facilities, research facilities with breast computed tomography (CT) and hospitals with different brands of CT and mammography machines. Furthermore, the database contains a number of anonymized X-ray patient images from tomosynthesis and mammograms, as well as whole body CT sets. Some of the images contain both benign and malignant formations, while others are lacking any kind of pathology. Besides the X-ray images the database also contains two types of breast computational lesion models. The first type is computational breast models, segmented from patient tomosynthesis images realized by using an in-house developed algorithm, while the second type of 3D models is created by applying mathematical algorithm based on a random walk approach. Currently, the database contains more than 70 images from breast tomosynthesis and 4 sets from whole body CT; 2 sets from scanned mastectomy cadavers, 50 segmented tumor models and 100 models generated by a mathematical algorithm. In addition, the database contains more than 50 different entries, which correspond to physical breast phantoms and step manufactured wedges. The developed database provides opportunities to researchers to study and work on improving techniques for early cancer detection.

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In-house optical system for X-ray imaging validation of processes

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Phase-contrast imaging is an imaging technique, which has been investigated a lot during the last 20 years. Its main advantage over the traditional X-ray imaging is the enhancement of the contours of the tissues, thus providing higher contrast between tissues. Three main geometrical acquisition setups are used to achieve this enhancement: (i) free propagation setup with no additional optics added to the system, (ii) grating based-imaging setup, which uses gratings, and (iii) diffraction-based setup, which implements crystals to detect the X-rays deflected at a specific angle. In most cases, these require the use of highly coherent light and thus availability at any time of synchrotron facilities. To advance in this field, the *LCSM* team has built up a custom optical setup to generate phase contrast data in the optical range.

The experimental setup is composed of red light laser (635 nm, 4.5 mW), spatial filtering system, Digital Light Processor (DLP) for object development and a high resolution CMOS camera. The DLP integrated circuit is the DLP3010 of Texas Instruments with more than one million 2 μm in size mirrors. The digital image sensor has a size of 5.70 mm × 4.28 mm and 2592 × 1944 active pixels used to form the image in real time. The current image sending data protocol is based on serial communication. Two software applications were developed under C++ to support the prototype device for: (a) image acquisition, and (b) forming the phase object to be irradiated.

The setup was tested successfully to produce diffraction images of the following objects: a non-transparent five pointed star, a transparent Swiss cross, various gratings, as well as breast lesions. It was proven that the prototype system can produce the famous Arago-Poisson spot behind a non-transparent circle. Excellent results were obtained by reproducing the Young's experiment. The same objects were used with simulation of the chain and then compared to the results produced in x-ray imaging by means of simulations. The developed prototype will be used for validation studies in x-ray phase contrast imaging.

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Evaluation of effective and peak skin dose of patients undergoing interventional cardiology procedures

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Introduction: Interventional cardiology procedures result in substantial patient radiation dose due to prolonged fluoroscopy time and radiographic exposure. These procedures not only lead to significant effective doses for the patient but also can potentially cause deterministic effects on the patient's skin. The aim of this study is to investigate the effective dose and peak skin dose(PSD) of patients during frequently performed cardiology procedures as: coronary angiography(CA) and combined – coronary angiography and percutaneous intervention(CA + PCI) and to evaluate if there is a chance of getting a skin injuries.

Materials and methods: The study was conducted in Military Medical Academy, Sofia on an angiography X-ray system. For each procedure and patient the following data were collected: age, sex, height and weight of the patient, air kerma-area product-P_{KA}, fluoroscopy time-FT, cumulative dose-CD, number of series acquired, as well as some more clinical patient data. The effective dose was calculated by using conversion factors proposed in the literature, using NRPB and Bozkurt coefficients.

Results: The study was conducted with a total of 40 patients – 18 for CA and 22 for CA + PCI procedures. The mean values for P_{KA} and FT were respectively: 55.6 Gycm^2 and 2.9 min. during CA and 136.2 Gycm^2 and 7.4 min. during CA + PCI procedures. The calculated mean values for the effective dose were: 10.0 mSv(NRPB) and 6.1 mSv(Bozkurt) for CA and respectively 27.2 mSv(NRPB) and 17.7 mSv(Bozkurt) for CA + PCI procedures. PSD of the patients varied between 0.3–0.8(mean value-0.5)Gy for CA and 0.4–1.7(mean value-1.0)Gy for CA + PCI procedures.

Conclusions: The estimated effective dose of patients in both the procedures showed that there is a minimal risk of occurance of stochastic effects. After the current study it was concluded that there are no patients with PSD larger than the trigger level set (3 Gy). A more extensive estimation of the patients dose is going to be done in order to evaluate if there is an additional risk of getting a skin injury.

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A software application for grating design dedicated to optical imaging: Preliminary results

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Introduction: Grating-based phase contrast mammography imaging reveals great potential in screening and diagnosing the breast cancer. To optimize an imaging setup, a detailed modelling of the individual components of the system: X-ray source, detectors, gratings and breast phantom is needed. This paper presents an approach for preparing different gratings dedicated to phase contrast mammography imaging and their use with optical imaging setup. The focus is given to the design parameters of the gratings setup: composition, periodicity, structure and dimensions of the gratings.

Materials and methods: For this purpose, we created a software application that generates 2D images, representing diffraction gratings. The windows-based application is written in C#. It consists of tools that facilitate modelling the parameters of the gratings, as well as such to access the file system so the user can choose where to store the generated diffraction grating. Further on, the obtained grating is being projected onto a digital micro mirror device (DLP3010), with a square pixel size equal to approximately 5 μm. FPGA based CMOS camera (pixel size of 2.2 μm) is used to capture the diffracted from the gratings image. Modelling parameters are: (i) width and height of generated image that is used by the DLP to create the grating (default values are 1280×720 pixels); (ii) slit width in pixels; and (iii) barrier width in pixels.

Results: The result of using the software application is a bitmap image containing the grating pattern. The image has black and white vertically arranged lines. White lines represent the slits where the beam can pass through, and the black lines represent the barriers that stop the beam. The generated image can be projected onto the DLP chip and then it can be irradiated in order to create diffracted beams. In this manner, the DLP turns out into dispersive element, which allows easy handling in order to create desired patterns.

Discussion and conclusions: By using the developed software application and digital micro-mirror device, we are able to create a variety of diffraction gratings in order to be used for testing and optimization of new imaging techniques. The approach proved to be cost-effective and time-efficient. The next step is simulating a 3D diffraction grating, as well as modelling the propagation of the waves through the modelled optical system.

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