breast self-check, looking for any changes in the size, shape, color, any distortion, swelling, etc. With the final implementation of this mobile application, it is expected the Bulgarian users to get more informed about the importance of breast screening and understand the importance of breast prevention activities.

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## 3D printing of anthropomorphic breast phantoms dedicated to research of X-ray image modalities

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Physical phantoms are a basic tool for the assessment and verification of performance standards in daily clinical practice of X-ray imaging modalities. Most of the physical phantoms have a homogeneous background with inserted test objects. For research purposes, many of the existing phantoms should be developed to a next degree of sophistication in order to mimic the real objects more closely in terms of radiographic and anatomical properties. The development of 3D printing technologies opens potentially new possibilities for phantom manufacturing. The aim of this study is to explore the absorption properties of common 3D printing materials such as resins, PLA, ABS, etc. and to estimate their potential for production of the anthropomorphic phantoms. To achieve this goal, step-wedge phantoms were computationally modeled and then manufactured using two popular 3D printing technologies: stereolithographic and fused-deposition modeling. X-ray images of the phantoms were acquired, using monochromatic beam at ID17, ESRF, Grenoble for three energies – 30 keV, 45 keV and 60 keV. Experimental data were further processed to obtain the linear attenuation coefficients of these materials. Comparison with theoretical data for the linear attenuation coefficients for breast tissues was performed. Based on the results, several breast anthropomorphic phantoms were manufactured. Finally, a practical approach for printing anthropomorphic phantoms has been established and verified. From the studied materials, most of the resins, Hybrid, PET-G show absorption properties close to the glandular tissue, while ABS shows absorption characteristics close to these of the adipose tissue. It allows the production of complex shapes, which are very advantageous for the case of breast phantoms.

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## Protection of personnel and patients in diagnosis and therapy with ionizing and non-ionizing radiation

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Most of the sources used in physiotherapy use pulse magnetic fields; spark-discharges; radiofrequencies (RF); direct and low-frequency electric currents, electrical pulses; ultraviolet (UV) and infrared (IR) radiation; broad-spectrum lamps; lasers. The most relevant diagnostic sources are MRI scanners emitting static magnetic field, low-frequency fields, RF. The exposure of medical personnel to NIR depends on the type of transmitter, irradiation power, mode of operation, specific application, access of medical personnel to the treatment zone, shielding of the source and workplace, time duration of exposure.

Devices for electric current therapy like pulses, ionophoresis therapy, vacuum therapy, emit magnetic field less than several μT. The devices for subthermal therapy emit RF energy up to 9,8 W/kg, compared to 0,4 W/kg basic restriction for whole body exposure. The average daily dose of the staff at 10 patients per day is 18,356 $(V/m)^2 \cdot h$. The dose of medical personnel in protective chambers averaged per patient is $W_E = 23{,}88\ (V/m)^2 \cdot h$.

Regard to MRI equipment, the basic restrictions for static magnetic field for normal operating conditions exceed the action values for people at specific risk, also for risk of attracting ferromagnetic materials. In the case of the use of optical sources, power densities exceed the exposure limit values, and therefore the permissible stay is limited to minutes and seconds, and in some cases it is inadmissible. In cosmetic centers, sanatoriums and SPA centres, power densities are significant and some of them are not controlled (tanning beds and IPL systems).

The laser systems applied in physiotherapy are mainly class 3R (visible range), which only pose a risk to the eyes, in some cases 1C. For some procedures, lasers of class 3B are also used which cause risk to the eye by intra-beam viewing as well as diffuse reflected radiation. In cosmetic centers where specific lamps and high class (4) lasers are used, there is a risk for serious skin burns and eye damage.

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## Professional realization of specialists in medical sanitary physics and sanitary engineering

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In Bulgarian legislation there are basically two medical specialties for physicists and engineers:

- *medical radiological physics*
- *medical sanitary physics*

In addition, for engineers, architects, environmentalists, the main medical specialty is:

- *Sanitary engineering.*

Here, we focused only on the specialties *medical sanitary physics*and*sanitary engineering* that are important for the prophylactic medicine.

These training courses last for 3 years, and trainees receive the highest degree of competence in the field of *measurement and exposure assessment of physical factors, risk evaluation and management, possible health effects of ionizing and non-ionizing radiation, methods for prevention.*Simultaneously, they are trained in the field of *occupational and environmental health concerning human exposure to physical factors.*Such, they are the best specialists for medical units dealing with imaging and medical treating using non-ionizing radiations (NMR, ultrasound, UV and IR radiation), for the health control bodies of the working and living environment, for ecological expertizes, for occupational health services. Unfortunately, most of them are requalified as medical radiological physicists and other professions or they are leaving the country because of better incomes and respect.

The BSMPE made big efforts to endorse these specialists in appropriate medical units but without any success: most of the medical units hire incompetent persons without the necessary qualification.

Our opinion is that BSMPE should put the question for the professional realization of such specialists in the right places, and to propose changes in the legislation providing in this direction.

The first step should be changes in the definition of *medical physicist*according to the broader definition of IOMP. Next, the legislation should include requirements for qualification of medical sanitary physicists and engineers for working in hospitals, medical/cosmetics/SPA centres, physiotherapy, NMR, occupational health services, control bodies of health, environment, labour ministries, accredited laboratories, occupational safety bodies, administration (ecological evaluation).

This requirement is set, also in EU Directives 2013/35/EC and 2010/25/EC for protection of workers exposed to electromagnetic fields and optical radiation.

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## Channelized Hotelling Observers and their application in measuring human performance

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The main goal of this work is to demonstrate how a Channelized Hotelling Observer works, to show its application and value in the field of medical physics and also, to highlight its advantages over other observers. Channelized Hotelling Observers are a variation of the Model Observers, which are applicable with 3D tomography for detection of masses. During image quality assessment, the classifier needs to make a decision concerning that specific image. This decision can be most likely one of two possible cases – "signal absent" and "signal present". These decisions represent the result, generated as a response to the input image. For this purpose, the widely used 4-Alternative Four Choice (4AFC) algorithm is applied, where one trial consists of a batch of four images – one from "signal present" and three more from "signal absent". If the system has correctly classified the image as "present", this is counted as a "hit", otherwise it is a "miss". This way, the final success rate of the observer is computed as the number of hits over the number of trials. These observers also have a channel mechanism, which reduces the dimensionality of the explored images. However, there is a need to be a tuning phase for the channels, with regard to the task. The next phase of the implementation is training. Here, an expected signal is compared to the covariance of the images, which results in a signal template. Due to the lack of a sufficient number of images, often they are used in both training and evaluation phases. The final "reading" phase (evaluation) involves two main features – observer reproducibility for various lesions and dose level estimation.

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## Creating a prototype of a robotic human hand for people with permanent disabilities

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Robotics is the technology of designing, constructing and exploiting robots with major applications. One such application is to use robots in assisting people with physical disabilities. The goal of this work is to create a prototype of a robotic human hand. The basic components used in designing the hand prototype are Arduino UNO based on ATMEL microcontroller development board, breadboard for easy assembly of electronic circuits, jumper cables, 3D printed components from PLA and ABS, servo motors, reinforced cord, linking elements and other elements for stability of the prototype. For printing the 3D hand model, a 3D fused-deposition modelling printer with two plastic printing materials, PLA and ABS, was used. The software solution for controlling the fingers and the basic safety of overturning/under-turning the fingers is C-based. The program was compiled and uploaded using the built-in IDE for Arduino. The project was completed in a 2-months period time. The result is a working and anatomically correct prototype of the human hand. Presently, the prototype can simulate normal contraction and relaxation of the fingers digitus quartus manus and digitus minimus manus, also known as the ring and pinky finger. This initial development is used as a base for a large scale project for creating a modern and functional design of robotic human hand. Depending on the patient needs, an individual model will be designed, allowing customization, depending on the patient's age, size and other factors, and will be produced.

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## Skin dose color mapping system in interventional radiology and cardiology

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The interventional radiology is among the fast-developing medical imaging modalities. There is an increase in the number of performed interventional procedures and the radiation-induced skin reactions became a concern. The type and degree of skin reaction depends of the absorbed skin dose. The National Cancer Institute (NCI) has established a skin reaction grading system, which classifies them according to the severity of the skin reaction, ranging from 1 to 4, with 1st grade being the least severe and 4th the most severe. The purpose is to (1) present the benefits and the limitations of available