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*Odessa National Academy
of Food Technologies*



International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

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Odessa National Academy of Food Technologies, 2021

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ROBOTIC PACKAGING SYSTEM PRODUCTS FROM PRIMARY TO SECONDARY PACKAGING

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Advisor: *Serhii Kovtun*

Odessa National Academy of Food Technologies (Ukraine)

Annotation

The paper considers the problematics of production lines of modern confectionery factories, discusses the issues of existing analogues and options for solving problems on the packaging lines, the advantages of implementing collaborative robotic complex in the ecosystem of the plant.

The main purpose of the work is to identify the problematics of production lines for packing products in secondary packaging in confectionery factories, to optimize the production area by introducing collaborative robot Universal Robots, to analyze the production of confectionery products, to develop a rational solution to the problem and calculate the ROI.

Key words: *confectionery factories, secondary packaging, robotic complex, collaborative robot, ROI.*

I. INTRODUCTION

According to 2020 data, nearly 3 million robots are used in industry worldwide, including collaborative robots. Collaborative robots are robots that are designed to work together with an operator.

The use of robots in modern industrial production and construction is due to the need to replace humans in the technological process to intensify production and create new technologies.

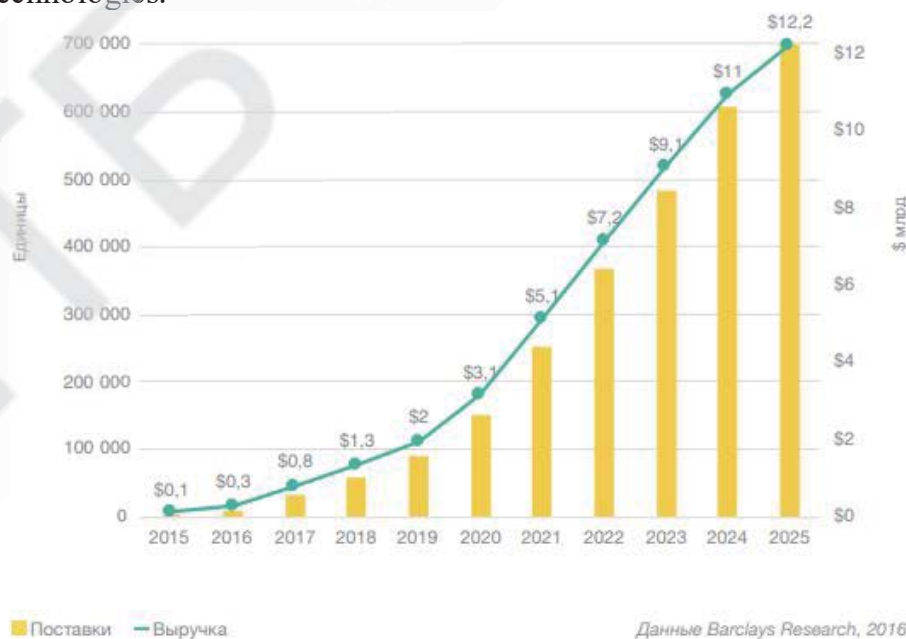


Image 1 - the dependence of end-user revenue on the supply of robots

The first cobot was invented in 1999 by Edward Colgate and Michael Peshkin, engineers at Northwestern University. But the breakthrough in the history of collaborative robotics came from the Danish company Universal Robots.

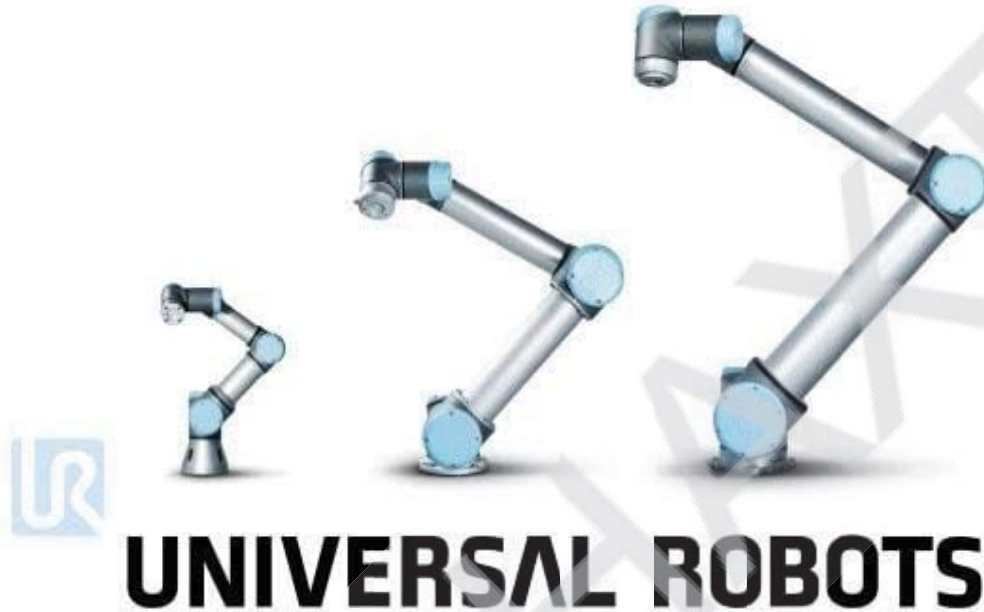


Image 2 - A series of collaborative robots from Universal Robots

One of the advantages of cobots is a wide range of applications, robots can be used in object relocation, injection molding, CNC machining, packaging and product stacking, quality control, assembly, polishing, for machine maintenance, laboratory testing, welding metal structures and others.

The payback period of such a robot (from 2 to 6 years) in the Ukrainian market and (from 12 to 36 months) in the European market.

By installing a robot you can remove the human factor in production, namely:

- a human can work for a limited time;
- a person can make a mistake;
- a person may fall ill;
- the person may quit.

II. LITERATURE ANALYSIS

The analogues in the field of industrial and collaborative robotics applications were analyzed. The theory of programming a modern collaborative robot Universal Robots was studied. Possible options for site automation in the confectionery production were studied.

The analogues of automation of a site on the basis of industrial robot KUKA AGILUS, with load-carrying capacity 6kg, but this robot is not suitable as the confectionery manufacture demands flexible application to production, hence the bias on the collaborative robot was made.



Image 3 - Picture of the KUKA AGILUS robot

The analogues of the gripper for this task are considered, considering the adaptability and mobility of the system, as well as the usability of the device itself. Of the existing analogs, one can consider the gripper from Robotiq, Schmalz, and OnRobot.



Image 4 - Photo of the analogues of the gripper device from the campaigns Robotiq, Schmalz, OnRobot

Object, subject and research methods

The subject of the study in this paper is the packaging process and its optimization in real production.

The following input data were used during the site analysis phase:

- 30 packs per minute enter the packing area;

- the product gripping mechanism should be adaptive;
- packaging options should be adaptable to any crate size;
- the product should be packaged without damaging the product.

The object of the study in this paper is the design of a robotic complex for packing confectionery products in secondary packaging based on collaborative robot Universal Robots.

This robotic complex consists of several areas:

1. Conveyor with products;
Conveyor on which 30 packs per minute are moved, the speed is limited due to a human standing in the packaging area
2. an automated shelf to collect the layer of packs;
Automated shelf based on electric axles and pneumatic cylinder
3. Primary product packaging areas;
Adaptable zones for crates (in 2 rows of 5 units and height of 6 units) and boxes (in 1 row of 3 units and height of 3 units/ in 1 row of 3 units and height of 1 unit/ in 2 rows of 2 units and height of 5 units/ in 1 row of 1 unit and height of 5 units)
4. Pylon with robot;
A mobile system that can be moved and disassembled as needed.
5. Rack with panel to control the robot and HMI panel to control the whole system.

System to control the robot and the mechanical shelf separately in order to select the "product packaging recipe", adjust the system to new products, calibrate the robot, etc.

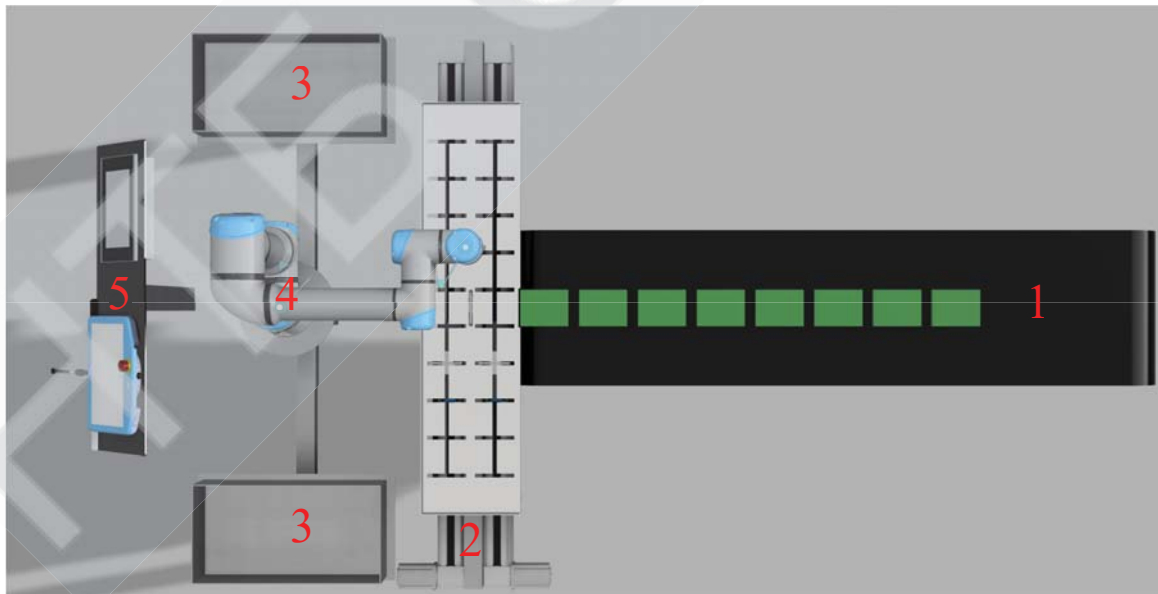


Image 5 - Schematic diagram of the developed robotic complex

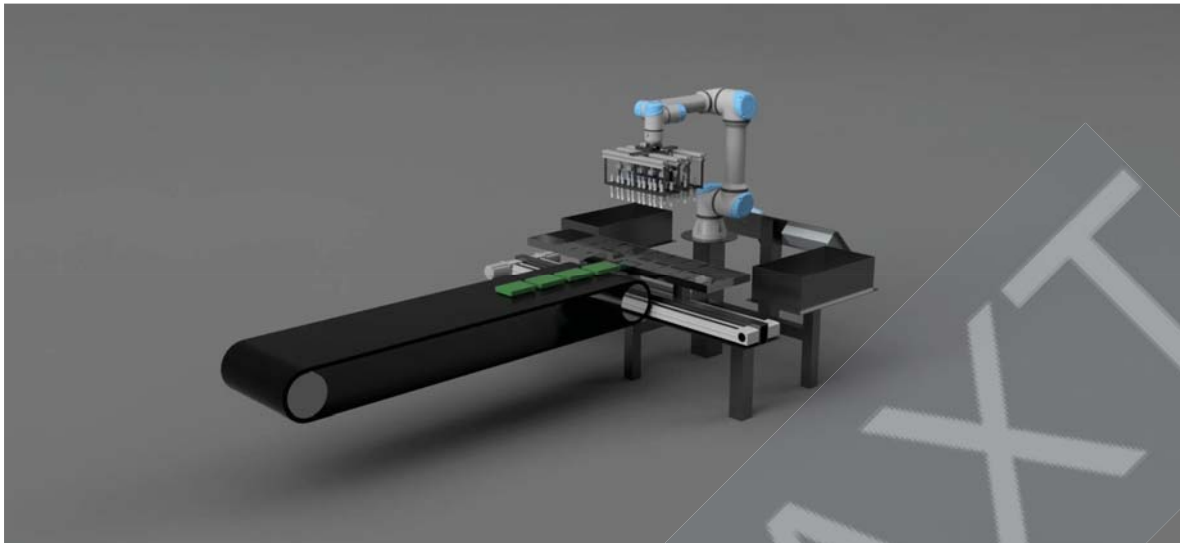


Image 6- Side view of the robotic complex

Cycle tests for approximate analysis were conducted at the Mironaft Mechatronics and Robotics Research Laboratory at the Odessa National Academy of Food Technology. The tests were conducted with the UR5 collaborative robot. The robot showed itself positively and managed to perform the necessary operations in precise cycles.

Baselines	Your Application	Potential Scenario	Your Application
Employee on a Shift [Unit]	4	Employee on a Shift [Unit]	0,5
Hours per Shift [Unit]	8	Shift per day [Unit]	3
Shifts per day [Unit]	1	Employee Yearly Salary [\$]	4 280 \$
Employee Yearly Salary and Benefits [\$]	4 280 \$	Downtime Cost	3 210 \$
Downtime Cost	3 210 \$	Scrap Part Cost	1 000 \$
Scrap Part Cost	1 000 \$	Jig and Process Enhancement Cost [\$]	1 000 \$
Jig and Process Enhancement Cost [\$]	1 000 \$	Weeks Worked per Year [Unit]	50

Table 1 - Scheme of site optimization in production

Below is a payback period in Ukraine and Europe, given that the robot has a stable wage of 13.82 \$ / hour.

Ukraine

Time of Reimbursement [Years]:	4,86	(Return on Investment)
Time of Reimbursement [Months]:	58,28	(Return on Investment)
Robot Cell Hourly Rate [\$ / hr]:	13,82 \$	(Total robotic cell cost / total robot working time)
Total Savings [\$]:	69 338 \$	(Cummulative savings after 5 years)

Table 2 - ROI on the Ukrainian market

Europe

Time of Reimbursement [Years]:	0,41	(Return on Investment)
Time of Reimbursement [Months]:	4,94	(Return on Investment)
Robot Cell Hourly Rate [\$ / hr]:	13,82 \$	(Total robotic cell cost / total robot working time)
Total Savings [\$]:	1 416 044 \$	(Cummulative savings after 5 years)

Table 3 - ROI on the European market

Approximately \$10,000 a year will save production by replacing 4 employees with 1 complex and 1 operator, and therefore the production of the product becomes cheaper. There is a possibility of 3 working shifts, which will increase the number of manufactured products by about 6 times.

Below are the charts, where the blue color indicates the cost of purchasing a robotic system, followed by the annual production savings.

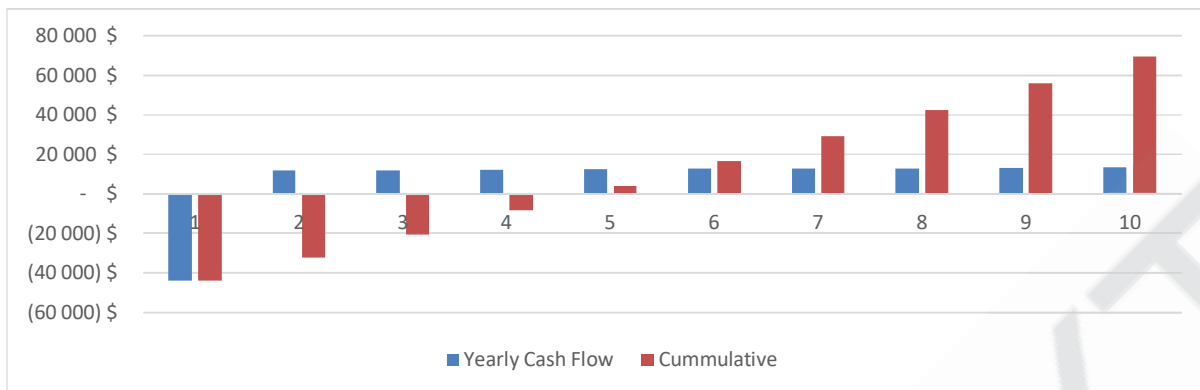


Diagram 1 - The payback period of this complex on the Ukrainian market

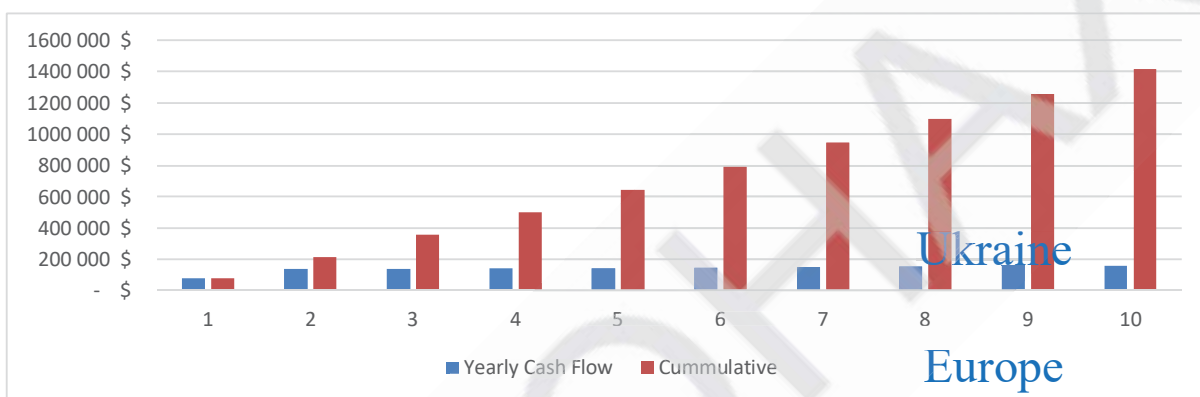


Diagram 2 - Payback on this complex in the European market

Conclusions

So, the problem of production lines for secondary packaging in confectionery factories was identified.

The optimization of the production area was carried out by introducing the collaborative robot Universal Robots, as well as the development of an automated system for the formation of a layer of products for packaging.

Production for the production of confectionery products on the Ukrainian market was analyzed, and an approximate analysis of similar production in the European market was conducted.

A rational solution, which allows increasing the speed of packaging of products in 2 times, was developed, and the RIO for the Ukrainian and European markets was calculated.

The analysis of gripper devices, presented on the market, for work with similar type of production was conducted, after what the decision was made to develop an adaptive analogue for convenient work with confectionery products.

The positive and negative qualities of collaborative robots and industrial robots were studied, after which it was decided to use cobots because they are more adaptive to changes in the packaging area.

I believe that this complex is relevant for the majority of confectionery factories, and the complex is one of the best solutions that are presented in the Ukrainian and European markets.

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MODERN SSDS: A HIGH-TECH SOLUTION TO THE OBSOLETE HDD SYSTEMS

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***Abstract.** Throughout the years, many innovations have been made to all computer components, except memory organization units. The transition from obsolete HDD systems to modern, ultra-fast SSDs has only been initiated in the last ten years. This paper researches basic similarities and differences between both configurations.*

***Keywords:** Data transfer, Error-correcting code, Hard disk drive, High-speed interfaces, NAND, Solid state drive.*

I. INTRODUCTION

HDD hard drive technology is relatively old (in terms of computer history). Computer hard-drive format was standardized at 5.25 inches in the early 1980s, and shortly after that came 3.5-inch desktop and 2.5-inch laptop drives. Nowadays, 2.5-inch and 3.5-inch devices use mostly SATA interfaces. Capacity has grown from a few megabytes to a few terabytes, an increase of a million times.

SSD has a much shorter history. From the invention of personal computers, there was a need for non-mechanical hard drives. Current flash memory is a logical extension of the idea, as it does not require constant power to store the data. The first SSDs were introduced during the rise of netbooks in the late 2000s. With the mass implementation of laptops, the capacity of SSDs has increased and standardized to

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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.

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