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Modeling of tumor growth: Preliminary developments

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The aim of this work is modeling the growth of three-dimensional tissue lesions, whose models and X-ray images are of crucial interest in research activities dedicated to improving diagnostic imaging of the mammary gland. The starting point is to model a section of a human tissue as composed of cells with anatomically true dimensions and location. The modelled healthy tissue is initially visualized and then the user triggers the lesion growth. The focus of the software application is the growing process of the tumor formation modelled as a process of gradually conversion of neighboring healthy cells to abnormal such. As a consequence, the healthy cells undergo transformations and change their properties to abnormal ones. The geometrical primitives used to model the cells are spheres. The sphere is a quadric surface and is easily visualized by exploiting the OpenGL library. The program is written in the C++ programming language and run under Windows platform. The application starts with the initialization of a tissue segment, approximated as a parallelepiped with a size, set by the user and filled with healthy cells with a specific radius ($6 \mu m$). One of these cells is then randomly sampled to become abnormal and the abnormal process begins. The cells when turning their properties to cancerous are also visualized in the three-dimensional space where they can be examined closely. The modeled tumor formations are intended for use in X-ray imaging research. Both, computational models and images are dedicated for developing of CAD applications for cancer detection and characterising, for development of machine learning algorithms to classify human breast tissues, as well as to speed up the development and optimization of new diagnostic procedures based on X-rays.

Realistic breast phantoms with segmented real tumour formations from tomographic images

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A common approach in the development and improvement of diagnostic imaging techniques is the use of anthropomorphic phantoms. These phantoms can be physical or computational. In this study the creation of computational breast phantoms with included pathological formations is presented. The creation of the realistic phantoms is achieved by utilizing real patient data in the form of tomographic images. The 3D tumour models are generated by segmenting the regions containing tumour formations in the patient images. The segmentation is performed with a developed software tool based on a semi-automatic algorithm, which makes use of a series of image processing and region growing techniques. The software tool also provides the user an opportunity for corrections after the automated segmentation. Then the acquired flat images are stacked in a 3D voxel matrix. Creation of the computational healthy breast model as well as the compression procedure is achieved with a software tool called *BreastSimulator*. The healthy breast model and the segmented tumour formation are then interactively combined with a software tool called *XRAYImagingSimulator*. While the user can select a location for the tumour formation, also an automatic software processing is applied for integration between the two computational models. The simulation procedure for acquiring tomographic images from the created realistic breast phantom with included tumour formation is performed with the *XRAYImagingSimulator* software tool. Finally, the acquired simulation images are reconstructed with a software tool called *FDKR*. The combination of mathematical models of the breast and tumour models segmented from real patient data leads to the creation of realistic breast phantoms, which can be used in X-ray imaging simulation studies. The presented approach gives an opportunity for generation of multiple cases of breast cancer; thus allowing for further progress in already existing software models and techniques in diagnostic imaging.

Testing of lead clothing in X-ray department

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Purpose. To test and implement a simple approach for examination of the suitability of the lead clothing used for protection of the staff in X-ray departments.