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*Vladimir Balaz, Marek Vagas, Jan Semjon, Rudolf Rusnak*

# ASSEMBLY WORKSTATION WITH VISUAL SYSTEM OMRON F150-3 FOR THE RECOGNITION OF COMPONENTS

*Владімір Балаз, Марек Вагаш, Ян Семйон, Рудольф Руснак*

# СКЛАДАЛЬНА СТАНЦІЯ З ВІЗУАЛЬНОЮ СИСТЕМОЮ OMRON F150-3 ДЛЯ РОЗПІЗНАВАННЯ КОМПОНЕНТІВ

*Владимир Балаз, Марек Вагаш, Ян Семйон, Рудольф Руснак*

# СБОРОЧНАЯ СТАНЦИЯ С ВИЗУАЛЬНОЙ СИСТЕМОЙ OMRON F150-3 ДЛЯ РАСПОЗНАВАНИЯ КОМПОНЕНТОВ

*The contribution describes workstation recognition undirected objects. The workstation is equipped robot Scara Yamaha YK600X, which is used for handling and palletizing of parts. Recognition component is used CCD camera Omron F150-3. Workstation transport system consists of two vibration trays, vibration conveyor and two belt conveyors. Control workstation is built on the base PLC omron CP1H.*

***Key words:*** *control system, visual system, robot SCARA.*

*Fig. 6. Bibl.: 12.*

*Описано розпізнавання робочих станцій неорієнтованих об'єктів. Робоча станція оснащена роботом SCARA Yamaha YK600X, який використовується для оброблення і пакетування деталей. Для розпізнавання компонента використовується ПЗС-камера Omron F150-3. Система транспортної робочої станції складається з двох лотків вібрації, вібрації конвеєра і двох стрічкових конвеєрів. Робоча станція управління побудована на базі ПЛК виробництва OMRON CP1H.*

***Ключові слова:*** *система управління, візуальна система, робот SCARA*

*Рис.: 6. Бібл.: 12.*

*Описано распознавание рабочих станций неориентированных объектов. Рабочая станция оснащена роботом SCARA Yamaha YK600X, который используется для обработки и пакетирования деталей. Для распознавания компонента используется ПЗС-камера Omron F150-3. Система транспортной рабочей станции состоит из двух лотков вибрации, вибрации конвейера и двух ленточных конвейеров. Рабочая станция управления построена на базе ПЛК производства OMRON CP1H.*

***Ключевые слова:*** *система управления, визуальная система, робот SCARA*

*Рис.: 6. Библ.: 12.*

**Introduction.** Currently, more intelligent assembly robot cells is a fast moving area in increasing the efficiency of assembly cells. Increasing intelligence must be achieved in order for the cell itself able to make decisions based on data obtained from various devices sensing process flow in the cell. In the case of irregular arrangement of objects on the pallet will set a situation where you can not use a fixed program and network deployment. In this case, it is appropriate to recognition the objects placed on the pallet and detecting the orientation of the CCD camera used.

A typical industrial camera captures and transmits images through a standard by camera bus, such as Camera Link or IEEE 1394 to connect to a PC or image processing systems, which evaluate images to extract the useful information. Intelligent cameras simplifies this process, as image analysis takes place directly in the camera. Their core is a processor on which a complete set of algorithms works on vision. Image sensor used in smart cameras is a high-quality CCD sensor type that can scan monochrome images in VGA resolution (640 x 480) at up to 60 frames per second. CCD sensor produces sharp images, increasing the accuracy of algorithms such as edge detection and pattern recognition. Intelligent camera control system given the necessary information about the object and then sends a signal to the robot (manipulator) for correctly grasping an object.

**Camera systems used in robotic applications.** For computer vision in automation and industrial production assumed the connection of vision. With the advancement in the field of semiconductor technology and microprocessors, the price decreased vision sensor, allowing greater penetration of these devices in the enterprise and the overall in industrial automation. Value camera system versus achieve quality benefits in production over time equalized, the market came new technologies faster processor for processing the flow of image information

with higher computing power, more memory, and today it can already be stated that CCD camera systems are a part of every major industrial operation. When mass production, which applies the so-called. Totally controlled (TQM) each piece of product produced visual inspection systems are simply irreplaceable. The industry is generally most frequently used camera to control product quality. The check is performed by comparison of shapes and geometric characteristics of parts manufactured with standard components. You are in memory of the camera system sometimes already inserted during the calibration of the cameras. Some applications of the camera system can be seen in Fig 1.

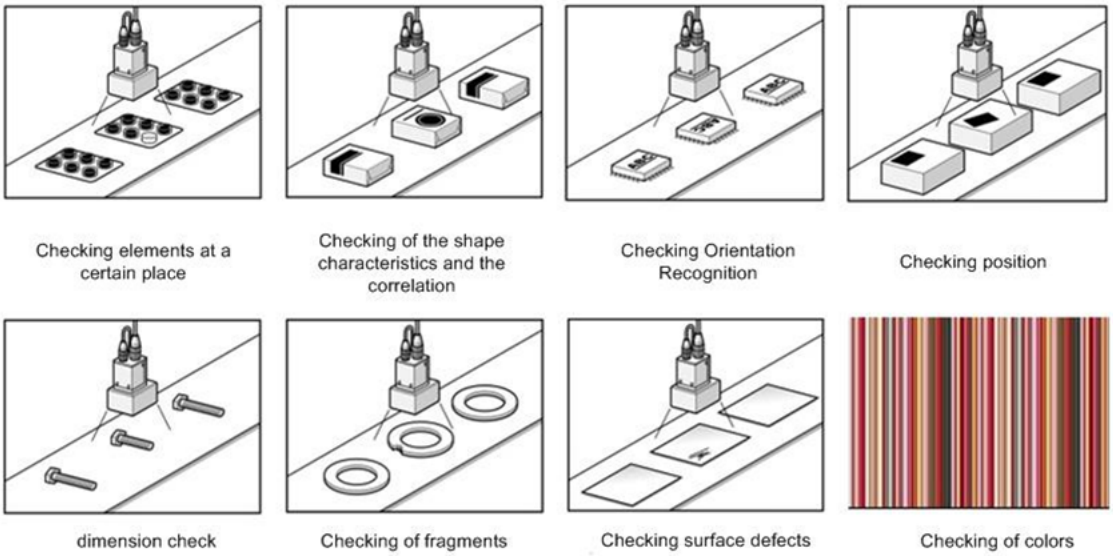


*Fig. 1. Application camera system*

Another application of cameras in the industry's control over the technology. Here is one example. continuous monitoring of machine welding using special cameras. This control is carried out even in the course of welding and allows the "real time" correction setting welding machine which performs welding, thus achieving optimum adjustment of the length of the weld. Undoubtedly progressive trends deployment of CCD systems in the industry (and laser scanner) is the ability of the subject of various shapes and sizes and their import into CAD systems using special software that converts the recorded object to a compatible 3D model. The most difficult elements of such a system is undoubtedly the software that implements the conversion and very important is its link with the actual scanning device and its moving parts, so in order to scan the object from different sides and angles. Reconstruction of scanned objects, and coordinate transformation within CAD systems will be made only after taking a sufficient number of views.

Identification and optimal navigation paths actuators and industrial mobile robots Another vast area where find their application video surveillance in industrial production. These systems have the task to find the most suitable trajectory of movement of the robot and avoid collision situations with other objects, so that the dynamically changing surroundings robot equipped with cameras to ensure smooth operation, shorten production times and avoid adverse events. Vision systems are often used to handling systems, material and robots for general management and also sort and selection of storage. Guidance of robots with vision systems provide solutions for industrial process automation, which increases production capacity and reduces the usual time of manufacture, saves money and increases overall production.

**Camera system omron f150-3 (2d).** The conceptual design of the cell assembly it is possible to use an inspection camera system OMRON F150-3, consisting of a camera and an evaluation unit. The camera lens is built and also has a passive lighting. Around the camera lens is placed a ring of red LEDs that forms the passive optical source and is used to illuminate the scene with adjustable brightness. Synchronizing measurement is carried out via

Digital input and output lines that are associated with the control system via the communication port RS 232/422. Fig 2 jis an inspection camera system OMRON F150-3.

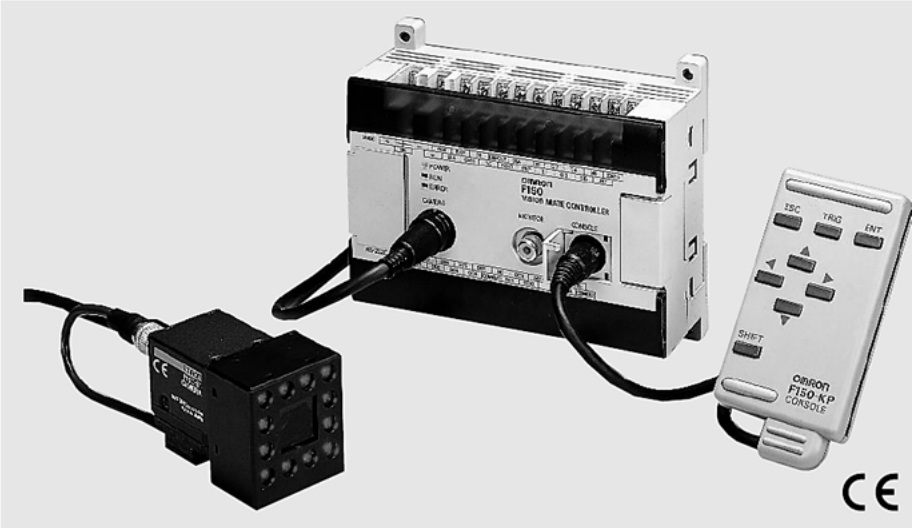


*Fig. 2. Inspection camera system Omron F150-3*

Term vision system 35 images, which are then used as patterns for recognition. One image is saved as a template and 34 as a possible failure. The system then compares the real scene and saved designs and evaluates the compliance rate. A slot for a standard portable Flash memory is part of the system, which can store image patterns, pictures of settings, but also real scene. Exit system displayed on the screen and user administration. The flaw rectangular area is automatic and adjusts the measured object. The system adjusts the measuring area when changing position the subject, which affects the rate of assessment. Rotated object is coveted by rotation from 0 to 360 degrees, giving the position and angle of rotation. Method of measuring the distance of the two edges is used to determine the length or width of the object.

Camera system OMRON F150 - 3 is composed of the following components:

– Two camera F150- S1, F150-S1A, 35mm lens
– F 150- KP, control unit camera system
– Basic control unit F150-C10E-3,
– LCD monitor F150- M05L
– Interfaces CompoBus/D, RS-232C
– Power supply and the associated cabling (F150- VS)
– Personal computer connected via serial port to the control unit
– F150-A20, unit that allows you to connect two cameras

Basic parameters of control unit F150-C10E-3 (specific features and functions), Fig.3:

– Number of connectable cameras – 1 until 2 (the use of F150 – A20).
– The number of pixels – 512(H) x 484 (V).
– Number of images – 16 (option to back up to a personal computer via serial port RS-232C).
– Image storage function - max. 23 saved images.
– Image processing method - Gray / Binary.
– Image filtering - smoothing, edge enhancement, edge extraction, background suppression.
– The number of digital levels - 256 to one area.
– The number of measurement regions - 16 regions / image.
– Measurement data - binary center of gravity and surface angle axis correlation value, search positions, position played, debugging, density averaging, rising edges.
– The functions of data operations - arithmetic calculation, distance, angle, max / min value, absolute value, etc.

– Results output - the overall result, outcome measurement / individual area (output can be connected in parallel via the serial port RS-232C).

– Linking monitor - 1 channel.

– Connection RS -232C - 1 channel.

– The number of parallel input / output (I / 0) - Output 11/21 outputs (including control I / 0 points).

– Types I/0 – NPN,PNP.

– Supply voltage - from 20.4 to 26.4 VDC (including ripple).

– Current consumption - 0.5A (approximately).

– Focal lenses mounted on the lens: 35 mm.

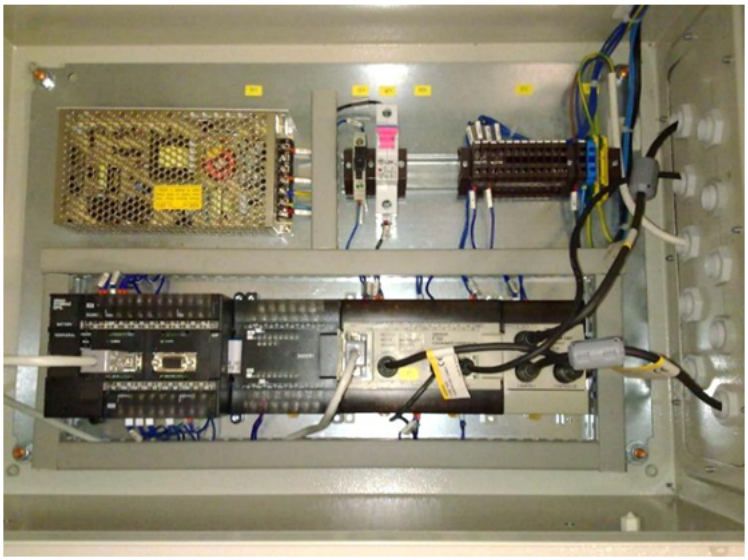

*Fig. 3. Control unit of camera system F150-C10E-3*

When applying intelligent light source due to the evenly lit scene with the measuring target object measurement is possible camera F150 - SLC50 capture object smaller than 50 x 50 mm at a distance of 16.5 to 26.5 mm. If the end user of the camera system chooses instead an intelligent light source to deploy common additional light source, so when the camera type F150 - SL50 can in the field of view camera detects an object the same dimensions (<50 x 50 mm), but from a distance (approx. 66 to 76 mm). Field of view cameras F150-S1A with 35 mm lenses without intermediate member at a distance of approx. 600 mm to 3000 mm from the object manipulation is from 50 x 50 to 300 x 300 mm. [2][3]

**Assembly workstation with visual system.** Robot with a camera Omron F150 is being built under the project, which is to be implemented workstation for laboratory tests SCARA robot for manipulating 3D objects undirected a visual system. Workstation with robot SCARA and camera system Omron F150-3 is Fig.4.

Components workstation:

– SCARA type of robot - industrial robot.

– Exchanges of equipment effectors - automatic device allows smooth change of effectors according to the requirements of the control system.

– Intelligent input conveyor - conveyor which operates semi-finished products or pallets.

– Output conveyor - conveyor which operates pallets, semi-finished or finished products.

– Vibratory conveyors - vibrating conveyor for conveying the material.

– Vibrating stack - used for storage and orientation of components in the desired position.

– Palletizing devices - devices capable palletize of palette as required.

– PLC control - control system upper level is able to communicate with subordinate control systems.

– Touchscreen - a device used to control and display information on the implementation process.

– Rotary actuators - Actuator used to create modular devices.

– Notebook - powerful laptop for programming handling equipment

– The control computer - PLC - control computer for the top management of the robotic cell and operate peripheral devices.

– Powerful computer - PC - a powerful computer for online and offline operation and programming of the robot

– Universal gripper - universal gripper for the gripper for handling components.

– Camera system – vision system for robot.

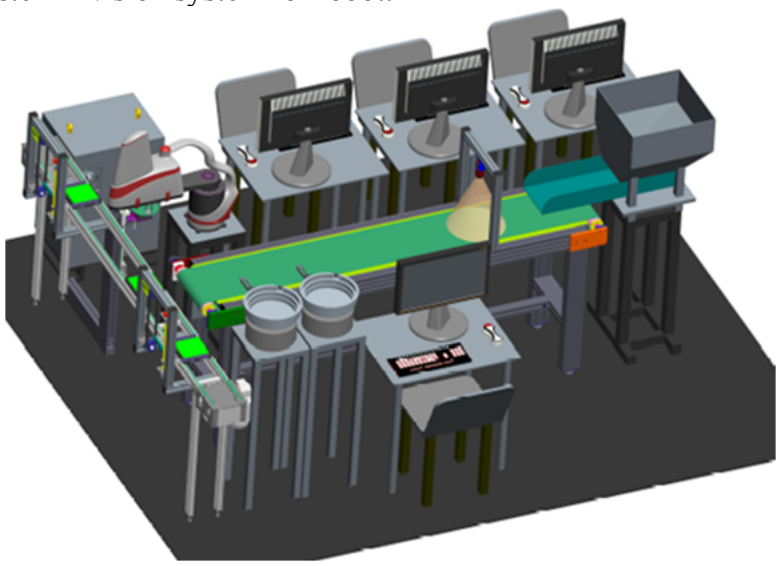

*Fig. 4. Design automated Workstation for recognition components by cameras*

To stand above the belt conveyor conveying the input volume parts are cameras whose field of vision covers the entire width of the conveyor. Manipulation of objects, handled by SCARA robot are a total of three. Representative volume element is a plastic molding designed for installation in electrical wall switches with power to 230 V. surface elements constituting the switch assembly, coming from work vibrating trays are made of steel thickness of 1 and 0.7 mm. The assembly composite switch without connecting material is shown in Fig. 5. [9][10]

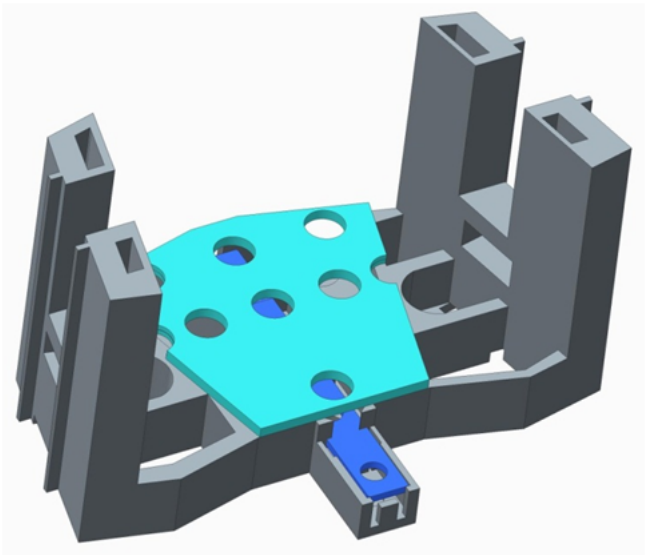

*Fig. 5. The assembly mounted switch*

Real workstation is mounted SCARA Yamaha YK600X QRCX with control system and camera system Omron F150-3. Control assembly workstation provide two PLC Omron CP1H-type units and CP1E. Camera system connection with the control unit PLC CP1H provided via RS232C PLC CP1L. The control unit is realized by a touch panel where we can choose from two modes - manual and automatic. Supply of pallets is solved by using the output conveyor with palletizing and depalletizing unit which are driven by stepper motors. The individual components of the assembly are located in two vibratory trays and a vibrating conveyor. Components of vibrating trays are taken out of the robot fixed positions. The components of the vibrating conveyor belt is transferred to the input conveyor, which are transported by the camera, where the position captured. Information about position components are sended to control system of workstation (PLC CP1H). Control system sends commands to control the robot QRCX. Robot gets coordinate components of the input conveyor and moves to the desired position, where the performance grip part and then stores it on a pallet. Palletizing and depalletizing system ensures supply of empty pallets and removal of full pallets. The workstation is equipped with a replacement system effectors in the event of a change for the workstation.Fig.6.

*Fig. 6. Workstation of SCARA robot and vision systém Omron F150-3*

**Conclusion.** Workstation will serve to verify the non-oriented algorithms for recognizing 3D objects for students to solve and projects. In collaboration with Yamaha YK600X robot can perform assembly processes, palletizing and depalletization. System for the exchange of effector extends the capabilities of the new components.

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## References

1. BRYAN, A.: Co-evolution of product families and assembly systems, The University of Michigan 2008.
2. CORKE Peter: Visual Control of Robots. Dostupné na Internete: http://www.petercorke.com/bluebook/book.pdf.
3. De Xu: Embedded Visual system and Its Applications on Robots.
4. DOBEŠ, Michal: Zpracování obrazu a algoritmy c C#. Praha : BEN-technická literatura, 2008, 144 s.
5. HAJDUK, M.: Pružné výrobné bunky, Vienala Košice, 1998.
6. JURIŠICA L., HUBINSKÝ P., KNOT J.: Algoritmy spracovania dynamických obrazov, AT&P Journal č.2/2004 str.79-82.

7. MICHELINI, R., ACACCIA, G., CALLEGARI, M., MOLFINO, R., RAZZOLI, R.: Computer-Integrated Assembly for Cost Effective Developments, CRC Press LLC/Lewis Publishers, BOCA RATON, USA, 2001.

8. SONKA M., Hlavac V., BOYLE R.: Image Processing, Analysis, and Machine Vision, https://www.google.sk/search?q=Image+Processinf,+Analysis,+and+Machine+Vision,++pdf&ie=utf-8&oe=utf-8&gws_rd=cr&ei=pPvXVtiIFuaL6ASts4TQAQ.

9. SUKOP M., HAJDUK M., BALÁŽ V., SEMJON J., VAGAŠ M.: Increasing degree of automation of production systems based on intelligent manipulation, 2011. In: Acta Mechanica Slovaca. Roč. 15, č. 4 (2011), s. 58-63.

10. TRUCCO E., VERRI A.: Introductory Techniques for 3-D Computer Vision, Prentice Hall Inc., New Jersey 1998.

11. VAGAŠ M., SUKOP M.: Architecture of robot with emphasis to 3D vision system - 2012. In: Transfer inovácií. Č. 23 (2012), s. 169-172. Spôsob prístupu: http://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/23-2012/pdf/169-172.pdf...

12. VAGAŠ M., SEMJON J.: Design of Robotized Workplace for Verification of Selected Types of Algorithms and Methods for Randomly Oriented Objects - 2015. In: Applied Mechanics and Materials : Theory and practice of industrial and production engineering. Vol. 791 (2015), p. 195-200. Spôsob prístupu: www.scientific.net...http://www.machinevisiononline.org.

**Vladimir Balaz –** Eng. Ph.D., scientific researcher, Technical university in Kosice, Faculty of Mechanical Engineering, Institute of Automatization, Mechatronics and Robotics, Department of Robotics (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Владімір Балаз** – Eng. Ph.D., scientific researcher, Технічний університет Кошице, Машинобудівний факультет, Інститут технологій, мехатроніки і робототехніки, факультет робототехніки (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Владимир Балаз –** Eng. Ph.D., scientific researcher, Технический университет Кошице, Машиностроительный факультет, Институт технологий, мехатроники и робототехники, факультет робототехники (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**E-mail:** vladimir.balaz@tuke.sk
**Scopus Author ID:** 55016664100

**Marek Vagas –** Eng. Ph.D., scientific researcher, Technical university in Kosice, Faculty of Mechanical Engineering, Institute of Automatization, Mechatronics and Robotics, Department of Robotics (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Марек Вагаш** – Eng. Ph.D., scientific researcher, Технічний університет Кошице, Машинобудівний факультет, Інститут технологій, мехатроніки і робототехніки, факультет робототехніки (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Марек Вагаш** – Eng. Ph.D., scientific researcher, Технический университет Кошице, Машиностроительный факультет, Институт технологий, мехатроники и робототехники, факультет робототехники (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**E-mail:** marek.vagas@tuke.sk
**Scopus Author ID:** 55014596100
**Google Scholar link:** https://scholar.google.com/citations?hl=en&user=zQLHOh4AAAAJ

**Jan Semjon –** Assoc. prof., Eng., Ph.D, Associate Professor, Technical university in Kosice, Faculty of Mechanical Engineering, Institute of Automatization, Mechatronics and Robotics, Department of Robotics (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Ян Семйон –** Assoc. prof., Eng., Ph.D, Associate Professor, Технічний університет Кошице, Машинобудівний факультет, Інститут технологій, мехатроніки і робототехніки, факультет робототехніки (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**Ян Семйон –** Assoc. prof., Eng., Ph.D, Associate Professor, Технический университет Кошице, Машиностроительный факультет, Институт технологий, мехатроники и робототехники, факультет робототехники (Komenskeho Park 8, 042 00 Kosice, Slovakia).
**E-mail:** jan.semjon@tuke.sk
**Scopus Author ID:** 55571411200

**Rudolf Rusnak** – Eng., Company owner/partner, 2R Invest s.r.o., Bratislava, Slovakia.
**Рудольф Руснак –** Eng., власник / партнер компанії, 2R Invest s.r.o., Братислава, Словаччина.
**Рудольф Руснак –** Eng., владелец / партнер компании, 2R Invest s.r.o., Братислава, Словакия.
**E-mail:** rudolf.rusnak@2rinvest.com
**Scopus Author ID:** 57191828540

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