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XV МІЖНАРОДНА НАУКОВО-ТЕХНІЧНА КОНФЕРЕНЦІЯ ФІЗИЧНІ ПРОЦЕСИ ТА ПОЛЯ ТЕХНІЧНИХ І БІОЛОГІЧНИХ ОБ'ЄКТІВ

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3D RECONSTRUCTION OF ANATOMICAL STRUCTURES USING RAPID PROTOTYPING FOR MEDICAL APPLICATIONS

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Currently, reconstruction of anatomical structures using rapid prototyping for medical purposes is necessary. The work is dedicated to the analysis of the process of the anatomical structures reconstruction. We shows an example of airways and sinuses reconstruction using the tomogrpahy data of the head. A promising direction for future research is the development of the model of the anatomical structures with different pathologies and deases. Also is necessary to improve a quality of the model at different points of view: the properties of material must be very close to real and the geometric structure of the model should be very precise.

Key words: prototyping, surgery, planning, reconstruction, training

В настоящее время, реконструкция анатомических структур с использованием трехмерного прототипирования является важной задачей. Работа посвящена анализу процесса реконструкции анатомических структур. В работе показан пример проведенной реконструкции воздухоносных путей и пазух на основе томографических данных головы. Перспективным направлением исследований является разработка моделей анатомически структур с различными патологиями и заболеваниями.

ACTUALITY OF WORK. Surgery is one of the most challenging and important profession. Experience the surgeon directly affect on the outcome of surgery, namely on the life of the operated patient. Specialist training in surgery takes a long time, but at the same time, the surgeon during the whole medical practice must to improve their skills. Given the fact that the direct surgical intervention is associated with risk to life of the operated patients, educational opportunities for surgeons are severely limited. Also, it is necessary to take into account the fact that, during the complex, non-standard surgical procedures the surgeon has no room for error, and can not "undo" already committed surgical manipulations. Therefore there is a need for tools that provide both medical training and preoperative planning. Such means may be as virtual as physical.

Using of the real physical object has its advantages, in comparison with the virtual, the most important of which is the natural manipulation for the learner. Construction of the physical simulators is mainly related to the complexity of reproducing of geometry of anatomical structures. In addition, the reconstruction should be highly accurate for preoperative planning. This is made possible with the advent of three-dimensional printing technology [1-3]. Thus, the main purpose of the work was to study the possibilities of using the three-dimensional printing technology for full-scale tasks preoperative planning and training [4, 5].

MATERIAL & RESULTS. We used the printer WANHAO Duplicator i3 (Fig. 1). Technical specification is shown in table 1.

Table 1 – Technical Specifications

Printing technology	Fused Filament Frabrication
Build volume	200 x 200 x 180 mm
Layer resolution	0.1 – 0.4 mm
Positioning accuracy (X)	0.012 mm
Positioning accuracy (Y)	0.012 mm
Positioning accuracy (Z)	0.004 mm
Nozzle diameter	0.4 mm
Print and travel speed	10 – 70 mm/sec

The initial data is a set of computed tomography (CT) slices of the head with the airways structures (fig. 2).

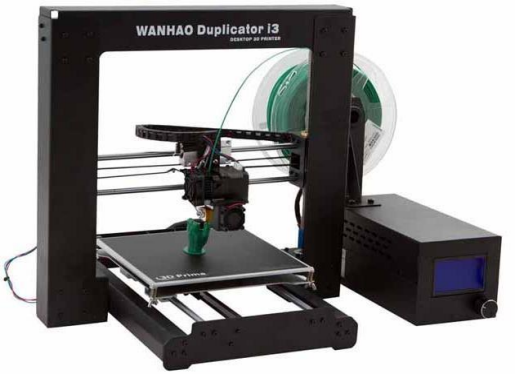


Figure 1 – 3D printer WANHAO Duplicator i3

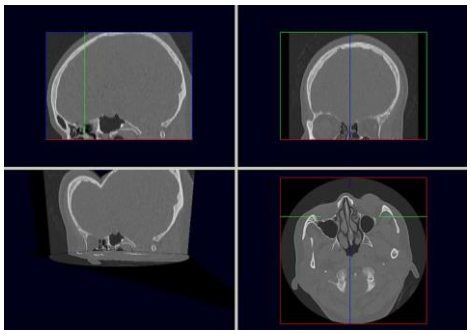
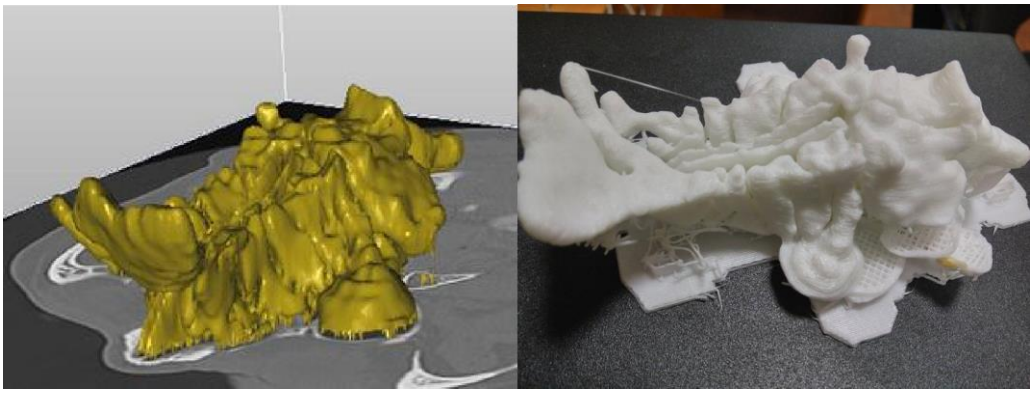


Figure 2 – An example of input dataset

The volume was subjected to segmentation, based on the scale of the X-ray density of Hounsfield, with the aim of isolating of the airways structures and sinuses. In the next step, three-dimensional model (Fig. 3 a) is reproduced using three-dimensional printing technology (Fig. 3 b).



a b

Figure 3 – Example of the 3d reconstruction : a – virtual 3d model; b – printed model

CONCLUSIONS. The study examined topical issues relating to the use of rapid prototyping technology for the reconstruction of anatomical structures on the example of the airways and sinuses of the human by tomographic data [5].

The work shows the serial process for physical reconstruction of structures. The reconstructed model of the airways and sinuses corresponds to the virtual model which is based on the tomographic data [5,6].

The results show wide possibilities of using the three-dimensional printing technology applied to medical problems.

A promising direction for further research is the development of advanced specialized software, providing software reconstruction otorhinolaryngological structures, according to the tomographic studies, in relation to the three-dimensional printing.

At the same time the software should ensure the construction of anatomical models, taking into account the structural features of the reconstructed structures. In addition, necessary to increase the realism of constructed models which should be as close to both the geometry and material properties of anatomical structures.

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