

types of students' activities as 1 point for 2 hours. Attention should be paid to the correspondence of point-rating technology to other systems of assessing students' activity results (table 2).

In the context of the credit-module system "Labour intensity" column in table 1 is of interest – in terms of its correspondence to credit units or credits on the whole for a discipline according to a curriculum and singled out modules. One credit unit is assumed to be equal to 36 academic hours: 1 credit = credit unit = 36 hours.

Conclusion

Complex test as a new component of EMC requires further elaboration to comply with the level of achieving different competences.

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THE EXPERIENCE SOFTWARE-BASED DESIGN OF VIRTUAL MEDICAL INTRASCOPY SYSTEMS FOR SIMULATION STUDY

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Abstract: *The questions of software-based design of "virtual" technical systems are considered as facility of imitation experiment for educational purposes. These virtual systems are usable for analysis of medical intrascopy systems functioning. The virtual educational technical systems allow guarantee the goodness technical training of bioengineers.*

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. The degree of virtual intrascopy system' adequacy depends on selection of presentation medium and software environment.

Objective

The aim is working up block diagrams of virtual intrascopy systems and their computer-based realization as trial learning software.

Materials and methods

The simulation of bio-object structure allowed creation the object phantom. Also the virtual emissive source built up. The virtual source simulates the main physical properties and technical characteristics of some real emissive sources. The simulation of phantom and virtual source interaction was used for creation virtual detector. The synthesis of block diagrams was realized for different e-learning virtual intrascopy systems. E-learning virtual intrascopy systems created as computer systems. The software environment Borland Delphi 6 and API OpenGL used for creation of special-purpose software. This software is created as simplified analogue of application programs which realize adjustment, data processing and visualization at real intrascopy systems.

Design projects and main results

The virtual intrascopy systems are software, which allow have relative structure of the technical system and investigate the process in 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;
- source - bio-object interaction;
- detection the result of interaction;
- images' reconstruction and visualization.

In compliance with foregoing there were created: virtual ultrasound system, virtual X-ray computer tomography (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.

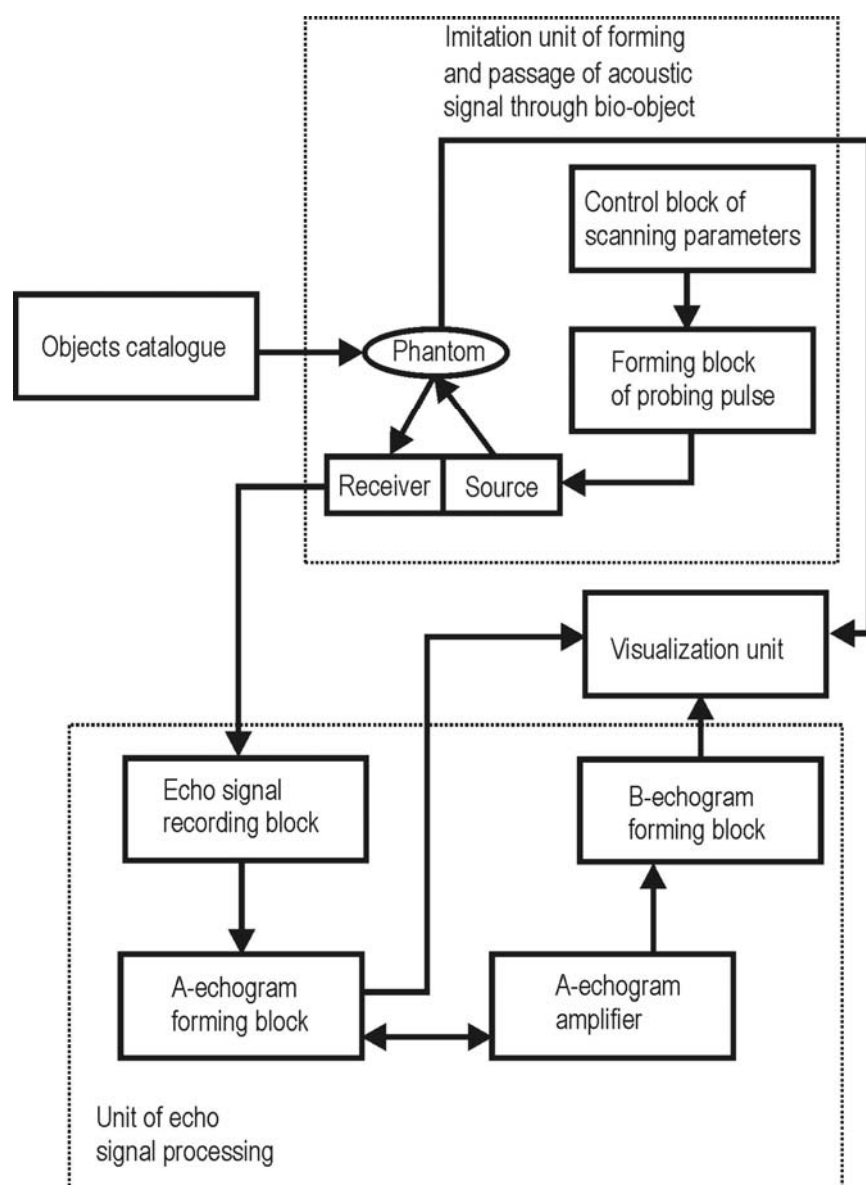


Fig. 1 The block diagram of virtual US-scanner

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 (fig. 2).

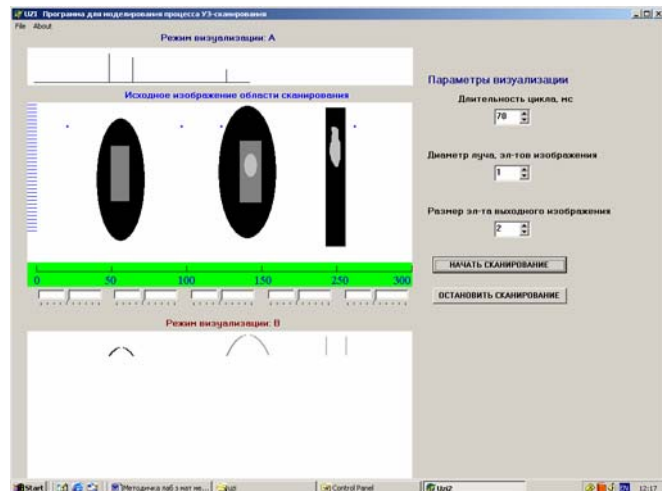


Fig. 2 The visualization of adjustment, scanning and image construction by virtual US-scanner

The virtual CT. This system is destined for imitation of functioning CT of different generations (fig.3).

The software of virtual CT is imitated getting of ray sums' array for one section (slice) of the phantom and reconstruction of section' image by method of reciprocal projection. The block diagram of the virtual CT system is shown at fig. 4.

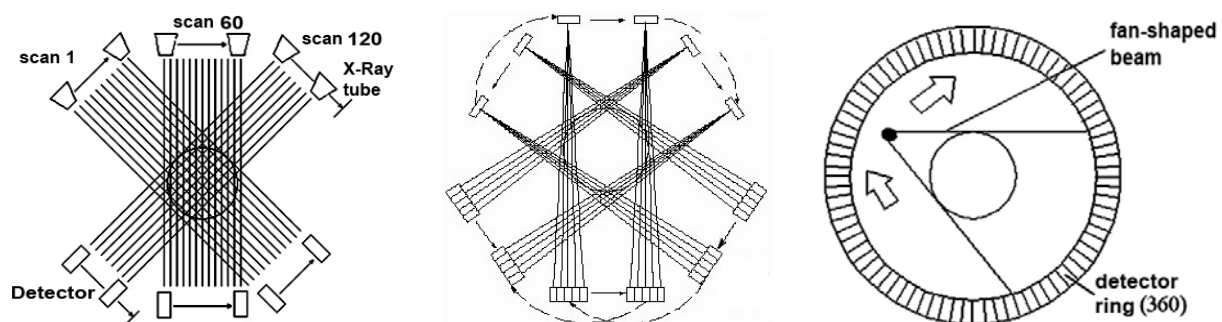


Fig.3 Tomographic scanner variants according to CT generation

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

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 (angle of system' rotation, step of X-ray tube-sensor system displacement). 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 (fig.5).

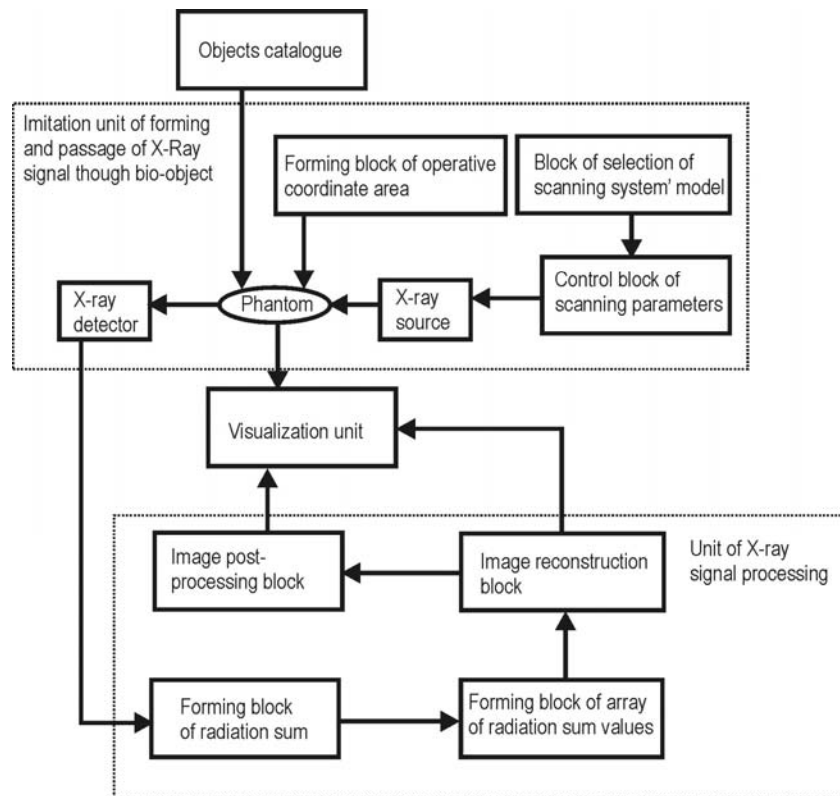


Fig. 4 The block diagram of virtual CT

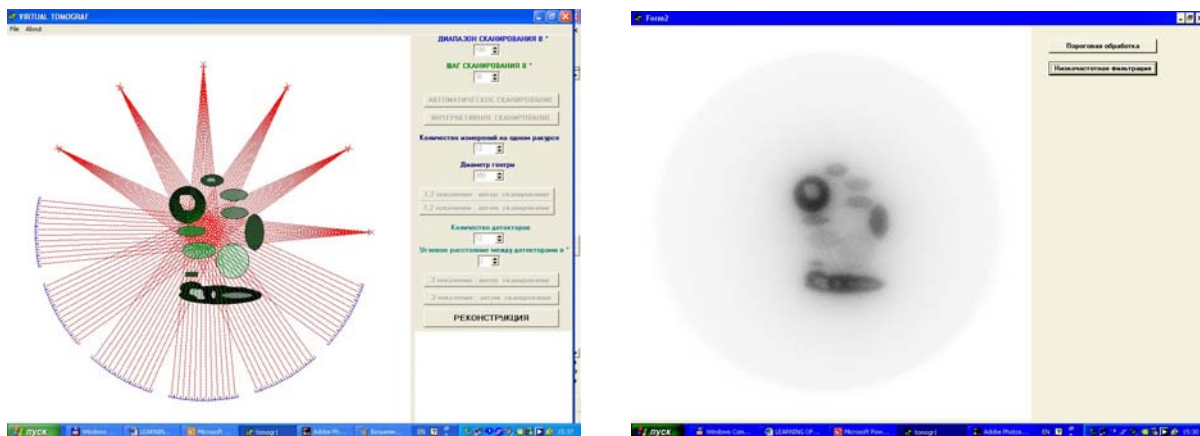


Fig.5 The visualization of adjustment, scanning and image reconstruction by virtual CT

The virtual radioisotope intrascopy system. This system is destined for imitation of data processing at the radioisotope intrascopy system (fig. 6). 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. **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 (fig.7).

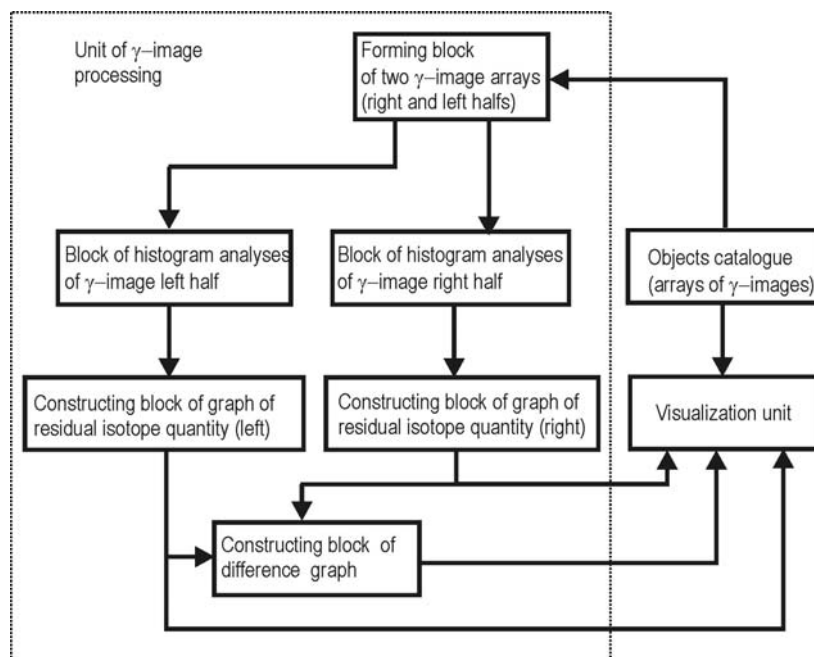


Fig. 6 The block diagram of the virtual radioisotope intrascopy system

Conclusion

Created virtual intrascopy systems allow carry out imitation experiments. Use of e-learning means is effective method for training of bio-engineers and physicians. These systems may be additional learning 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.

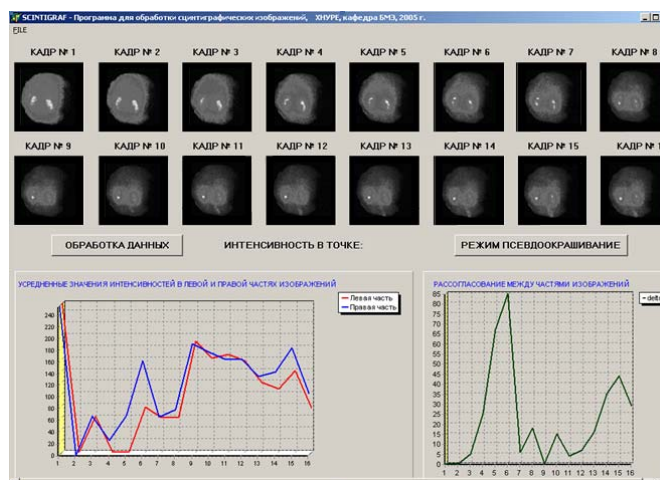


Fig.7 The visualization of kidney γ -image arrays and graphs of residual isotope quantity by virtual radioisotope intrascopy system

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