

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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The smaller the optimality criterion, the closer the system is to the real

### Conclusions

PID control	Direct quality indicators		optimality criterion
	$\Delta T_r^{\text{МАКС}}$	$t_{\text{per}}$	
before optimization	0,2	10	146,9
after optimization	2	5	68,52

The paper considers the task of production safety in the wine industry, namely, the safe contact of people with collaborative robots in the packaging section of the wine champagne technological process.

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8. <https://rozum.com/robotic-arm/#available>

## AUTOMATION OF POSITIONING OF PNEUMATIC ACTUATORS BY MEANS OF INTRODUCTION OF THE PHOENIX CONTACT CONTROLLER

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Advisor: **Serhii Kovtun**

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### Abstract

*Abstract Object of research or development - Automation of control of process of positioning of piston executive mechanisms*

*The purpose of the work is to develop a system of automatic control of the process of positioning of piston actuators, which would support adjustable variables in the regulatory zones both in steady and transient modes of operation.*

*Research methods and tools - when identifying the properties of the object of control, the methods of imaginary active and passive experiment were used with further processing of their results; control object models and control systems were developed in Simulink / Matlab environment; parametric synthesis of the control system is carried out by the method of optimization of the quality indicator of its functioning; the development of the advanced system was carried out analytically*



Analytical analysis of the literature

We have reviewed a large number of publications by various authors who study this issue.

Object, subject and research methods

Analysis of the physical essence, possible ranges of change and frequency properties of input actions and their consequences.

Development of schemes for modeling the dynamics of action transformation channels, obtaining transient characteristics of models and comparing them with experimental transient characteristics.

First you need to get a mathematical model of management.

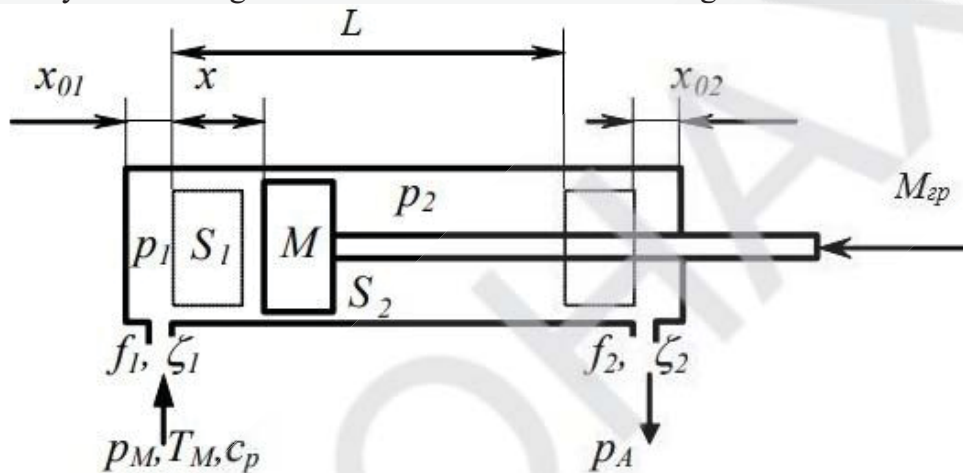


Figure 2.2 model of a pneumatic cylinder

Basic symbols:

$p$  - pressure, Pa;

$p_A$  - outlet pressure, Pa;

$p_M$  - supply pressure, Pa;

$x$  is the coordinate of the position of the piston, m;

$x_0$  - the given coordinate characterizing volume of harmful space, m;

$f$  is the cross-sectional area of the pipeline,  $m^2$  ;

$M_{zp}$  - weight of cargo, kg;

$M$  - mass of moving parts, kg;

$S_1$   $S_2$ -area of the piston and rod cavity,  $m^2$ ;  $L$  is the maximum stroke of the piston, m;

Numerical values of parameters for air at temperature  $T = 2930K$  (200C) and pressure  $p = 101,3$  kPa (1 atm.):  $K = 1,4$ ;  $R = 287$  J / (kg \* K):  $\rho = 1.204$  kg /  $m^3$ ;  $\gamma = 344$  m / c.

1. The equation of motion of the drive has the form:

$$M \frac{d^2 x}{dt^2} = p_1 F_1 - p_2 F_2 - p_A (F_1 - F_2) - N. \quad (2.2)$$

Mathematical model of air is expressed by adiabata:

$$p^K \cdot V = const \quad (2.3)$$

where p is the pressure in the cylinder, MPa; V is the volume of the cylinder, m<sup>3</sup>.

$$p^K \cdot V = k \cdot m \quad (2.4)$$

To solve k we take 1 cubic meter of air at atmospheric pressure then

$$0,1^{1,4} \cdot 1 = k \cdot 1,29 \quad (2.5)$$

$$k = \frac{0,1^{1,4}}{1,29} = 0,03086 \quad (2.6)$$

To develop a mathematical model, it is necessary to consider the state of the air in the left and right cavities

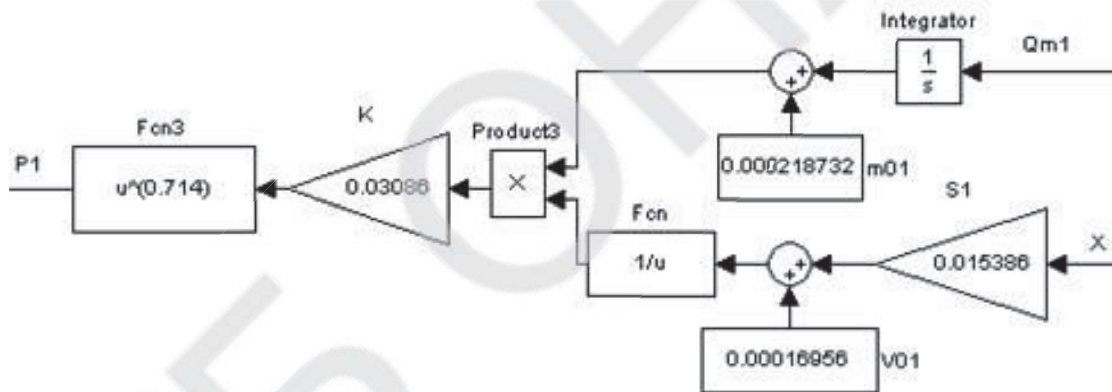


Figure 2.3 - S-model of the state of the air in the left cavity

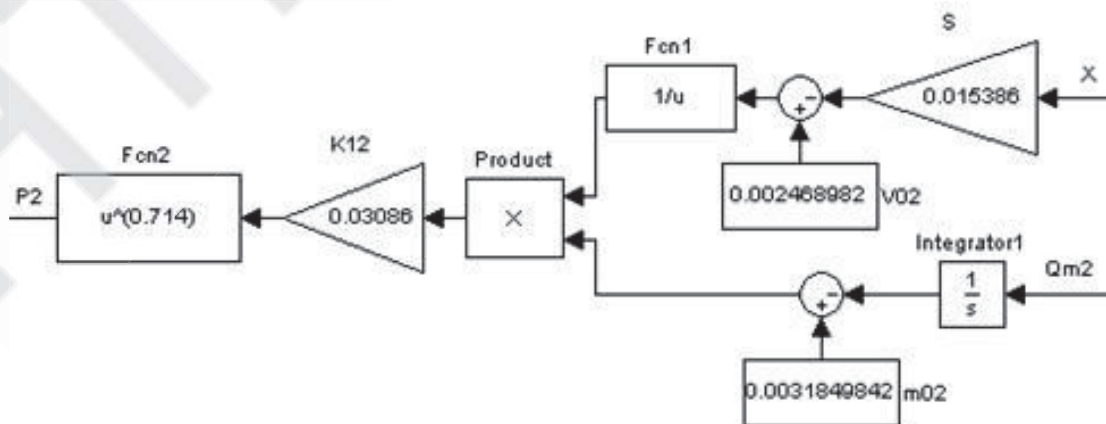


Figure 2.4 - S-model of the state of the air in the right cavity

Development of a mathematical model of air drive aeromechanics The mathematical model of air drive aeromechanics is expressed by equations

hydrodynamics for two cavities. The expression determines the mass flow rate Qm1 of air in the left cavity, the expression - the mass flow rate Qm2 in the right

cavity. 
$$Q_{m1} = \sqrt{2\rho} \cdot \mu \cdot S_{\partial y} \cdot \sqrt{(P_{\text{хит}} - P_1) \cdot P_1}$$
 (2.7)

$$Q_{m2} = \sqrt{2\rho} \cdot \mu \cdot S_{\partial y} \cdot \sqrt{(P_2 - P_{\text{атм}}) \cdot P_{\text{атм}}}$$
 (2.8)

It is seen from the expressions that the input value for the models of air aeromechanics in the cavities of the pneumatic cylinder is the pressure in the respective areas, and the output is the mass flow rate in the respective areas.

Figures 2.5 2.6 show S-models of aeromechanics for the left and right cavities, respectively.

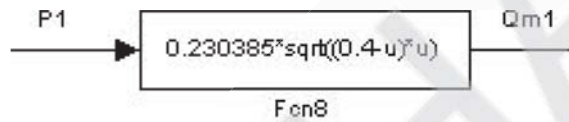


Figure 2.5 - S-model of aeromechanics in the left cavity of the pneumatic actuator

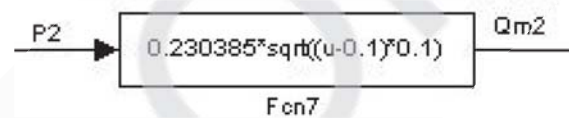


Figure 2.6 – S-model of aeromechanics in the right cavity of the pneumatic actuator

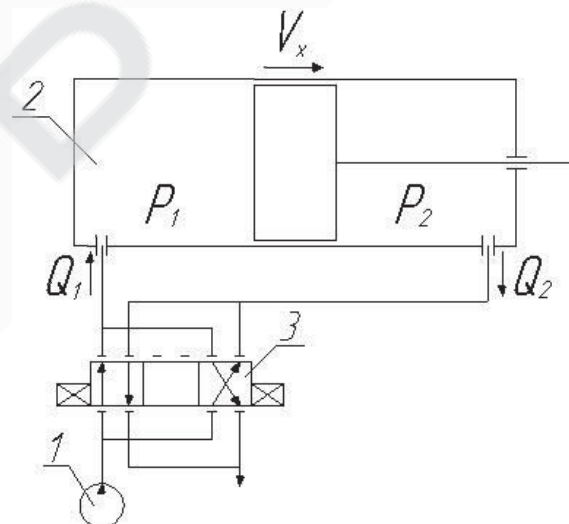


Fig.2.7 mathematical model of a pneumatic cylinder

- Schematic diagram of the control of the pneumatic cylinder GM air consumption from an unlimited volume (highway) is most often determined by the formula of Saint-Venant and Wenzel

$$G_M = \mu_1 \cdot f_1 \cdot P_M \cdot \sqrt{\frac{2k}{k-1} \cdot \frac{1}{R \cdot T_M} \cdot \left[ \left( \frac{P_1}{P_M} \right)^{2/k} - \left( \frac{P_1}{P_M} \right)^{\frac{k+1}{k}} \right]} \quad (2.9)$$

The volume V1 of the working cavity is equal to the product of the area of the piston F1 to move the piston x (taking into account its initial coordinate X01), we obtain

$$\frac{dP_1}{dt} = \frac{k \cdot \mu_1 \cdot f_1 \cdot K \cdot P_M \cdot \sqrt{R \cdot T_M}}{F_1 \cdot (x_{01} + x_1)} \cdot \varphi(\sigma_1) - \frac{k \cdot P_1}{(x_{01} + x_1)} \frac{dx}{dt} \quad (2.10)$$

The flow of air from a limited volume of V2 in the highway is also described by the formula of Saint-Venant and Wenzel, but it should put  $T_M = T_2$ ,  $P_m = P_2$  bearing in mind that all these values are variable

$$\frac{dP_2}{dt} = - \frac{k \cdot \mu_2 \cdot f_2 \cdot K \cdot P_2 \cdot \sqrt{R \cdot T_2}}{F_2 \cdot (s + x_{02} - x)} \cdot \varphi\left(\frac{1}{\sigma_2}\right) + \frac{k \cdot P_2}{s + x_{02} - x} \frac{dx}{dt} \quad (2.11)$$

#### Dynamic calculation of a differential drive

The equation of motion of the piston of the differential drive has the form

$$m \frac{d^2x}{dt^2} = P_1 \cdot F_1 - P_2 \cdot F_2 - P$$

where m is the mass of the piston;

P1 - force of harmful resistance (friction); P2 is the force of useful resistance

P is the result of all the forces applied to the piston

$$m\ddot{x} = P_1 \cdot F_1 - P_2 \cdot F_2 - (P_{axom} + F_{mp}),$$

$$m\ddot{x} = P_1 \cdot F_1 - P_2 \cdot F_2 - P_{axom} - \mu \cdot \dot{x},$$

$$\ddot{x} = \frac{P_1 \cdot F_1}{m} - \frac{P_2 \cdot F_2}{m} - \frac{P_{axom}}{m} - \frac{\mu}{m} \cdot \dot{x};$$

$$\ddot{x} = \frac{P_1}{m} - \frac{P_2}{m} - \frac{P_{axom}}{m} - \frac{\mu}{m} \cdot \dot{x} \quad (2.13)$$

Consider the reverse stroke of the piston. The equation of its motion in reverse when the piston cavity 2 connects to the atmosphere has the form:

$$P = P1 + P2 + P3 + Pa \quad (P1 - P2) \quad (2.14)$$

If the pneumatic cylinder is in the extreme left position, then the program must immediately after calculating the acceleration artificially set the acceleration, speed and coordinate equal to zero, ie to the obtained equations of the mathematical model

of the pneumatic actuator must add a condition:

$$\text{если } x \leq 0, \text{ то } \frac{d^2x}{dt^2} = \frac{dx}{dt} = x = 0. \quad (2.16)$$

Similarly, for the case when the piston reaches the end in the extreme right position, it is necessary to write a condition that limits the coordinate  $x$  the length of the drive  $S$

$$\text{если } x \geq S, \text{ то } \frac{d^2x}{dt^2} = \frac{dx}{dt} = x = 0. \quad (2.17)$$

$$\left. \begin{aligned} M \frac{d^2x}{dt^2} &= p_1 F_1 - p_2 F_2 - p_A (F_1 - F_2) - N, \\ \frac{dp_1}{dt} &= \frac{k f_1 \sqrt{RT_M}}{F_1 (x + x_{01}) \sqrt{\zeta_1}} \sqrt{p_M^2 - p_1^2} - \frac{k p_1}{x + x_{01}} \frac{dx}{dt}, \\ \frac{dp_2}{dt} &= -\frac{k f_2 \sqrt{RT_M}}{F_2 (S - x - x_{02}) \sqrt{\zeta_2}} \left( \frac{p_2}{p_M} \right)^{\frac{k-1}{2k}} \sqrt{p_2^2 - p_A^2} + \frac{k p_2}{(S - x - x_{02})} \frac{dx}{dt}, \\ \text{если } x \leq 0, \text{ то } \frac{d^2x}{dt^2} &= \frac{dx}{dt} = x = 0, \\ \text{если } x \geq S, \text{ то } \frac{d^2x}{dt^2} &= \frac{dx}{dt} = x = 0. \end{aligned} \right\} \quad (2.18)$$

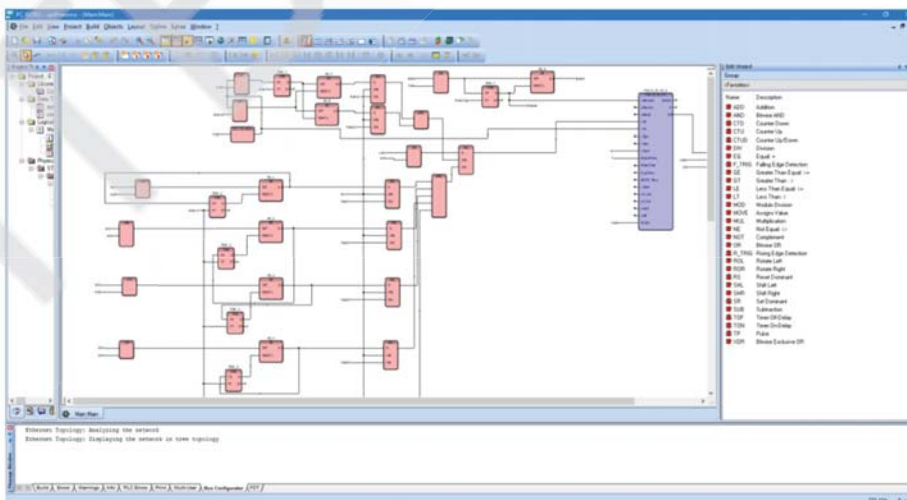


FIGURE 2.8 Screenshot of the logical control program findings

The Phoenix Contact Axiocontrol AXC 1050 controller was selected for the Office and software was developed to perform the task.

The paper deals with the task of Automating the positioning of pneumatic actuators behind the help of the Phoenix Contact controller

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### **KINEMATIC ANALYSIS OF THE HINGE-LEVER MECHANISM OF THE GRIPPING DEVICE ANTHROPOMORPHIC ROBOT**

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Advisors: *Yevgen Mykhaylov, Oleksandr Kniukh*  
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**Abstract.** *The analysis of forearm prostheses presented on the modern market has been carried out. Their features, advantages and disadvantages are characterized.*

*The relevance of this research work is shown.*

*A prototype of the prosthesis was selected. Selected drive type with justification of the choice. A method for controlling the prosthesis has been developed. The kinematic diagram of the brush has been compiled. The analysis of the functionality of the modular hand prosthesis was carried out. Calculated brush drive. Corresponding drive selected Hand force factors calculated.*

**Keywords:** *PROSTHESIS OF FOREAR, Four-bar Linkage, Kinematic diagram of fingers, Hand Mechanism Design, 3D Printing, DC motor.*

#### **INTRODUCTION**

Prosthetics is the restoration of lost forms and functions of individual organs or parts of the body. Prosthetic construction is engaged in development and production of artificial technical means of restoration.

Currently, 42,000 people with disabilities in the Odessa region are in need of prosthetic and orthopedic care.

The largest number of amputations on the upper extremity - amputation at the level of the forearm (50.5%). Disabled people who have undergone such an amputation are primarily deprived of the opportunity for self-care, and in most cases

<b>Environment for teaching children the Kazakh alphabet.</b> Author: <i>Sagyngaliyev Renat</i> , Advisors: <i>Zhakhiena Aizat, Bazarbayeva Ainur</i> , Zhangir khan University (Kazakhstan)	402
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**International Competition of Student Scientific Works**

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**Proceedings**

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