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3D PRINTERS IN MEDICINE, IT PRESENT AND FUTURE

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Abstract. This article is devoted to modern technologies in medicine and exactly to the technologies of 3D printing. The creation of 3-D printing back in 1984 brought the promise of a new age in manufacturing. Although it has only begun its takeoff, there is already so much we are able to do with the technology. From building screwdrivers to chairs to cars, the possibilities are endless. More importantly, however, is the impact of 3-D printing in medicine. In the past few years, biomedical engineers and physicians alike have realized that 3-D printing can make surgery, bone replacement, organ transfers, and other procedures a whole lot easier and more effective.

Introduction. 3D printers were invented about thirty years ago, but society has recently started meeting them. In past some 3D printers worked very slowly and were very expensive. However, there are a lot of models of 3D printers which have high speed of working and available price at the moment. Technologies of 3D printing become more and more popular. Nowadays they take a great part in medicine of present and future. In the past few years, biomedical engineers and physicians have realized that 3-D printing can be used in surgery, bone replacement, organ transfers, and other branches of medicine.

History. History of 3D printers has been started around in 1980. The first published account of a printed solid model was made by Hideo Kodama of Nagoya Municipal Industrial Research Institute in 1982. The first working 3D printer was created in 1984 by Chuck Hull. Continued invention was required to push the technology further into full commercial use. Chuck and his team had to overcome several challenging problems as they unit with hydrodynamics and chemistry. “3-D printing isn't easy. You see a machine, you think it's straightforward and easy, but it's not. It takes a long time to figure out technically”, said Chuck Hull. During hard developing he had published a number of patents on the concept of 3D printing, many of which are used in today’s additive manufacturing processes.

In two decades, 3-D printing has grown from a niche manufacturing process to a $2.7-billion industry, responsible for the fabrication of all sorts of things: toys, wristwatches, airplane parts, food. Now scientists are working to apply similar 3-D–printing technology to the field of medicine, accelerating an equally dramatic change. But it's much different, and much easier, to print with plastic, metal, or chocolate than to print with living cells.

Technologies of 3D printing with living cells have developed quickly and in 1999 group of scientists from Wake Forest Institute for Regenerative Medicine implanted lab-grown organ in human. When young patients undergo urinary bladder augmentation using a 3-D synthetic scaffold coated with their own cells. This knife opened the door to developing other strategies for engineering organs, including printing them. Because they are made with a patient’s own cells, there is little to no risk of rejection.

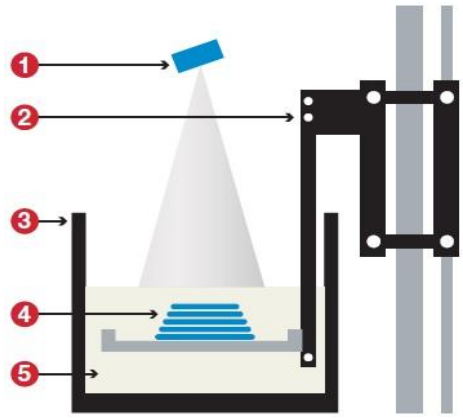
In the new millennium scientists engineer a miniature functional kidney that is able to filter blood and produce diluted urine in an animal.

In 2008 scientists implanted a 3D-printed prosthetic leg, with all parts: knee, foot, and socket. It printed in the same complex structure without any assembly.

Bioprinting innovator Organovo, relying on Dr. Gabor Forgacs's technology, uses a 3D bioprinter to print the first blood vessel in 2009.

In 2012 year scientists in the Netherlands use a 3D printer made by LayerWise to print a customized three-dimensional prosthetic lower jaw. It is subsequently implanted into an 83-year old woman suffering from a chronic bone infection. This technology is currently being explored to promote the growth of new bone tissue.

3d the printers in work. 3D printers work like inkjet printers. Instead of ink, 3D printers deposit the desired material in successive layers to create a physical object from a digital file.



Picture 1 – 3D printer device

A laser source sends a laser beam to solidify the material (1). The elevator raises and lowers the platform to help lay the layers (2). The vat contains the material used to create the 3D object (3). Advanced 3D printers use one or more materials, including plastic, resin, titanium, polymers and even gold and silver (4). The 3D object is created as parts are layered on top of each other (5). This 3D object printed due to virtual design, which is made in a CAD (Computer Aided Design) file using a 3D modeling program (for the creation of a totally new object). To prepare the digital file created in a 3D modeling program for printing, the software slices the final model into hundreds or thousands of horizontal layers. When this prepared file is uploaded in the 3D printer, the printer creates the object layer by layer.

The 3D printer reads every slice (or 2D image) and proceeds to create the object blending each layer together with no sign of the layering visible, resulting in one three dimensional object. Construction of a model with contemporary methods can take anywhere from several hours to several days, it depending on the technologies used and the size and complexity of the model.

Present of the 3D printers. Approximately 18 people die every day waiting for an organ transplant. But that may change someday sooner than you think – thanks to 3D printing. Scientists from based bio-printing company Organovo will unveil the world's first printed organ – a human liver. Also British surgeons were able to use 3-D printing to reconstruct a man's entire face. By taking an image of the half of the man's face that wasn't destroyed, scientists were able to recreate an identical copy to replace the destroyed half. The amazing element of their achievement is that they were able to create a precise and perfect copy of the man's face, making it seem as if almost nothing happened once the surgery was complete. In order to rely less on immunosuppressant drugs, scientists are now using samples of the patient's own cells to construct the material necessary to build the organs.

Using 3D printing has given us the reproducibility and the automation needed to scale up in medicine. Medical solutions will be more customized for individual patients. 3D bioprinting will allow for the cells placed in predetermined patter to replicate human tissues, organs, and blood vessels. With 3D printers potentially eliminate the need for organ donors. Also it may provide doctors and surgeons with on-demand human tissue and scanning device will examine limbs and provide a detailed computer image that can be sculptured.

Future of the 3D printers. Conclusion. There are many implications for the future of medicine with the recent spike in 3-D printing advancements. Not only does it aid current surgeons in effectively transplanting organs/other parts, but it also helps medical students practice their

surgical skills. Now, biomedical corporations are able to create "ultra-realistic" 3-D printed organs and other parts that almost perfectly mimic the texture and structure of actual body parts. The plastic used in these parts can be made using several textures, shapes, colors, and degrees of sturdiness. The relative ease in creating these "parts" makes the practice faster, cheaper, and globally available. Whether it is performing heart surgery, removing tumors, or carrying out a knee replacement, the existence of such materials exponentially expands the frontiers of medical research.

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РАЗРАБОТКА ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ ДЛЯ КАРМАННОГО ЭЛЕКТРОКАРДИОГРАФА

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SOFTWARE DEVELOPMENT FOR PORTABLE ELECTROCARDIOGRAPH

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This article describes the software development process of portable electrocardiograph and the results of data collection with it.

Целью работы является разработка программного обеспечения для карманного электрокардиографа. Карманный электрокардиограф предназначен для индивидуального использования человеком с целью отслеживания и выявления заболеваний сердца в домашних условиях. Подобное наблюдение за сердцем необходимо для людей, которые, прежде всего, уже перенесли различные заболевания сердечно - сосудистой системы, например в постоперационный период, а также для людей, склонных к подобным заболеваниям. Использование прибора также поможет обнаружить заболевания на ранней стадии.

Программное обеспечение построено на базе операционной системы (ОС) реального времени *FreeRTOS v4.7.2* [1]. Благодаря использованию ОС удалось сократить время разработки посредством создания соответствующих задач [2]. Для контроля задачи имеются специальный набор *API* функций, описание которых можно найти на официальном сайте *FreeRTOS* [3]. В электрокардиографе было создано 6 задач для организации необходимого функционала в приборе.