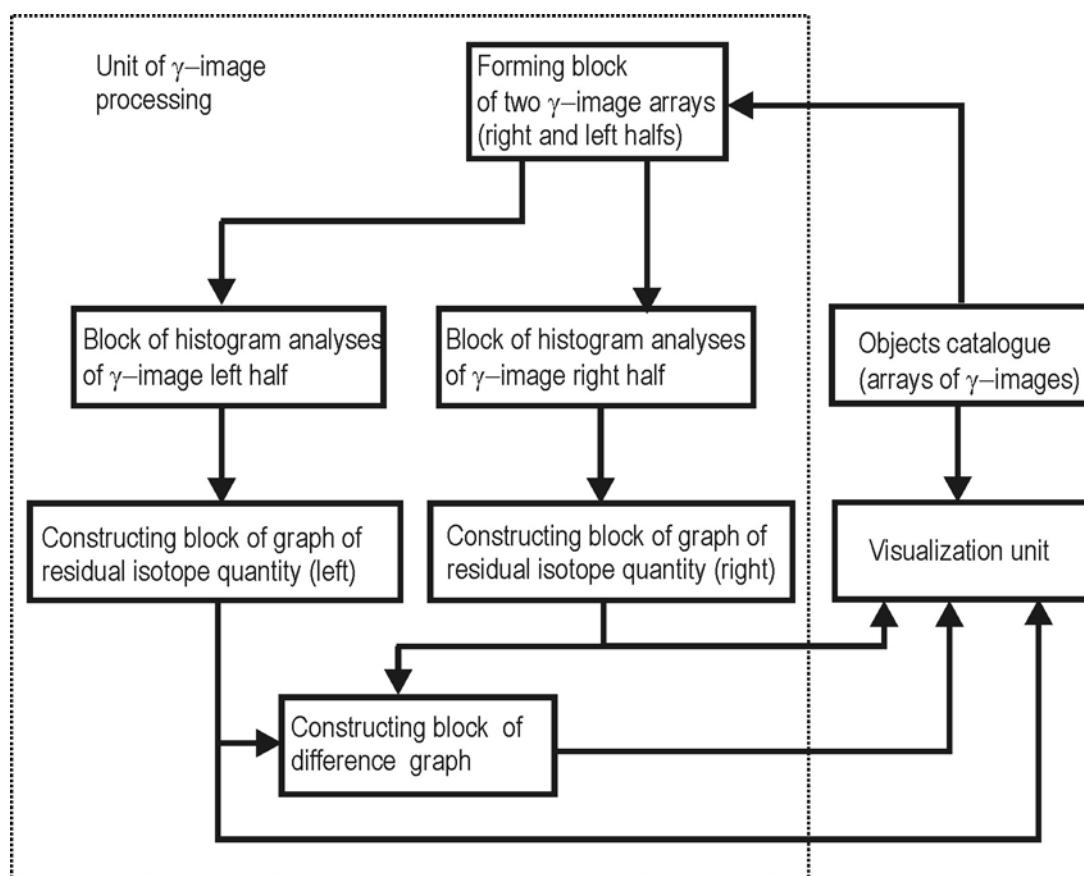

Fig. 3 The block diagram of the virtual radioisotope intrascopy system

Objects catalogue. There are folders with array of graphic files of phantoms and real γ-images, for each examination are p successive frames (at this program $p = 16$).

Unit of γ-image processing. There are following parts of this unit: forming block of two γ-image arrays from initial array, blocks of histogram analyses these arrays, constructing blocks of graph of residual isotope quantity for each half of γ-image and difference graph.

Visualization unit. This unit allows visualize: initial array of γ-image frames, two graphs of residual isotope quantity for right and left image parts and difference graph.

Conclusion

Created virtual intrascopy systems allow carry out imitation experiments. Use of e-leaning means is effective method for training of bio-engineers and physicians. These systems may be additional leaning means at study of any high-end technology apparatus. The perspective of this work is design software for creating virtual operation room with several intrascopy systems and modern surgical tools models for surgical planning. This technology is very actually, for example, for neurosurgery planning. This special software will allow surgeon to simulate operation process and choose small-invasive surgical access.

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