

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

Editorial board:

Prof. B. Iegorov, D.Sc., Rector of the Odessa National Academy of Food Technologies, Editor-in-chief

Prof. M. Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations, Editor-in-chief

Dr. S. Kotlyk, Ph.D., Assoc. Prof., Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0”, Editor-in-chief

O. Sokolova – Senior Lecturer of the Department of Information Technology and Cybersecurity, ONAFT, Technical Editor

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.

These materials of International Competition of Student Scientific Works «Black Sea Science 2021» contain the works of the contest participants in the section «Information technologies, automation and robotics» (not winners).

The author of the work is responsible for the accuracy of the information.

Odessa National Academy of Food Technologies, 2021

Organizing committee:

Prof. Bogdan Iegorov, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

Prof. Maryna Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

Prof. Stefan Dragoev, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

Prof. Baurzhan Nurakhmetov, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

Prof. Mircea Bernic, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

Prof. Jacek Wrobel, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

Prof. Michael Zinigrad, D.Sc., Rector of Ariel University (Israel)

Dr. Mei Lehe, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

Prof. Plamen Kangalov, Ph.D., Vice-Rector for Academic Affairs of “Angel Kanchev” University of Ruse (Bulgaria)

Dr. Alexander Sychev, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

Dr. Hanna Lilishentseva, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

Prof. Heinz Leuenberger, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

Prof. Edward Pospiech, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

Prof. Lali Elanidze, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

**The jury for the section
«Information technologies, automation and robotics»**

Head of the jury:

Sergii Kotlyk – Ph.D., Associate Professor, Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0” of Odessa National Academy of Food Technologies (Ukraine)

Members of the jury:

Piotr Artiemjew - Dr hab., Associate Professor in Decision Systems of the Faculty of Mathematics and Computer Science, University of Warmia and Mazury in Olsztyn (Poland)

Francisco Antonio Augusto – Dr., International Relations Manager of Higher Institute of Information and Communication Technologies (Angola)

Andrey Kuprijanov – Ph.D., Associate Professor of the Department of Software for Computers and Automated Systems of Belarusian National Technical University (Belarus)

Simon Milbert – Vice-President of Xtra Information Management, Inc. (USA)

Ivan Palov – D.Sc., Professor of University of Ruse “Angel Kanchev” (Bulgaria)

Degla Gérard Hugues – Communications and Training Manager of “MAPCOM solutions informatiques” company group (Benin)

Nugzar Kereselidze - Academic Doctor of Informatics (Computer Science), Associate Professor of the Department of Natural Sciences, Mathematics, Technology and Pharmacy, Sukhumi State University (Georgia)

Etibar Seyidzade - Associate Professor of the Department of Computer and Information Technologies, Baku Engineering University (Azerbaijan)

Vladimir Golenkov, D.Sc., Professor of the Department of Intelligent Information Technologies, Belarusian State University of Informatics and Radio Electronics (Belarus)

Zhanar Omirbekova - Ph.D., Associate Professor of the Department of Automation and Management, Satbayev University (Kazakhstan)

Ivan Palov - D.Sc., Professor of the Department of Power Supply and Electrical Equipment, University of Ruse “Angel Kanchev” (Bulgaria)

Siarhei Palavenia - Ph.D., Associate Professor, Head of the Department of Telecommunication Systems, Belarusian State Academy of Communications (Belarus)

Alexander Goloskokov - Ph.D., Professor of the Department of Software Engineering and Information Technology Management, National Technical University “Kharkiv Polytechnic Institute” (Ukraine)

Peter Nikolyuk - D.Sc., Professor of the Department of Computer Technology, Vasyl Stus Donetsk National University (Ukraine)

Vladimir Palagin - D.Sc., Professor, Head of the Department of Radio Engineering, Telecommunications and Robotics Systems, Cherkasy State Technological University (Ukraine)

Viktor Khobin – D.Sc., Professor, Head of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Valeriy Plotnikov – D.Sc., Professor, Head of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Sergii Artemenko – D.Sc., Professor, Head of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Fedir Trishyn - Ph.D., Associate Professor, Vice-Rector on Scientific and Educational Work, Odessa National Academy of Food Technologies (Ukraine)

Valerii Levinskyi – Ph.D., Associate Professor of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Viktor Yehorov – Ph.D., Supervisor of the Laboratory of Mechatronics and Robotics of Odessa National Academy of Food Technologies (Ukraine)

Pavlo Lomovtsev – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Yurii Kornienko – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Serhii Shestopalov – Ph.D., Associate Professor of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Anatoly Galiulin - Ph.D., Associate Professor, Acting Head of the Department of Electromechanics and Mechatronics, Odessa National Academy of Food Technologies (Ukraine)

Secretary of the jury:

Oksana Sokolova – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**VICTORY MANIPULATOR UNIVERSAL ROBOTS IN THE LINE
SORTING OF FINISHED PRODUCTS OF THE WINE INDUSTRY**

Author: *Igor Kotsur*

Advisor: *Volodymyr Honhalo*

Одеська національна академія харчових технологій (Ukraine)

Annotation

The work considers the introduction of collaborative robots (manipulators) into the line of the technological process for the bottling, drying and packaging of sparkling wines, for safer work of people with manipulators and to reduce accidents at the plant itself.

Key words: collaborative robots, industrial manipulators, production safety, technological process, engine failure.

Introduction

Production safety - to this day they are striving for this. Initially, the human muscle was replaced by mechanical, which simplified the work of man. For example, turning a part on a lathe, a turner - in this case operates with a process, since all the work on rotating the part is performed by an electric motor. But even this work is not completely safe, there are many accidents during such work.

As a result of scientific and technological progress, the mechanical work of man was replaced by automation, that is, the cleansing abilities were performed by program-logic controllers, and not the human mind, where he was in the operator's room and controlled the technological process through a computer.

How many methods are used for the safety of production, for example, at elevators (cereals, sunflower seeds, corn) and flour mills, since a large amount of dispersed dust is released, an explosion occurs when a spark appears. This is avoided by removing dust from the walls of the enterprise. By similar parameters, in chemical plants where vapors can explode, they are also diverted from the process itself. In addition to such productions, use pneumatic or hydraulic actuators, since they do not give a spark.

Most enterprises use conveyors, like other moving elements, they can easily tighten the limbs of a person who, in turn, did not adhere to safety precautions, so that as soon as possible to stop the conveyor, a cable is attached to its base, if it is pulled, it will trigger the end a switch that will operate as a lock and the conveyor will stop.

The use of manipulators in industry is very common, for example, in automobile manufacturing, without them large-scale production of products did not exist. Also, manipulators can be used in the food industry.

Analytical analysis of the literature

We have considered a large number of publications by various authors exploring this issue.

The production line and its sparkling wine champagne process are discussed below[1, 2, 3].

Object, subject and research methods

Field of application of “Universal Robots” collaborative manipulators in the wine industry. Let us single out a section of technological production for the use of collaborative manipulators (robots). By those. The process will be a sparkling wine production site.

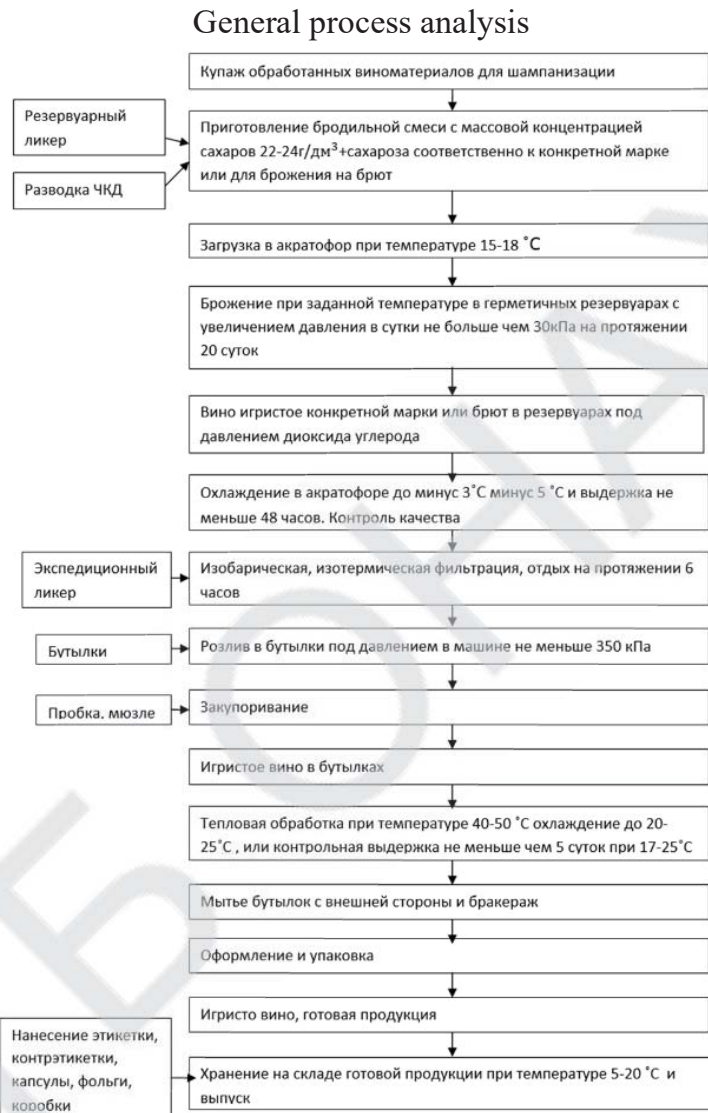


Image 1. The technological process of champagne wine

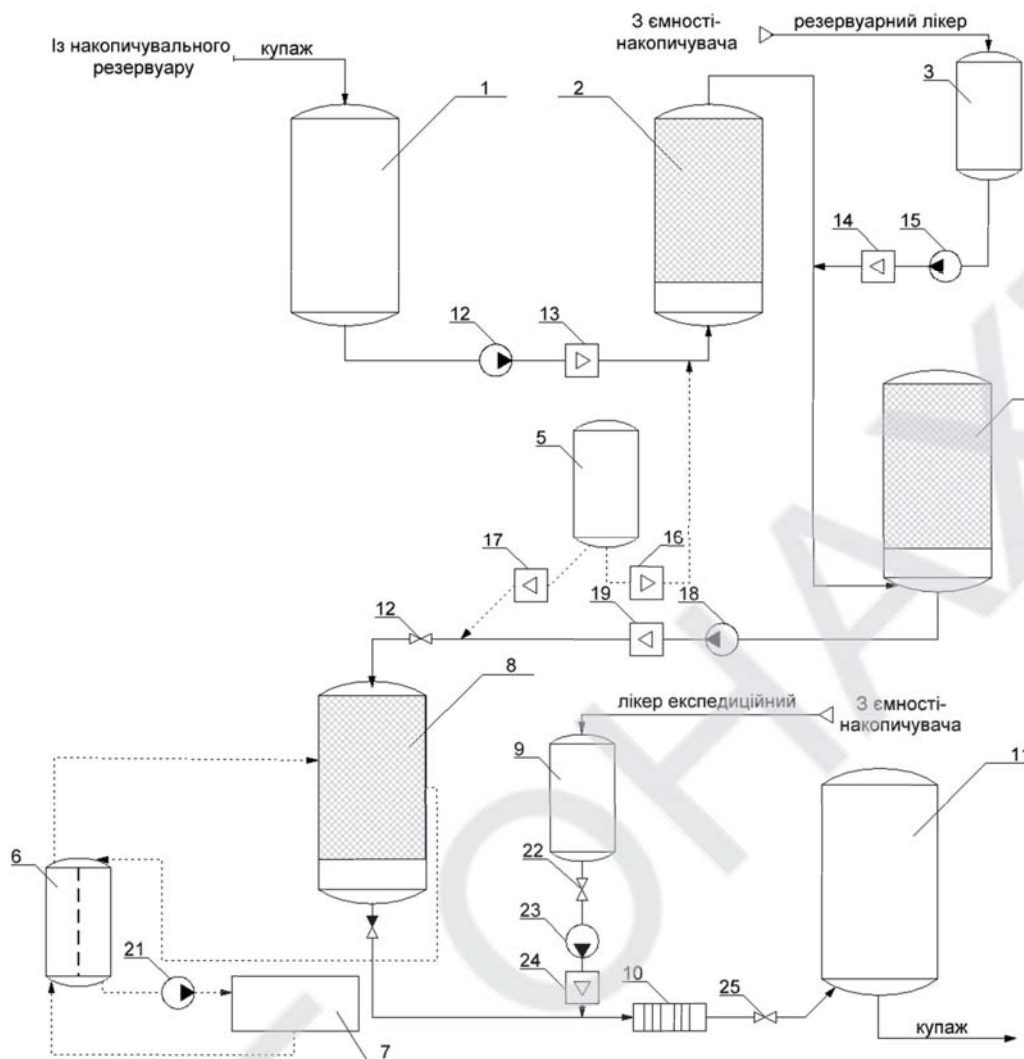


Image 2. Flow diagram of a section of a line for production of sparkling wines

The blending from the reservoir (1) by the pump (12) through the flow meter (13) is supplied to the apparatus (2) with the filler. Simultaneously with the blend, yeast wiring with dispersed mineral and yeast-growing apparatus is injected into the stream (5).

In the apparatus (2), processes of deoxygenation, stabilization and filtration of the blend occur.

Further, the worked blend is fed into the storage tank (4) for preparing the fermentation mixture by supplying the liquor (3) to the tank liquor stream using a pump (14) through a flow meter (15).

The fermentation mixture is pumped with a batcher (18) through a flow meter (19) and stop valves (20) into the acratophore (8) with a filler for the process of champagne. The fermentation mixture is dosed yeast wiring cultured with dispersed mineral.

At the end of the secondary fermentation, the sparkling wine is cooled, dispensed in the stream by expeditionary liquor from the tank (9), by opening the

shut-off valves (22) of the pump (23) and the flow meter (24). It is filtered on the filter (10), through the stop valves (25) it enters the receiving unit (11) and enters the bottling.

The refrigerant from the tank (6) is pumped to the refrigeration machine (7) by a pump (21). It cools, enters the reservoir (6) and enters the pipe system, which are connected with the acratophore jacket (8), the spent refrigerant returns to the reservoir (6).

The use of cobots "Universal Robots"

After bottling and corking the bottles, they move along the conveyor to the sink and sent to the packaging. On the way to the packaging, filled bottles with sparkling wine are checked for defects, that is, they are illuminated by a laser with a special sensor on the one hand, and on the other hand, the receiving part of the sensor analyzes the density of the signal beam from the laser, if the signal is weak, then the bottle filled with wine, but suddenly the signal turns out to be stronger, then the density is lower, which in turn means that the bottle is empty, maybe the dispenser did not fill it. In any case, it is impossible to pack a defective product with a full one.

It is necessary to eliminate it from the conveyor, for this the manipulator (robot) "Universal Robots" of the UR10e model series is suitable, since they are safe when working with people. Since there is a washing, a marriage check, a label sticker and the packaging itself, which most people can do, is located in the workshop. The use of conventional manipulators can lead to injuries to people at work in cramped workshops, as they do not provide protection.

In cobots "Universal Robots" protection is provided for working with people, for example, when it is working, it accidentally touches a person, the robot instantly stops and will wait for some time according to the algorithm or already an operator's command to continue working, which will give time to a person, which hit, leave this place.

Consider a line of collaborative robots, which consists of four instances (shown below).

A brief description of the line e-series: created with a view to the future, the e-Series line allows you to expand your business, is a springboard to improving quality and increasing productivity, helping you always get ahead of your competitors. With an intuitive programming option, versatile use and an endless list of accessories, the e-Series line fits harmoniously into production regardless of industry, company size or product nature.

Universal Robots “UR3e”



Image 3. Universal Robots UR3e
Specification

- Radius – 500 mm / 19.7 inch
- Payload – 3 kg / 6.6 lbs
- Footprint – \varnothing 128 mm
- Weight – 11.2 kg / 24.7 lbs

Universal Robots “UR5e”



Image 4. Universal Robots UR5e
Specifications

- Radius –800 mm / 33.5 inch
- Payload – 5 kg / 11 lbs
- Footprint – \varnothing 149 mm
- Weight 20.6 kg / 45.4 lbs

The latest offering in our collaboration robot series, UR5, extends the capabilities of agents ready for future change with collaborative innovation, Human Centric UX, and the ecosystem for each application. Transform ambition into results by changing the way you manufacture using the most flexible automation platform.

Universal Robots “UR10e”



Image 5. Universal Robots UR10e Specifications

- Radius – 1300 mm / 51.2 inch
- Payload – 10 kg / 22 lbs
- Footprint – \varnothing 190 mm
- Weight 33.5 kg / 73.9 lbs

Universal Robots “UR16e”



Image 6. Universal Robots UR16e

Specifications

- Radius – 900 mm / 35.4 inch
- Payload – 16 kg / 35.3 lbs
- Footprint – \varnothing 190 mm
- Weight 33.1 kg / 73 lbs

Universal Robots “UR16e”, a recently released novelty that expanded the e-series family, one of the main differences from the “UR10e” is the reduced range from 1300 mm to 900 mm, but this is offset by an increase in carrying capacity by 6 kg, for example, “UR10e” - 10 kg vs “UR16e” - 16 kg, also “UR16e” became 400 grams lighter than its predecessor.

Consider an analogue of the Universal Robotics

ROZUM Robotics model 90



Image 7. PULSE 90
Specifications

- Payload – 4 kg
- Radius – 900 mm
- Weight – 13.6 kg
- Footprint – 120 mm
- Non-Stop lifetime cycle – 20000+ hours

In this work, it will be rational to choose a collaborative robot “UR5e”, since the maximum weight of the bottles will reach 3.5 kg, it would also be better to use the robot “UR10e” in the radius of use, but for the work area, “UR5e” is enough, in addition, a larger radius may be needed only in isolated cases, it will not be necessary to overpay for a more expensive modification if it does not work out at 100 percent.

One of the main differences and arguments for using cobots of the “Universal Robots” from their counterparts is the safety of working with people around, for example, if a person touches him while the robot is working, the cobot will stop and wait for further action or according to the algorithm it will work after a specified time further

Also, the presence of the robot itself is not sufficient to realize its full functionality - grips are additionally used (we will consider below different analogs of grips that have unified mounts for a universal platform of colorative robots).

Manipulator Grip WSG25-CR



Image 8. Grip WSG25-CR

Specifications

- Compliance with safety requirements for human-robot interactions
 - Quick integration
 - Built-in web interface with documentation for configuration and diagnostics
 - Support for textual communication protocols over TCP / IP and UDP, as well as the industrial Modbus / TCP interface
 - Grip control directly by the robot controller via the integrated Modbus / TCP interface

Grip integration without the need for programming. The built-in controller uses the latest capture algorithms, high-speed object detection and capture control.

External position sensors are no longer required since position measurement is carried out using internal sensors. This simplifies the process of integrating a robotic solution into your manufacturing process.

OnRobot RG2 Gripper



Image 9. OnRobot RG2 Gripper Specifications

- Easy installation
- Integrated control board
- Flexible, easy to reconfigure
- Support for two grips simultaneously
- Adjustable force
- Wide working range, work with objects of different sizes
- Fast change of fingers of capture
- Plug & play
- Easy programming
- Retention of gripping force in case of power loss
- Analog Robot Feedback

Adjusting the grip force allows you to hold both light and heavy objects. Standard fingers can be used with many different objects. Installation on capture of third-party fingers is possible. Configure and control capture from Universal Robots software. Technical specifications are shown in the image 10.

Параметр	Мин.	Типичное	Макс.
Полный ход (регулируемый)	0	-	110 мм
Точность позиционирования захвата	-	0,1 мм	-
Повторяемость	-	0,1 мм	0,2 мм
Обратный люфт	0,2 мм	0,4 мм	0,6 мм
Сила захвата (регулируемая)	3 Н	-	40 Н
Точность силы захвата	$\pm 0,05$ Н	± 1 Н	± 2 Н
Скорость захвата	55 мм/с	110 мм/с	184 мм/с
Время захвата	0,04 с	0,07 с	0,11 с
Рабочее напряжение	10 В	24 В	26 В
Потребляемая мощность	1,9 Вт	-	14,4 Вт
Максимальный ток	25 мА	-	600 мА
Рабочая температура окружающей среды	5 °С	-	50 °С
Температура хранения	0 °С	-	60 °С
Вес	-	0,65 кг	-

Image 10. Technical specifications

And the last of the three grip options

GRIPKIT-E1



Image 11. GRIPKIT-E1 Specifications

- 20 million work cycles guaranteed
- Uptime 24/7

- Automatic detection and monitoring of captured objects
- Support for up to 8 captures connected to one robot

A fully integrated solution for Universal Robots. GRIPKIT contains everything you need to realize the task of capturing and moving within a few minutes. It is fully compatible with all Universal Robots models and integrates seamlessly into the Polyscope software environment with the easy-to-use URCaps plug-in.

GRIPKIT is available in various sizes with grip forces from 7.5 to 550 Newtons and is compatible with all robots from Universal Robots, making it the ideal solution for a wide range of applications.

Software was used to work as collaborative robots.

- URsim
- RoboDK
- Programming environment – Python

The software RoboDK is such a description:

Processing robots

Use your robot arm like a 5-axis milling machine (CNC) or a 3D printer. You can simulate and convert NC programs (G-code or APT-CLS files) in the program of the robot itself. RoboDK automatically optimizes the robot path, avoiding features, axis restrictions and collisions.

Offline programming software

Modeling and autonomous programming of industrial robots has never been easier. Create your own virtual environment to simulate your application in minutes.

Easily create robotic programs offline for any robot controller. You no longer need to learn vendor specific programming.

Also, RoboDK has a built-in online library or manually loaded with many different manipulators, robots that you will find on the market, there are also many objects with which these robots work, for example, a grab or drill, or even a welding machine.

One of the conveniences of this program is that the programming of collaborative robots allows you to download program code written in the python language and edit in the program itself each movement in each axis individually for any task.

It can also be noted that robots can be controlled not only by a software algorithm, but also use a real-time control display (shown in the image 12).

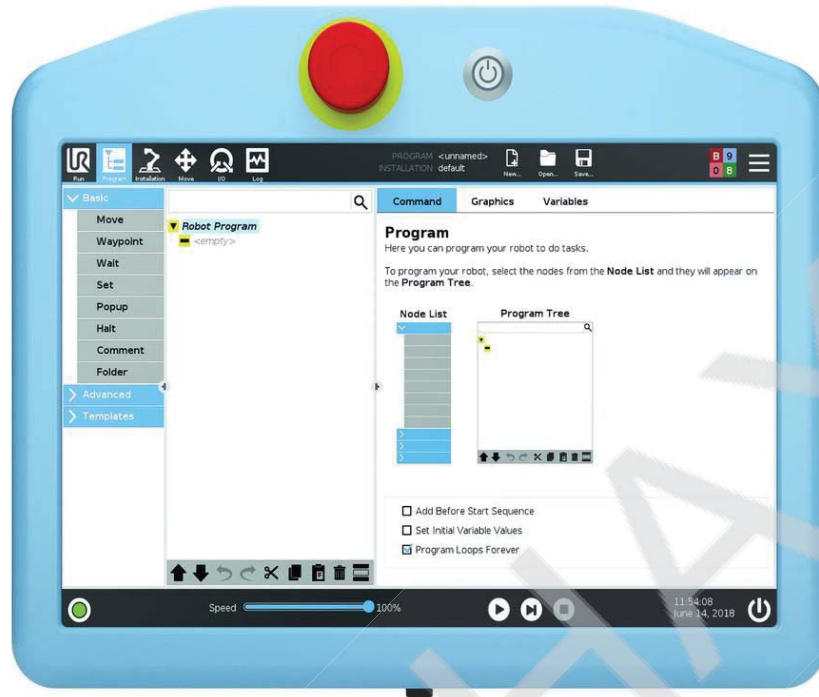


Image 12. Control display
Display features

- Real-time robot control
- Emergency stop
- Monitoring the work of each axis and their degrees of rotation
- Robot calibration

Also, one of the programs for work is yursim software, it allows you to start work in a virtual mode, it is convenient when your robots are busy with work and stopping them can cause the process to stop, therefore testing certain modes of work in virtual mode is a good solution.

Principle of operation

The standard position of this robot above the conveyor belt and products, using transillumination sensors or a vision camera, determines the product itself and its quality. in this case, these are bottles of wine products, if the bottle is very easy to see through, it means that it is empty. (image 12).

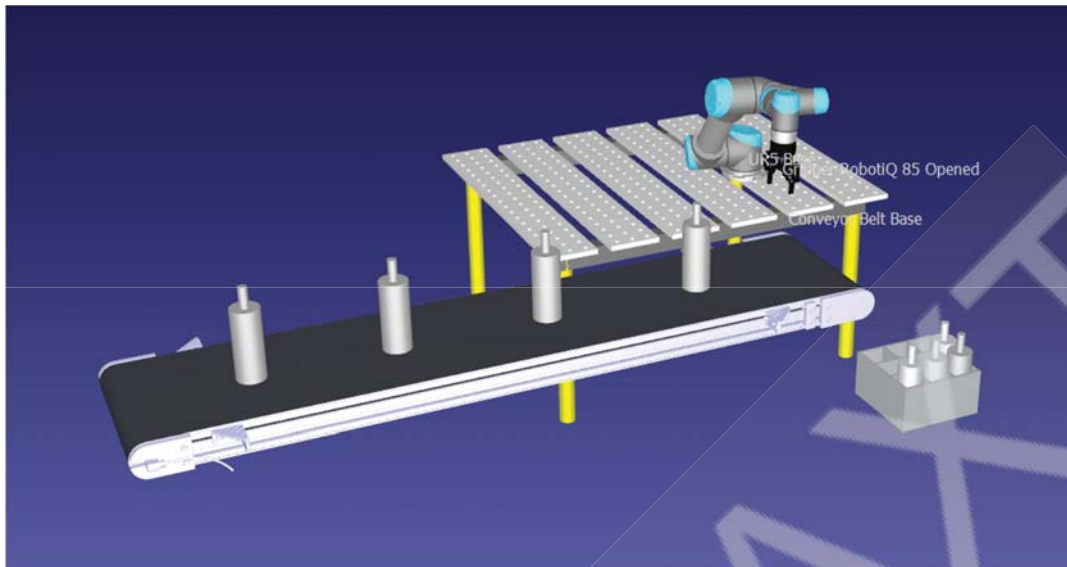


Image 12. Initial position

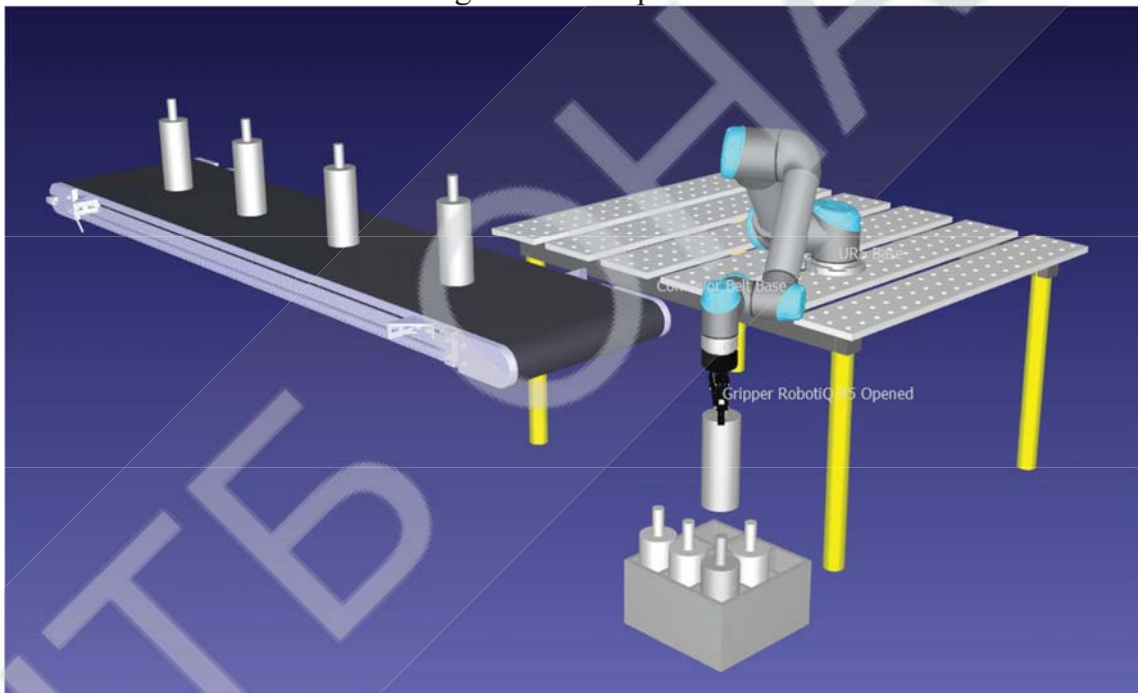


Image 13. Initial position

Image 13 shows the mode of operation when the robot places the gripped product in the container.

When a defective product is identified, the robot places it not in a container, but in a special area. in image 14, a yellow square is displayed. After that, the robot continues to pack the products as usual.

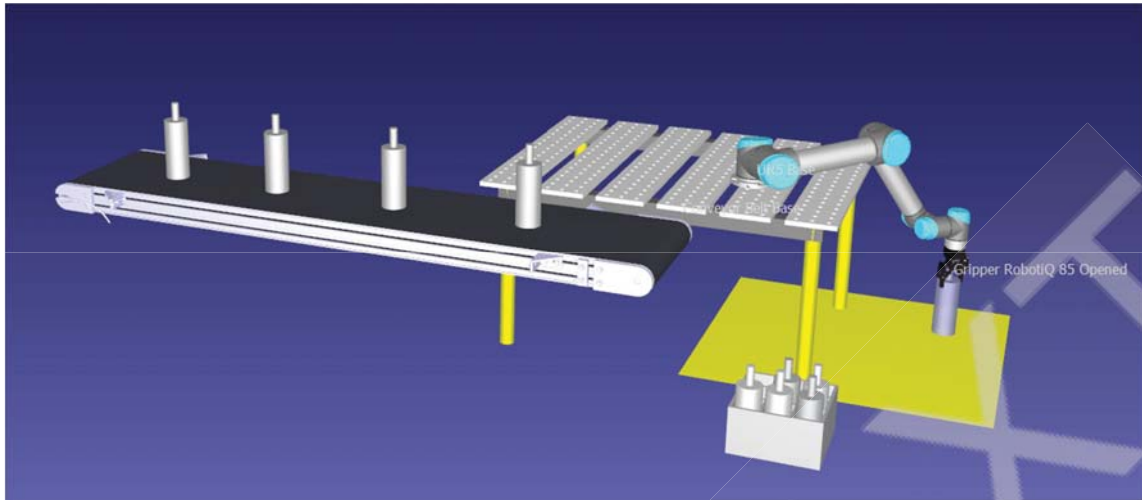


Image 14

Laboratory tests

Laboratory tests were carried out on a laboratory bench (image 15) in the laboratory of robotics and mechatronics fab lab. Also, to control the conveyor, a programmatic controller of the Phoenix Contact company was used, where the regulating body was a frequency converter to control the speed of a three-phase motor. In order to properly maintain the variable conveyor speed, PID control was used. In order to select the tuning parameters of the controller parameters, an identification of the control object was made, namely the conveyor. We managed to get the data of the transient process from the SCADA system (Image 16). After that, according to the data of the control object, the parameters of the PID controller were calculated, after which the process was simulated (Image 17) and the parameters of the PID controller were optimized - Image 18.



Image 15

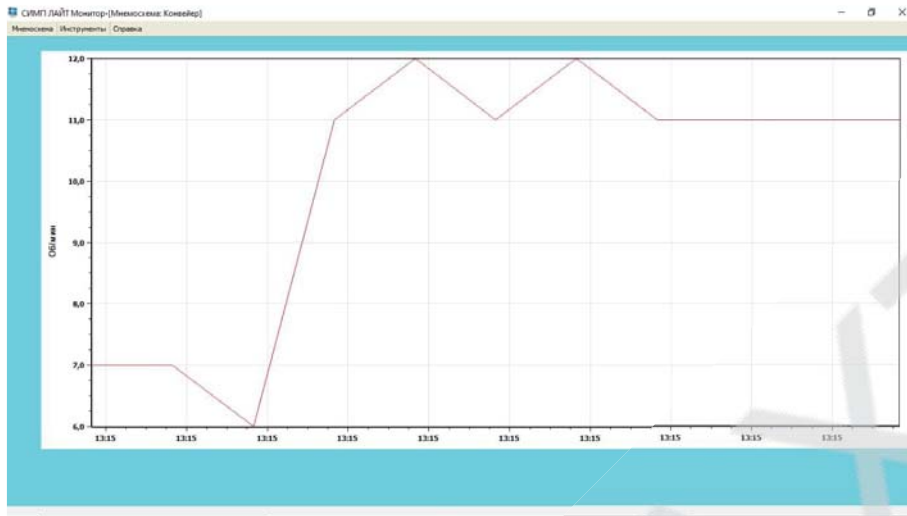


Image 16

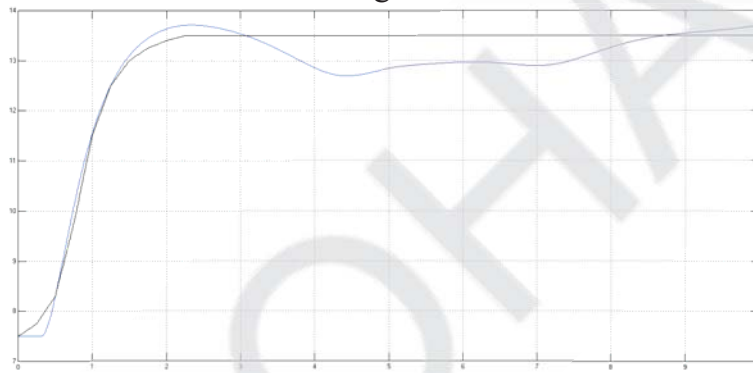


Image 17

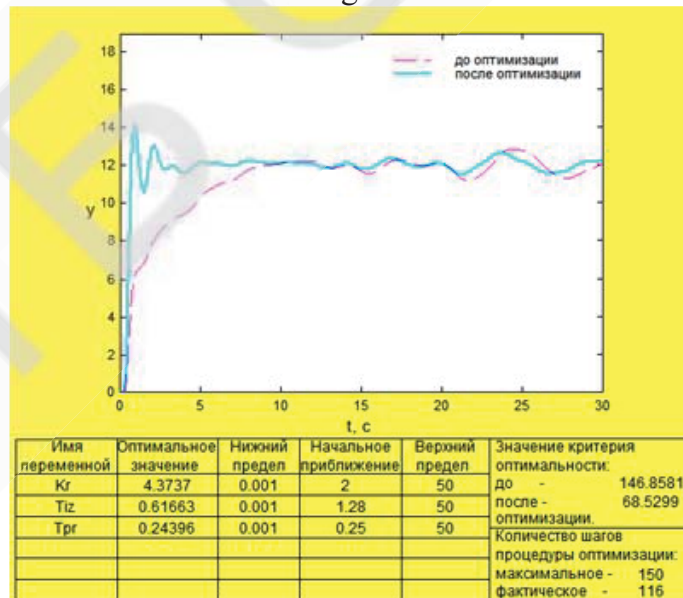


Image 18

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_{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.

Literature

1. Jean-Riberto Guyon. Theory and practice of winemaking. T. 3. Methods of winemaking wines. Remaking in wines - M.: Kharchova promislovist, 1980 - 480 p.
2. Sarishvili N.G., Reyblat B.B. Microbiological fundamentals of technological champagne wine - Moscow: Kharchova promislovist, 2000 - 364 p.
3. Makarov A.S. Virobnitstvo champagne. - Simferopol: "Tauris", 2008 - 416 p.
4. <https://www.universal-robots.com/products/ur10-robot/>
5. <https://sovtest-ate.com/equipment/wsg25-cr/>
6. <https://sovtest-ate.com/equipment/gripkit-e1/>
7. <https://sovtest-ate.com/equipment/onrobot-rg2-gripper/>
8. <https://rozum.com/robotic-arm/#available>

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

Author: **Dmytro Makletsky**

Advisor: **Serhii Kovtun**

Одеська національна академія харчових технологій (Ukraine)

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

Environment for teaching children the Kazakh alphabet. Author: <i>Sagyngaliyev Renat</i> , Advisors: <i>Zhakhiena Aizat, Bazarbayeva Ainur</i> , Zhangir khan University (Kazakhstan)	402
Monitoring and managing system of microclimate indicators in educational facilities. Authors: <i>Viesielovskyi Danylo, Ivashchenko Oleksii</i> , Advisor: <i>Ischenko Mykola</i> , Kryvyi Rih National University (Ukraine)	414
Development of electronic payment systems and security of their functioning. Author: <i>Anna Severenchuk</i> , Advisor: <i>Lyudmila Polovenko</i> , Vinnytsia Trade and Economic Institute KNTEU (Ukraine)	426
Use of K-Nearest neighbour method in analysis of student data from surveys. Authors: <i>Ekaterina Konstantinova, Kamen Kalchev</i> , Advisor: <i>Tsankov Tsvetoslav</i> , Konstantin Preslavsky University of Shumen (Bulgaria)	435
Mobile study application informatics of schoolchildren. Author: <i>Sofia Ruslanovna Cherednichenko</i> , Advisor: <i>Evgeniy Oleksiyovych Shakurov</i> , KHNPU named of G.S.Skovoroda (Ukraine)	438
Organization of international cargo delivery in a digital economy. Author: <i>Yelyzaveta Arkhanhelska</i> , Advisor: <i>Olga Katerna</i> , National Aviation University (Ukraine)	446
Victory Manipulator Universal Robots in the line sorting of finished products of the wine industry. Author: <i>Igor Kotsur</i> , Advisor: <i>Volodymyr Honhalo</i> , Одеська національна академія харчових технологій (Ukraine)	457
Automation of positioning of pneumatic actuators by means of introduction of the Phoenix Contact controller. Author: <i>Dmytro Makletsky</i> , Advisor: <i>Serhii Kovtun</i> , Одеська національна академія харчових технологій (Ukraine)	473
Kinematic analysis of the hinge-lever mechanism of the gripping device anthropomorphic robot. Author: <i>Vladyslav Borysov</i> , Advisors: <i>Yevgen Mykhaylov, Oleksandr Kniukh</i> , Odessa national Polytechnic University (Ukraine)	480
Robotic packaging system products from primary to secondary packaging. Author: <i>Vlad Sydorov</i> , Advisor: <i>Serhii Kovtun</i> , Odessa National Academy of Food Technologies (Ukraine)	491
Modern SSDs: a high-tech solution to the obsolete HDD systems. Author: <i>Ekaterina Konstantinova</i> , Advisor: <i>Tsvetoslav Tsankov</i> , Konstantin Preslavsky University of Shumen (Bulgaria)	498
Complex system of AI interactions in social simulation of a city infrastructure. Author: <i>Ildar Sabirov</i> , Supervisor: <i>Olga Olshevskaya</i> , Odessa National Academy of Food Technologies (Ukraine)	505
System of automated detection of ceramic disc surface defects. Author: <i>Bohdan Konechnyi</i> , Advisors: <i>Maksym Semenchenko, Roman Velgan</i> , Lviv Polytechnic National University (Ukraine)	513

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa National Academy of Food Technologies

The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

Responsible for the issue: Sergii Kotlyk

Computer typesetting and layout: Oksana Sokolova

Odessa 2021