THE ROLE COMPUTER AIDED DESIGN (CAD) IN MEDICINE

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Annotation. Advances in bioinformatics, mathematical methods in biomedical science, and advances in computer and communications systems and networks are leading to the emergence of high-performance medical technologies and general medicine now and in the future. There are several standards for working with medical imaging today.

Keywords: computer aided design, computer aided manufacturing, medicine, diagnostic methods.

РОЛЬ КОМПЬЮТЕРНОГО ПРОЕКТИРОВАНИЯ (САПР) В МЕДИЦИНЕ

Аннотация. Достижения в области биоинформатики, математических методов в биомедицинских науках, а также достижения в области компьютерных и коммуникационных систем и сетей ведут к появлению высокоэффективных медицинских технологий и общей медицины сейчас и в будущем. На сегодняшний день существует несколько стандартов работы с медицинской визуализацией.

Ключевые слова: автоматизированное проектирование, автоматизированное производство, медицина, методы диагностики.

Progress in the development of bioinformatics, mathematical methods in biomedicine, the development of computer and telecommunication systems and networks determine the appearance of present and future high medical technologies and medicine in general. To date, a number of standards for working with medical images have already been created. By analogy with CAD / CAM (computer aided design and computer aided manufacturing) systems for technical applications, CAD (computer-aided diagnosis) systems are also being developed for medical purposes. Some of them are already successfully functioning, but so far, such systems are just "assistants" to the diagnostician who makes the decision. Algorithms of CAD-systems of medical images, as a rule, include image segmentation, selection of objects of interest (“masses”), their analysis, parametric description of selected objects, and their classification. Classification of objects of interest can be carried out using the methods of neural networks, support vectors, discriminant analysis, etc. CAD systems significantly increase the efficiency of radiation diagnostic methods. However, the practical application of radionuclide diagnostic methods demonstrates the continuing lack of information in algorithms and programs that provide visualization and analysis of medical images. This is especially noticeable when using radionuclides that do not have a high specificity of accumulation in pathological foci. These include the method of osteoscintigraphy.

Planar whole-body scintigraphy with phosphate complexes labeled with 99mTc is widely used in the diagnosis of skeletal metastatic disease. By binding to hydroappatite crystals, phosphate complexes reveal tumor-associated osteoneogenesis and make it possible to detect a metastatic lesion of the skeleton long before the appearance of pronounced local demineralization and bone destruction, which is recorded during X-ray examination. At the same time, various pathological processes in the skeleton, as well as metastases, are manifested by polymorphic foci of hyperfixation (HF) of the radiopharmaceutical (RP). Despite the fact that bone scintigraphy is the method of choice in the early diagnosis of skeletal metastases of tumors prone to skeletal damage, the interpretation of scans in cancer patients presents significant difficulties. Early diagnosis of metastatic lesions of the skeleton has a very significant impact on the choice of tactics for the treatment of patients with malignant neoplasms. In this regard, it is necessary to search for approaches to optimize the analysis of scintigraphy results. The use of CAD analysis could significantly increase the specificity of bone scintigraphy. However, works on the use of CAD systems in skeletal scintigraphy are rare and are performed only abroad.

When using the Mimics program, slice files are processed in a semi-automatic mode. The program allows you to select the desired areas on the images of tomograms in accordance with their color (grayscale). Each color on the tomogram corresponds to a certain value of the density of a human tissue or organ. Therefore, by choosing a density interval, it is possible to isolate the required human tissue or organ. If you use a CAD-computer-aided design system such as SolidWorks, then the images of cross-sections are loaded into the program one by one, and the operator manually traces the desired contours and creates flat sketches. The resulting set of sketches is used to create a three-dimensional solid model of the object under study. Both in the first and in the second case, building a model is impossible without eliminating artifacts, roughness and uneven terrain. If we consider these two methods from the point of view of the suitability of the constructed geometric model for numerical calculations and finite element modeling, then the second method is more preferable, since when it is used, the output is a three-dimensional geometric model of the object under study, which consists of a volume, its surfaces bounding, lines and points. Only in this configuration, a three-dimensional computer geometric model is convenient for further processing, editing, setting boundary conditions, and creating a computational grid. In the case when the Mimics program is used to create the geometry of an object, either a set of computational grid nodes or a set of surfaces bounding the object are obtained. Both of these options turn out to be inconvenient both for setting the boundary conditions and for creating a finite element mesh. Modeling in any finite element software package is carried out according to the standard scheme. The algorithm for solving the problem by the finite element method consists of choosing a mathematical model, when the need to select the appropriate finite element is implied or it is required to set differential equations that describe the process under study, creating or importing a geometric model, entering material properties, boundary and initial conditions and parameters, splitting the model into finite -element grid, solutions and processing of the obtained results.

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