

Ministry of Education and Science of Ukraine

*Odessa National Academy
of Food Technologies*



International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa, ONAFT 2021

UDC 004.01/08

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Black Sea Science 2021: Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

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11. Igumenov, V., Rusyaeva, P. (2017, October 26th). *Digital avalanche: why the ICO market is growing so fast.* RBC. <https://www.rbc.ru/magazine/2017/11/59e62b5d9a7947de527907d4>
12. Balashova, A., Lee, I. (2017, October 4th). *In Russia, raising money for ICO is to be legalized soon.* RBC. https://www.rbc.ru/technology_and_media/04/10/2017/59d4e0f29a7947d74c4aca6b
13. Russian news agency TASS (2017, October 9th). *The Ministry of Economic Development proposed to develop laws on cryptocurrency in "legal sandboxes".* Russian news agency TASS <https://tass.ru/ekonomika/4630885>
14. Ovechkin, O. (2017, May 26th). *German Gref called for the legalization of Bitcoin and other cryptocurrencies in Russia.* RB. <https://rb.ru/news/grefcoin/>
15. Losev, A. (2017, October 23rd) *The secret ruble: why the Russian economy needs a national cryptocurrency.* RBC. <https://www.rbc.ru/opinions/economics/23/10/2017/59edb53a9a79477502fc7ee1>
16. Kazarnovsky, P., Istomina, M. (2017, August 28th). *Bitcoin is not for everyone: the Ministry of Finance proposed to prohibit "ordinary people" from buying cryptocurrency.* RBC. <https://www.rbc.ru/business/28/08/2017/59a3cd869a7947835e1300d1>
17. Content Marketing Institute (2020, Dec 10th). *What is content marketing?* <https://contentmarketinginstitute.com/what-is-content-marketing>
18. Statista (2020, Dec 16th). *2018 B2C ecommerce sales worldwide.* <https://www.statista.com/statistics/261245/b2c-e-commerce-sales-worldwide>
19. Coingecko (2021, Jan 8th). *Price chart for STQ tokens in USD.* https://www.coingecko.com/en/price_charts/storiqa/usd

DEVELOPMENT OF A MILLING MACHINE WITH COMPUTER NUMERICAL CONTROL

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Abstract. *The use of computer numerical control (CNC) machines makes it possible to reduce labor intensity and increase labor productivity by reducing the time required to prepare a product for production, reducing rejects, and ensuring the interchangeability of parts. Therefore, the design and further improvement of CNC machines is an urgent and priority task.*

The paper shows one of the possible approaches to the design and manufacture of a CNC milling machine based on a portable personal computer and an "open control system".

Stepper motors are selected as actuators, which are controlled by special drivers. Machine control programs can be written in the G-code language.

The machine is made in a single copy, has been working for 3 years and is constantly being improved through the introduction of new hardware and algorithmic components of the control system.

Keywords: *CNC, milling, production automation, stepper motors, coordinate table, machining, machining accuracy.*

I. INTRODUCTION

The emergence of CNC machines in the 50s of the twentieth century was due to the need to increase labor productivity (while ensuring stable quality) in industries with mass and large-scale production. The continued use of humans as the main element of the machine control system began to restrain the growth of equipment productivity. The subsequent half-century of experience in using CNC machines not only confirmed the correctness of the initial ideas, but also significantly supplemented and continues to complement the numerous advantages of these machines in comparison with manual machines or mechanical semiautomatic devices and automatic machines. Modern machine-building production is unthinkable without the widest possible use of machine tools, equipment, as well as CNC machining centers.

The use of CNC machines made it possible to obtain a significant economic effect and free up a large number of universal equipment. The efficiency of CNC machines, according to domestic and foreign data, is characterized by an increase in productivity; reduction of the terms of preparation of production and technological equipment; decrease in marriage; ensuring the interchangeability of parts; reduction or complete elimination of marking and fitting and fitting works; the introduction from the beginning of the launch of a new product of calculation and technical standards and thereby ensuring a significant reduction in labor intensity and an increase in labor productivity.

The experience of using CNC machines has shown that the efficiency of their use increases with increasing accuracy, complicating processing conditions, if necessary, in the process of processing the mutual movement of a part and a tool in five to six coordinates, with multi-tool multi-operation processing of parts from one installation, etc.

Precision machining, surface quality, productivity, as well as reliability and cost – all highly dependent on the drive. The main parameters of the servo drive are power, speed, speed and accuracy. In some cases, efficiency, cost, and ease of use are also considered. Particular attention is paid to the overall dimensions and weight per unit length [1].

Tracking drives are used both in contour programmed control systems (PCS) and in positional ones. The main reason for using a servo drive in contour PCS is the need for continuous control of variable speeds of movement of the working bodies of machine tools with significant required powers and high specified accuracy of movements along several simultaneously controlled coordinates.

The use of CNC machines in almost all branches of mechanical engineering in recent years has become one of the main directions in the field of processing automation [2].

In recent years, the development of CNC systems has reached a completely new level of accuracy and speed (Fig. 1.).



Figure 1. – Modern complex with CNC

II. LITERATURE ANALYSIS

There are currently many books and articles written about CNC machine tools. In the bottom you can find various information – about the main units of machine tools, methods of developing control programs, how to improve the accuracy of machine tools, etc. However, not a single book has been written on how to make a CNC machine at home and from available materials. This topic is reaped only on numerous forums, where information is very scattered and not structured. Therefore, the purpose of this work was to describe the creation of a CNC machine at home and to demonstrate the result – a part made on this machine.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The object of the research is numerical control system. The subject of the research was a numerically controlled milling machine. To study the subject, computer modeling methods were used in SolidWorks and Matlab (for mechanical assemblies) and Multisim (for electrical circuits). A working CNC milling machine was also created to check the accuracy of all calculations and supplement the study with experimental data.

IV. RESULTS

4.1. CNC milling machines

CNC milling machines are designed for processing flat and spatial surfaces of blank with complex shapes. The designs of CNC milling machines are similar to those of traditional milling machines (Fig. 4.1a), the difference from the latter is the automation of movements according to the control program during shaping. The classification of CNC milling machines is based on the following features:

- location of the spindle (horizontal or vertical);
- the number of coordinate movements of the table or milling head;
- the number of instruments used (single or multi-instrumental);
- method of installing tools in the machine spindle (manually or automatically).

By arrangement, CNC milling machines are divided into four groups:

- vertical milling with a cross table;
- console milling;
- longitudinal milling;
- broadly versatile instrumental.

In vertical milling machines with a cross table (Fig. 4.1b, a), the table moves in the longitudinal (X-axis) and transverse (Y-axis) horizontal directions, and the milling head in the vertical direction (Z-axis). In console milling machines (Fig. 4.1b, b), the table moves along three coordinate axes (X, Y and Z), and the headstock is stationary.

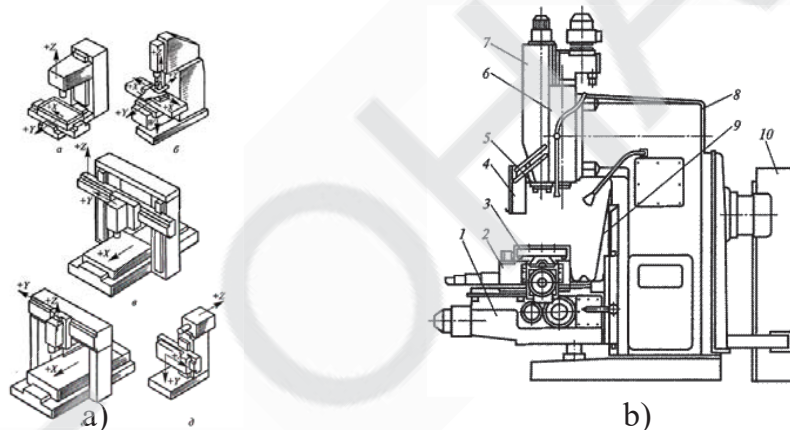


Figure 4.1 – a) Arrangements of CNC milling machines b) CNC milling machine: 3– table; 5–spindle; 6– milling headstock; 8– bed

In bed-type milling machines with a movable cross-bar (Fig. 4.1b, c) the table moves along the X-axis, the spindle head along the Y-axis, and the cross-bar along the Z-axis. In bed-type milling machines with a fixed cross-bar (Fig. 4.1b, d), the table moves along the X axis, and the spindle head along the Y and Z axes. In universal tool milling machines (Fig. 4.1b, e), the table moves along the X and Y axes, and the spindle head along the Z axis.

The number of controlled coordinates is usually three, and in some cases, four or five. with contour control, the shaping movement is carried out at least along two coordinate axes simultaneously. In CNC milling machines, asynchronous motors (in these cases, there is a gearbox) or DC motors are used as a drive for the main movement. Drives of movement of feeds of CNC milling machines have short kinematic chains, transferring movement from the motor directly to the executive body.

4.2. Functional components of CNC

In order to make a CNC machine out of a conventional machine, it is necessary to introduce certain components into its structure (Fig. 4.2). It is not enough just to connect the machine to a computer so that it works according to the program – it is necessary to modernize the mechanical and electronic "stuffing" of the machine.

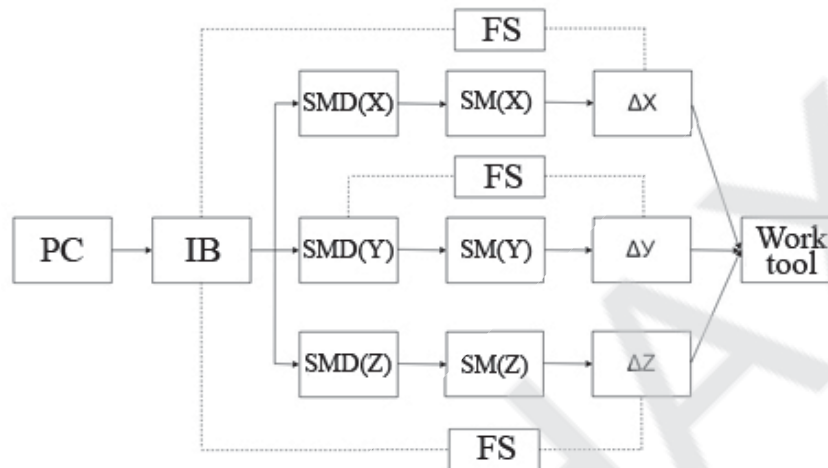


Figure 4.2 – Functional diagram of a CNC machine: PC – personal computer; IB – interface board; FS – feedback sensor SMD – stepper motor driver; SM – stepper motor

Conventionally, the PCS (Program Control System) can be divided into three subsystems:

- control subsystem;
- drive subsystem;
- feedback subsystem.

The control subsystem is the central part of the entire control system. On the one hand, it reads the control program and issues commands to various machine units to perform certain operations. On the other hand, it interacts with a person, allowing the operator to control the processing process. The heart of the subsystem is the controller (processor), which is responsible for controlling all the electronic components of the machine. The control system can be either closed or open. Closed systems have their own algorithms and work cycles. Closed systems cannot be modified. Open systems are being introduced more and more into production. the operator has full access to all algorithms and work cycles, and allows you to change the processing program.

Subsystem of drives (Fig. 4.3) – a system of motors and transmissions, which ensures the execution of commands of the control subsystems.

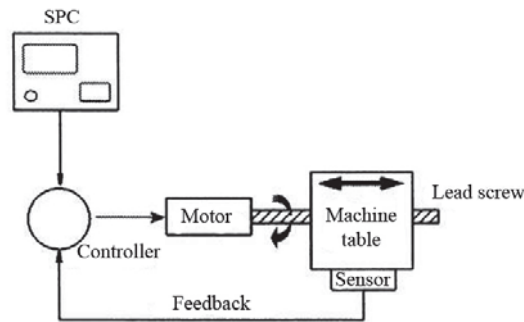


Figure 4.3 – Subsystem of drives

The feedback subsystem is designed to provide information to the control subsystem about the current state of the machine tool and the workpiece using various sensors [4].

The developed machine implements the following functional diagram (there is no feedback) (Figure 4.4)

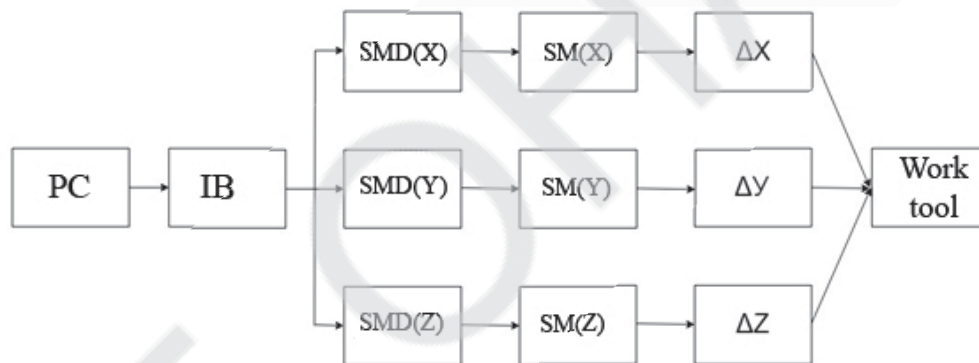


Figure 4.4 – Functional diagram implemented on the machine

4.3. The main components and assemblies of the developed CNC machine tool

Let us consider the appearance and main units and assemblies of the developed CNC milling and engraving machine (Fig. 4.5a): by its design, the machine is a longitudinal milling machine with a fixed cross member.

Bed 1 provides the machine with the required rigidity. A movable table, portal, stepper motors, Z-axis and a spindle will be installed on it. To create the supporting frame, 10mm plywood was used. All elements are connected with each other using aluminum corners. To strengthen the structure, an additional square frame made of wooden beams was made inside the main frame.

At the ends of the frame 1, holes are drilled and bearing blocks 2 are installed to install the drive screw of the movable table. Table 3 is attached to the bed through four furniture rails of full extension 5, they replace the combination of linear bearings

and shafts, and as practice has shown, the backlash when using them is not much greater.

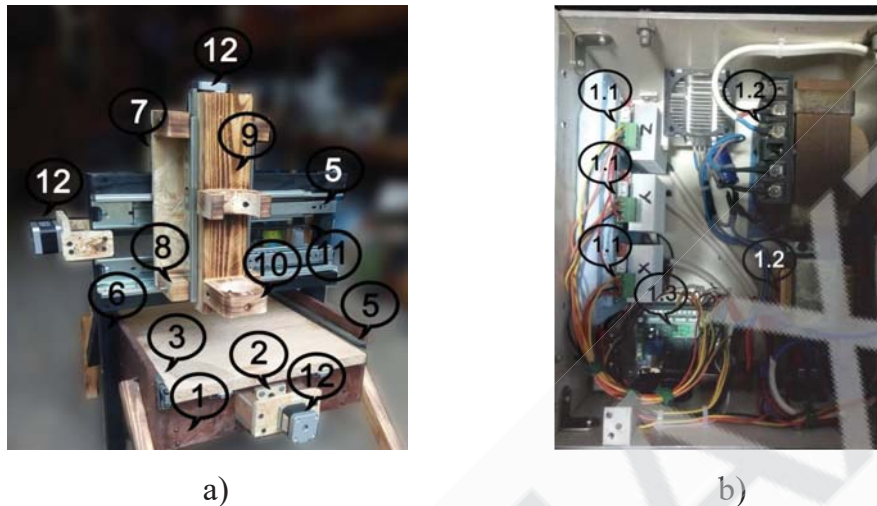


Figure 4.5 – a) External view of the developed CNC machine tool b) External view of the machine control unit

Portal 6 – in our case it is stationary, instead of a mobile portal, it was decided to use a movable table to reduce the load on the guides. The higher the portal, the thicker the blank that you can process. However, a high portal is less resistant to stresses that arise during processing. The high side posts of the portal play the role of levers relative to linear rolling bearings (furniture guides in our particular case).

In the design of the Z-axis 7, a panel was used, which is attached to the movable parts of the Y-axis full extension rails, which are located on a fixed portal; on two supports 8, three full extension guides are installed, which provide a smooth movement of the bar 9, with a mount for the spindle 10 in the vertical direction.

Screws 11 convert rotary motion from stepper motors 12 into the linear motion. When designing your machine, you can choose several options for this unit: a screw-nut pair or a ball-screw pair (ball screw). A screw nut is generally more exposed to frictional forces during operation and is also less accurate relative to the ball screw. If there is a need for increased accuracy, then it is definitely necessary to opt for a ball screw, but the price for this unit is quite high.

The design of the machine uses a screw-nut with a lock nut to eliminate backlash. This allows you to adjust the backlash, maintaining the correct ratio between the friction values in the screw-nut pair and the backlash.

Next, we turn to the analysis of the machine control unit device (Fig.4.5b):

The main components of the electrical circuit are:

1. Stepper motors (12);
2. Stepper motor drivers (1.1);
3. Power supply unit (1.2);
4. Interface board (1.3);
5. Personal computer or laptop;

6. Emergency stop button.

For the development of the machine, 3 Nema-17 stepper motors were purchased (Fig. 4.6a).

A stepper motor is an electric motor in which a pulsed supply of electric current causes the rotor to discretely rotate through a given angle of rotation. The stepper motor generates high torque at low speed and operates at half the torque at rest (Fig. 4.6b). It is controlled by discrete pulses that are generated on the stepper motor driver. Used in CNC machines to move the working tool along the axes.

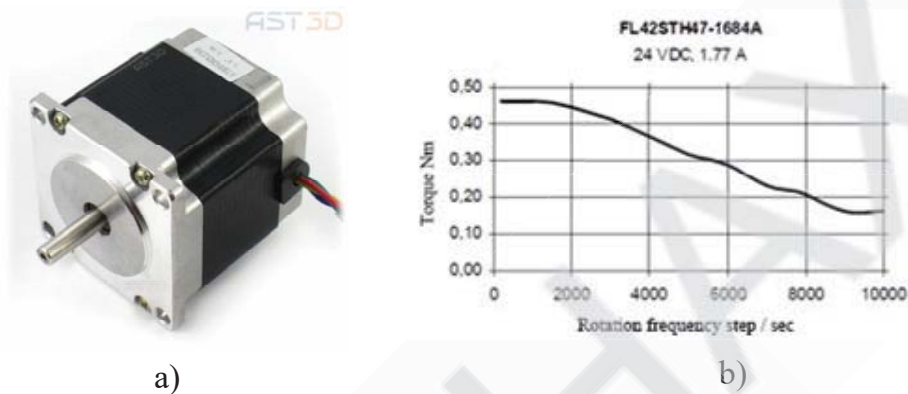


Figure 4.6 – a) Nema-17 stepper motor b) Dependence of the torque on the motor shaft on the speed

The next thing you need to design the machine is 3 suitable TB-6600 drivers (Figure 4.7)



Figure 4.7 – External view of the TB-6600 driver

A stepper motor driver is an electronic power device that, based on digital control signals, controls the high current / high voltage windings of a stepper motor and allows the stepper motor to take steps (rotate).

Stepper motor control is much more difficult than with a conventional collector motor, because it is necessary to switch the voltages in the windings in a certain sequence with simultaneous current control. Therefore, special devices have been developed for stepper motor control - stepper motor drivers. The stepper motor driver can control the stepper motor rotor rotation in accordance with control signals and electronically divide the stepper motor physical step into smaller half steps.

The power supply, the stepper motor itself (its windings) and control signals are connected to the stepper motor driver. The standard for control signals is STEP / DIR or CW / CCW and ENABLE.

STEP / DIR protocol signals have the following meaning:

STEP signal – Timing signal, step signal. One impulse leads to the rotation of the stepper motor rotor by one step (not the physical step of the stepper motor, but the step set on the driver - 1: 1, 1: 8, 1:16, etc.). Typically, the driver works out a step on the rising or falling edge of the pulse;

DIR signal – Potential signal, direction signal. Logic unit - SM rotates clockwise, zero - SM rotates counterclockwise, or vice versa. DIR signal can usually be inverted either from the control program or by swapping the connection of the stepper motor phases in the connection connector in the driver;

ENABLE signal – Potential signal, driver on / off signal. Typically, the logic of operation is as follows: logical unit (5V is applied to the input) – the stepper motor driver is off and the stepper motor windings are de-energized, zero (nothing is supplied or 0V to the input) – the stepper motor driver is on and the stepper motor windings are powered [5].

The last significant component in the control system of a CNC machine tool is the interface board, for communicating the computer and the machine through the LPT port (Figure 4.8)

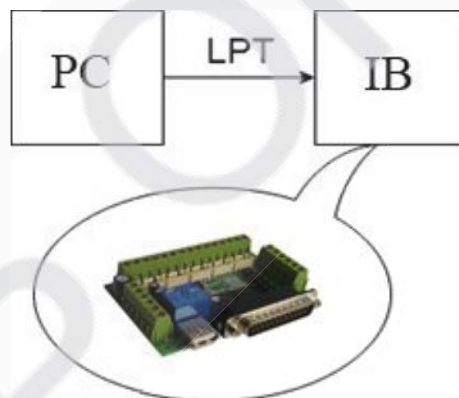


Figure 4.8 – Interface board, for communicating the computer and the machine through the LPT port

The power source for all electronics is a step-down mains transformer, at the output of which there is a voltage of 24V, a diode bridge and a smoothing capacitor are installed after the transformer to obtain a constant voltage to power the stepper motors, thus, the voltage supplied to the stepper motor fluctuates within 32-33V, which is optimal for this type of drivers and stepper motors. The logic part is powered by a voltage of 5V, obtained by means of a USB cable connected to a personal computer or a charger unit from a mobile phone.

V. CONCLUSIONS

The existing rates of development of modern production could not be achieved without the use of CNC systems. The technology of processing on CNC machines is intended to simplify the methods of obtaining parts during mechanical processing in conditions of serial and mass production. In most cases, CNC systems allow providing better accuracy, speed and repeatability in the machining of materials, leveling out some mechanical positioning errors on the machine, thereby improving the quality of products.

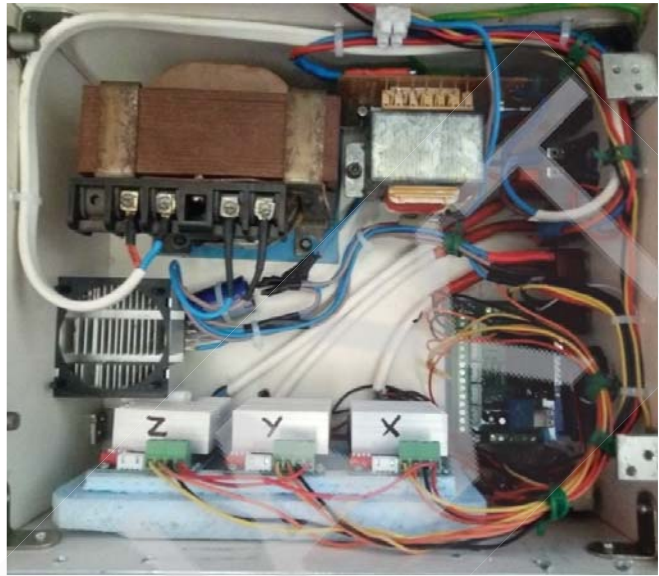
As part of this project, I developed my own CNC milling and engraving machine (Appendix A). Its main units are similar to industrial counterparts, but they are made of affordable and inexpensive materials, which could not but affect the accuracy of the developed machine. The maximum permissible deviations from the specified dimensions of the part are no more than 1 millimeter, and are caused by insignificant backlash in the screw-nut pair and insufficient hardness in some places of the material from which these or those units are made.

As an example of processing a part on the developed milling and engraving machine, the emblem of the department 305, engraved on white polystyrene foam with a brown coating, was chosen. The result of this work can be found in the video link (Appendix B).

VI. REFERENCES

1. Encyclopedia of Mechanical Engineering XXL [Electronic resource]. - Access mode: <https://mash-xxl.info/info/700868/>
2. [Electronic resource]. - Access mode: <https://studbooks.net/2573944/>
3. Deryabin, A.L., Esterzon, M.A. Manufacturing technology of parts on CNC machines and in GPS: a textbook for mechanical engineering schools — Moscow: Mechanical engineering, 1989. — 288p.
4. PureLogic [Electronic resource]. - Access mode: http://wiki.purelogic.ru/index.php?title=Step_Motor_Driver

Appendix A - Appearance of the developed machine



Appendix B - The process of manufacturing a part on a CNC machine

<https://youtu.be/21e8CEpw7ek>



**THE MODERNIZATION OF THE INFORMATION MEASURING SYSTEM
OF POSITIONING OF THE OPTICAL GRINDING MACHINE**

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***Abstract.** The object of development is an automated control system for an optical grinding machine. The purpose is to modernize the existing control system of the optical grinding machine. During the development process, an automated control system for an optical grinding machine based on an STM32 microcontroller was designed and implemented, control boards were developed, and performance tests were carried out. The development stage: the system has been introduced into production.*

***Keywords:** microcontroller, optical grinding machine, encoder, control, automation.*

University Kharkiv Aviation Institute (Ukraine)	
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Odessa 2021