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Mechatronics in Medicine

Аннотация

Цель данной статьи - рассказать о странах, изготовляющих механизированные устройства, а также объяснить их достоинства, область применения роботизированных устройств в процессе медицинских операций и способы управления. Также рассмотрен способ их применения в медицине.

Ключевые слова: роботы, роботизированные устройства, микротехнологии.

Abstract

The purpose of this article is to tell about the countries producing mechanized devices, the scope of robotic devices in the process of medical operations and management methods. Also the way of their application in medicine is considered.

Keywords: robots, robotic devices, microtechnologies.

Mechatronics in medicine

There are a number of robots designed to solve three main tasks: diagnosis of diseases, therapeutic, and surgical treatment. A number of existing diagnostic systems with the image on the screen of the study area (for example, a tomographic device controlled by a computer) are already using elements of mechatronics and robotics. It is assumed that the mass appearance of medical devices for various purposes, computer-controlled, will have a strong impact on medical practice.

Japan has patented a micromanipulator designed for medical and biological research at the cellular level, allowing measuring the electrical resistance of the cell, making microinjections in the cell of medical products and enzymes, changing the design of the cell and extract its contents.

Another area of application of robots is radiotherapy, where they are used to reduce the level of radiation danger to medical personnel. The use of robots is considered to be the most expedient in the process of replacement of several expensive stationary radioactive sources in multi-beam installations. The development of manipulators for radiotherapy departments is in the experimental phase. At the same phase they are working to create a robot – massager.

There are a number of complex surgical operations, the implementation of which is constrained by the lack of experienced surgeons, because such operations require high accuracy. For example, in eye microsurgery there is such an operation as radial incisions of the cornea (radial keratotomy), with which you can adjust the focal length of the eye when eliminating myopia. The ideal depth of the incision of the eye shell should not exceed 20 microns. An experienced surgeon during this operation can perform cuts to a depth of 100 microns. In Canada, a medical robotic system is being developed that is capable of making high-precision cuts on the eye cornea and providing the necessary curvature of the eye.

Another example of high-precision surgery is microsurgery. Created in the United States medical robot with a manipulator "Puma" demonstrated the possibility of extracting a piece of brain tissue for biopsy. With the help of a special scanning device with a three-dimensional system of information display, the place and speed of entering a two-millimeter drill for taking samples of brain tissue were determined.

France developed a medical robot assistant to assist during surgical procedures on the spine, when any mistake by the surgeon may lead to total paralysis of the patient. In Japan, the created medical robot demonstrated the possibility of corneal transplantation of the eye taken from a dead donor.

The advantages of medical robots include their ability to reproduce the required sequence of complex movements of Executive instruments. In the UK, a medical robot simulator for training doctors and modeling the processes of surgical operations on the prostate is demonstrated, during which a series of complex cuts are made in various directions, the sequence of which is difficult to remember and perform.

In the United States a patented robotic system assists the surgeon in performing operations on the bones. This system is used in orthopedic operations, in which the most important thing is the precise positioning of the tool relative to the knee joint. The robotic system consists of an operating table, a fixed device, a robot, a controller and a supervisor. The patient is placed so that the thigh is fixed inside the device. The other thigh of the patient is fixed to the operating table with straps. The base of the robot is firmly fixed on the operating table. The tool is installed on the robot, the manipulator of which can move with 6 degrees of mobility. The manipulator contains a positional sensor device for generating signals indicating the position of the manipulator relative to the coordinate system. The robot uses a serial manipulator PUMA 200, which due to its relative simplicity can be easily adapted to surgical operations. The controller monitors all robot movements and transmits them to the supervisor. Commands for moving and controlling auxiliary operations produced by the controller are transmitted to the robot by positioning signals, coming through the connecting cables. There are several ways to control the movement of the robot. In the manufacture the robot is equipped with an additional device with a training program. The training device is a device with semi-automatic control of robot maneuvering. Maneuvering consists of a series of individual steps – movements. The controller records these steps so that then the robot can repeat them. To control the robot speech commands or another type of control can be used. The robot can also move in a passive way, for which the manipulator provides manual motion control. The supervisor, as well as the controller, is provided by the control commands and programs in the language of VAL – 11. When working with the supervisor, all the movement commands go through the controller. A special screen known as "Touch window" (TSW) is installed in front of the display, which is used as a device for entering commands during the operation. All changes on the dice are displayed on the monitor screen. In the operating room, this screen is covered with a sterile film, which allows the surgeon directly to control the surgical operating process. Programs of operations are based on the geometric relations between the parameters of the prosthesis, the parameters of bone sections and the axes of drilling holes. The robot will move the tool on certain positions in the corresponding planes. The origin of the coordinate system will be some fixed point on the reference surface.

In recent years, in the field of automation of surgical processes, there have been reports of attempts to create robotic systems for remote surgery using television sets, when the surgeon and the patient are separated by large distances. There is the diagnosis and surgery of vascular diseases among the most urgent tasks. In Japan, Italy and Russia, work is underway to create mobile micro robots designed to destroy atherosclerotic deposits in blood vessels. It is assumed that mobile micro robots will work automatically, moving along the anatomical bed of the circulatory system.

Note that clinical robotic systems are ergatic i.e. operate with the participation of the operator. The high level of technology can significantly expand the possibilities of surgery. An example is a remote-controlled manipulation system for heart surgery. In the latter case, the surgeon is able to carry out operations with a resolution of 2-3 times less than his hand allows for direct work with the instrument. It should be emphasized that such operations are possible only with a sufficiently high level of information technology, the use of active interface and expert systems, providing a dialogue with the surgeon robotic system throughout the operation, controlling its actions and preventing possible errors. Along with the direct control of the movement of mini – manipulators and micro robots with the help of hand controls, the surgeon has the ability to use speech commands to control both the working tool and the means of information support. Thus, the use of clinical robotic systems allows not only refusing in some cases from traditional medical technologies, but also significantly facilitating the working conditions of the surgeon and the diagnostic doctor.

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