DEVELOPMENT OF AN AFFORDABLE ROBOTIC ARM

Diana Biryukova, Alexander Shidlowsky
VSU named after P.M. Masherova, Vitebsk, Belarus

Currently, the development of scientific and technological progress is almost impossible to imagine without robotic mechanisms. For example, the production of products at large and small enterprises has long been carried out on the basis of the conveyor principle, which simplifies and speeds up the process of delivering goods to the final consumer.The attendants at each stage of the conveyor carry out a certain monotonous series of actions, which leads to the idea that these manipulations can be programmed and replaced by a robotic mechanism. Today, there are already many examples of the use of various robotic manipulators that simplify and speed up production at conveyor enterprises. In today's market there are many robotic manipulators that vary in type of control, functions and volume. The most serious and expensive are fully autonomous manipulators, which can perform a programmed cycle of actions without human intervention and adjust their actions as necessary. They can be used for mechanical engineering, welding, packaging and the like.

The leaders in the industry of industrial robots of manipulators can rightly be called FANUC, UNIVERSAL ROBOTS, KUKA and others. However, the models of these brands are far from even affordable for a stable profitable company, which makes them inaccessible for small businesses and society as a whole (Fig. 1). Also, the difficulty is to use the manipulator in practice since it is also difficult to program the robot.

Figure 1. Industrial Robot Arms

The aim of the study is to develop our own, affordable robot manipulator with a clear and simplified software part based on the ROS framework.

Material and methods. The material for the study was the models of robotic manipulators, a single-board Raspberry Pi computer with the ability to

connect a number of sensors, as well as the Arduino hardware platform, which allows expanding the capabilities of Raspberry PI. During the research, computer modeling and programming methods were used.

Findings and their discussion. Industrial robotic manipulators use expensive and reliable controllers to ensure safe control of the device, and also have a complex structure, both of the mechanical part and of the software. Therefore to create an affordable and low-cost robot you need to develop a simplified, but at the same time reliable mechanics, as well as to use a reliable controller from the budget price range [1].

To develop the mechanical part of the future manipulator, which will be able to perform a number of useful tasks, first of all, it is necessary to use 3D modeling software, which allows in computer simulation mode to check the nodes of the future design for loads and rotation. Such software products include SolidWorks, Fusion 360 Autodesk, Compass 3D, Onshape. The bulk of the program for 3D modeling are paid. Therefore the choice of modeling in Onshape is the best choice, since the service is cloudy, free and accessible from anywhere in the world, which allows you to conduct development, regardless the location.

To control the robot with a manipulator, a computationally powerful microcontroller is required, therefore 8-bit boards similar to Arduino and others will not work as the main managed control board. An alternative for the better are single-board computers with 64-bit architecture, such as the Raspberry Pi board, which many times exceeds the computational and resource indicators of Arduino boards [2]. A plus is the ability to install the distribution of a full-fledged Linux operating system, namely Ubuntu, as well as the presence of programmable GPIO outputs (Fig. 2). The capabilities of the Raspberry Pi allow you to create robots with Wi-Fi control, connect full-fledged monitors, process data from connected cameras, security systems with face recognition and the like.

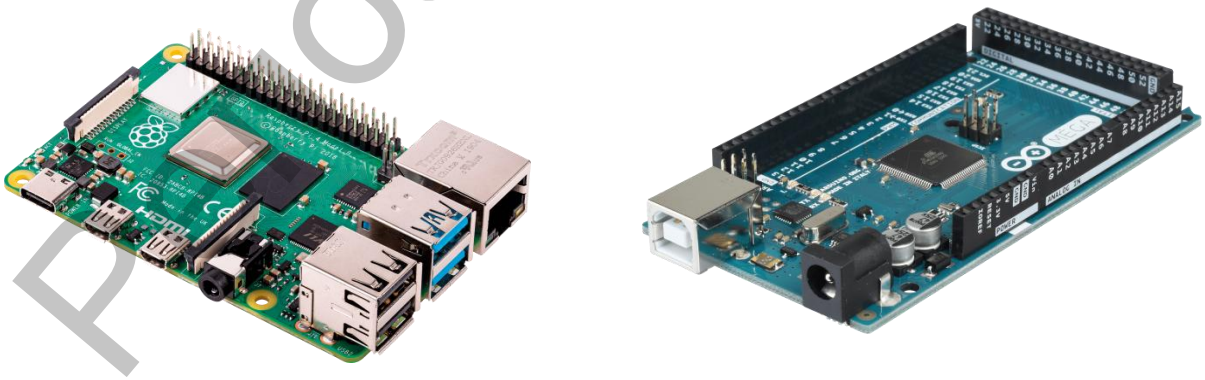

Figure 2. Controls boards

To set the robot in motion the stepper motors NEMA 17, 1.7A type will be used, which are controlled using drivers that allow you to set a microstep for a smooth running of the engine.

To control the robot arm, namely stepper motors, ROS will be installed on the Ubuntu operating system. ROS (Robot Operating System) is a robot programming framework that provides functionality for the distributed operation of all programmable robot systems. ROS is based on graph architecture, where data processing occurs at nodes that can receive and transmit messages between themselves.

The advantages of ROS allow processing and connecting complex sensors to the robot, which speeds up and simplifies the development of software modules for the end device.

Conclusion. The analysis of the modern market of robotic mechanisms for various spheres of human activity showed that it is necessary to use advanced software and current technologies that will allow to adapt manipulators for use in everyday life. Creating a low-cost robotic manipulator is possible by using the Raspberry Pi board in conjunction with the Arduino to control the robot itself and when printing robot parts by printing 3D models on a 3D printer.

1. John J. Craig. Introduction to Robotics: Mechanics and Control. Reading, MA: Addison-Wesley, 1985, 400 pp.
2. Raspberry Pi 4 (2011). Available at: https://xakep.ru/2019/09/16/raspberry-pi-4-review/ (accessed 5 October 2019).

ON THE APPLICATION OF THE TCHIRNHAUS TRANSFORMATIONS FOR AN ALGEBRAIC EQUATION OF THE THIRD DEGREE

Mikhail Chernyavsky
VSU named after P.M. Masherov, Vitebsk, Belarus

From the history of mathematics, it is known that E. V. von Tchirnhaus in 1683 published his own method of solving algebraic equations of various degrees. His goal was to obtain an algorithm for solutions an algebraic equation of the fifth degree [1, p. 166]. Nevertheless, Tchirnhaus's ideas and results can be used to more easily solve algebraic equations of the third and fourth degrees. However, in most authoritative literature on the theory of polynomials and the solution of algebraic equations, only general ideas of the Tchirnhaus transformations are given and there are no specific analytical intermediate formulas. This fact significantly reduces the practical value of the investigated method.

So, the aim of the research is to obtain in a convenient form all the intermediate formulas involved in the Tchirnhaus's transformations for a cubic algebraic equation.