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Using of Assembly Cell with SCARA Robot to Education of Teachers at Secondary Vocational Schools

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Abstract: This article presents the possibilities of education of teachers in secondary vocational schools in the field of robotics. It is possible to use the assembly cell with SCARA robot, which is provided with a visual recognition system components. The second option consists of the use of virtual laboratory. Virtual laboratory enabling projects to work with robots, NC machines, conveyors and other types of objects. The solution is a system for recording special marks under which a computer generates the appropriate object.

Introduction

Slovakia is characteristic of car production, and it is entirely based on highly automated and robotized production and assembly systems. For the work of many car manufacturers in Slovakia are considerably a lot of suppliers that their operations in terms of quality assurance, flexibility and efficiency are built based on the use of robots. Furthermore, robotics is rapidly penetrating in other industries. In Slovakia, there are several companies designing and implementation of robotised workstation (MANEX, ZTS VVU, MIA Vráble, Sučany, Vukov Extra Prešov, Liptovský Mikuláš etc. and still is increasing them). These businesses can be a success based solely on well-trained graduates from secondary vocational schools for functions: operator of robotic workstations, programmer, diagnostic maintenance, mechatronics and computer science. However, businesses face the problem of lack of knowledge of this graduates of secondary vocational schools operate these robotic systems because they have almost no knowledge of deployment, programming, management and operation of this robotic equipment. After performing deeper analysis it showed that the missing information in the field of robotics leavers are mainly due to insufficient teaching of robotics while studying in their high school. Many secondary schools are not adequately equipped and cannot therefore provide students with adequate training in this area. Similarly, teachers in secondary vocational schools do not have adequate and timely information in the field of robotics. It was therefore prepared a project aimed at training teachers of secondary vocational schools.

Aims of Project

Project is focused on educating of teachers of secondary and vocational schools in the field of robotics. The topic of robotics was chosen as it is widely used in automotive industry in its cutting edge form and automotive industry is the one most developing and growing industry in the Slovak republic and in Europe as well. However, the businesses suffer a great lack of professional operators of these robotized assembly lines and technologies. The lack is significant at the fresh graduates who graduated vocational and secondary schools. The main lack of skills considers inability to operate, program, control, and handling robotized systems. After the state of the art analysis evaluation there were certain conclusions gained, showing lack of information from the field of robotics among graduates. The lack is caused by low level of education at vocational schools. Low level of education in the field of robotics is caused by poor material and technical facilities at secondary schools as well as by poor level of theoretical and practical experiences of teaching staff. Therefore the staffs are not able to pass on important and satisfactory level of education in the field of robotics. Due to above mentioned information the project is focused on teaching staff and it is aimed to create an educational system based on ICT platform. Up to date information from the field of industrial and service robotics will be processed and available to the learners in this platform in the form of e-learning lessons. The second part of educational system will consist of virtual laboratory containing 3D virtual models of robotized and automated devices which can be used in the virtual laboratory. On top of that the project will provide teaching staff of secondary vocational schools (the target group) with review of robotic competitions containing conditions and rules for submission. As these robotic competitions are widely spread and popular with business and educational providers in many countries we want Slovak republic to take part in these activities in greater scale for the purpose of increasing its positive image among other EU countries. There will be seven project partners from three different countries: The Slovak republic, Germany and Poland. Project partners represent and unify wide range of professionals in the field of robotics, production, such as education and a partner of cluster type. The project aims to have an impact and benefits on three areas: the target group - teaching staff of secondary vocational schools, production businesses and students of vocational schools. The target group - teachers - will benefit in terms of gaining the latest information and knowledge from the field of industrial and service robotics, which is now highly popular and attractive giving them the benefit of professionalism. This will give them the chance to be promoted or find a good position at labour market. In the long term point of view the businesses will benefit from having educated graduates of vocational secondary schools. The graduates of secondary schools will possess a high quality education level in the field of programming, operation and handling robotic devices which will give them perfect opportunity to get a job in one of the production businesses which provide high number of vacancies and working positions in the field of automotive production using robotic devices.

The aims of the project are specified as follows:

- Innovation in the content,
- Innovation in modern approach to education, ICT, e-learning, virtual models,
- Innovative for dual education.

Target groups

- Teachers of secondary vocational schools,
- Students of secondary vocational schools,
- Manufacturing companies.

Assembly cell with SCARA robot

Assembly cell serves as an experimental workplace verification module assembly comprising several components. Verify the conditions for entry to Assembly Hall with the claim of intelligent manipulation, i.e., the camera system will evaluate what type of object it is, and then decide on the method of attachment, coordination and synchronize each device cell. Workplace in addition to experimental verification will be used for the project RUSOS. RUSOS project is focused on theoretical and practical training of teachers of secondary vocational schools in the field of robotics. Students will Rusos at the workplace will be individually practicing SCARA robot programming, and programming of the entire workplace. They will be explained in detail the various components of the workplace. Particularly robot-camera system.

To verify the functionality of the assembly process robotized workplace was chosen Electrical socket, the function of which is connecting electrical circuits (loads) and short circuit protection is shown in Fig. 1. Its core is the plastic insert el. socket (detail A). Plastic insert el. the socket consists of three elements, namely the plastic bearing part of the metal tab and the metal substrate in Fig. 1. The parts are assembled piece by piece in a plastic support piece electrically. outlet. Metal tab and pad thickness of 0.8 mm made from sheet metal surface-treated with galvanic alumination.

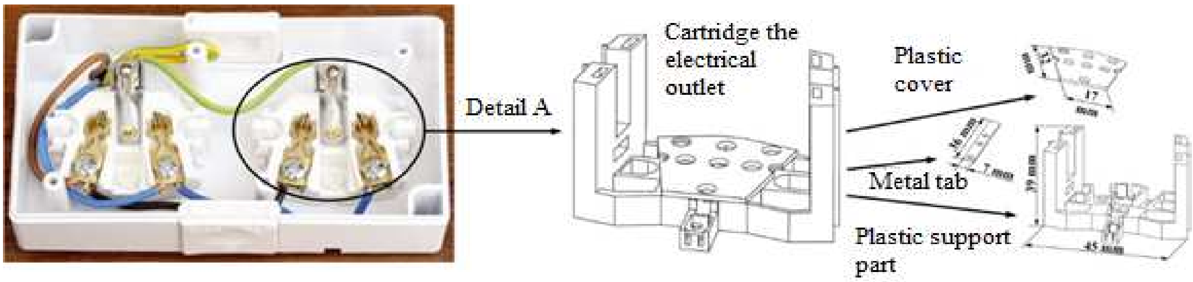

Fig. 1 Individual parts Inserts el. drawer - object assembly

Motivation

The motivation of our work is to show students and teachers the possibility of using robotic technology to a higher level of automation. Our extra motivation:
1.Insufficient training of graduates in the field of automation of production lines with robots
2.Missing profiling subjects of robotics in secondary vocational schools,
3.The need for further training of teachers in secondary vocational schools in the field of robotics.

Assembly process

Verifying the functionality of the assembly process was carried out so that the proposed system are stored in a variety of different parts of the plastic liner wall outlet, and this variety is to store them properly adjusted.

Functional testing of selected components of the assembly process of the plastic liner wall outlet was carried out so that the plastic carrier on the insert power. jacks for output from the vibratory conveyor automatically stored in the system palette with the help of industrial SCARA robot mounted with the appropriate type of effector[1][4]. System palette is positioned by end stop in the desired position. During the verification process is automated installation of plastic inserts el. the socket took place in three steps:

- Step 1 - Grasping the plastic backing of the liner el. outlet. It was carried out directly from the conveyor belt and was realized industrial SCARA robots. Industrial robot is equipped with a gripper adapted to grip plastic backing of the EL. parts. After moving the system palette her position on guide pins. At the same time it ensures the locking system pallet mechanical stop, Fig.2.

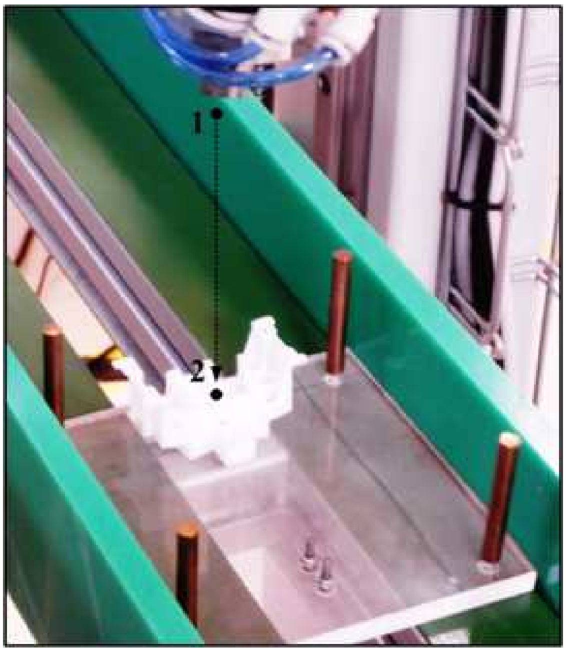

Fig. 2 Step 1: fit, transfer and insertion of plastic bearing inserts el. outlet guide pins on the system pallet

- Step 2 - Grasping the metal tab. SCARA robot was carried out directed position using a vibrating tray. Metal tab has been prepared and directed to the desired position, and was chosen appropriate design of gravity track with respect to a stable position abstracted stop. After moving the system a variety of robot metal tab position to the plastic backing of the EL. outlet that is adapted to its reliable storage.
- Step 3 - Grasping the metal substrate. SCARA robot was carried out oriented position by further vibrating tray. The metal plate was made and oriented into position, with the appropriate construction has been chosen in view of gravity pathway in the stable pad removal position. After moving the system a variety of robot metal substrate position to the plastic backing of the EL. outlet that is adapted to its reliable storage.

The conceptual design of assembly cell can use an inspection camera system OMRON F150-3, Fig. 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. Figure 5 shows the inspection camera system OMRON F150-3[2].

The visual system can hold 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[3].

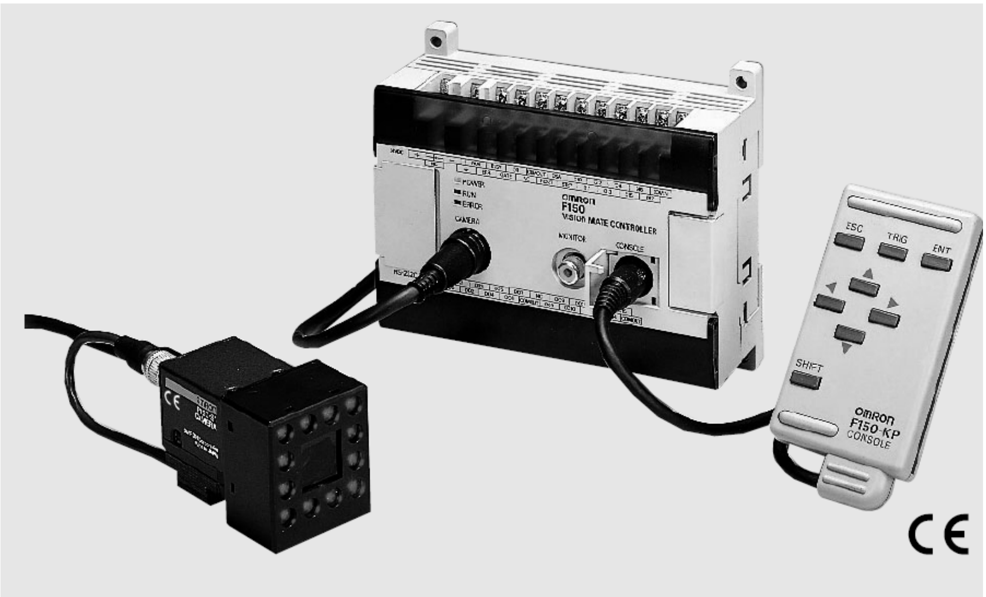

Fig. 3 Camera system Omron F150-3

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, obr.7. Workstation with robot SCARA and camera system Omron F150-3. Real workstation is mounted SCARA Yamaha YK600X QRCX with control system and camera system Omron F150-3[6][7]. 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[2]. 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[5]. 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. 4 Assembly cell with SCARA robot and 3D object detection

Order to build robotic assembly work is inter alia the possibility of using it in the educational process for the preparation of students in the field of robotics and automation. It provides the possibility of using the workplace as well as for experimental and research purposes and contributes significantly to better prepare students for practical as well as theoretical aspects after.

Virtual laboratory

Within of the project RUSOS is designed and realized part of the virtual laboratory. Virtual laboratory to create robotics with no real access. Allows manipulation of objects, detection of collision situations and programming of selected objects (robots). Overall, it should be able to place on the desktop 200 objects. The system is programming with web technologies (HTML, JavaScript, IE, Cortona, ...), Fig.5

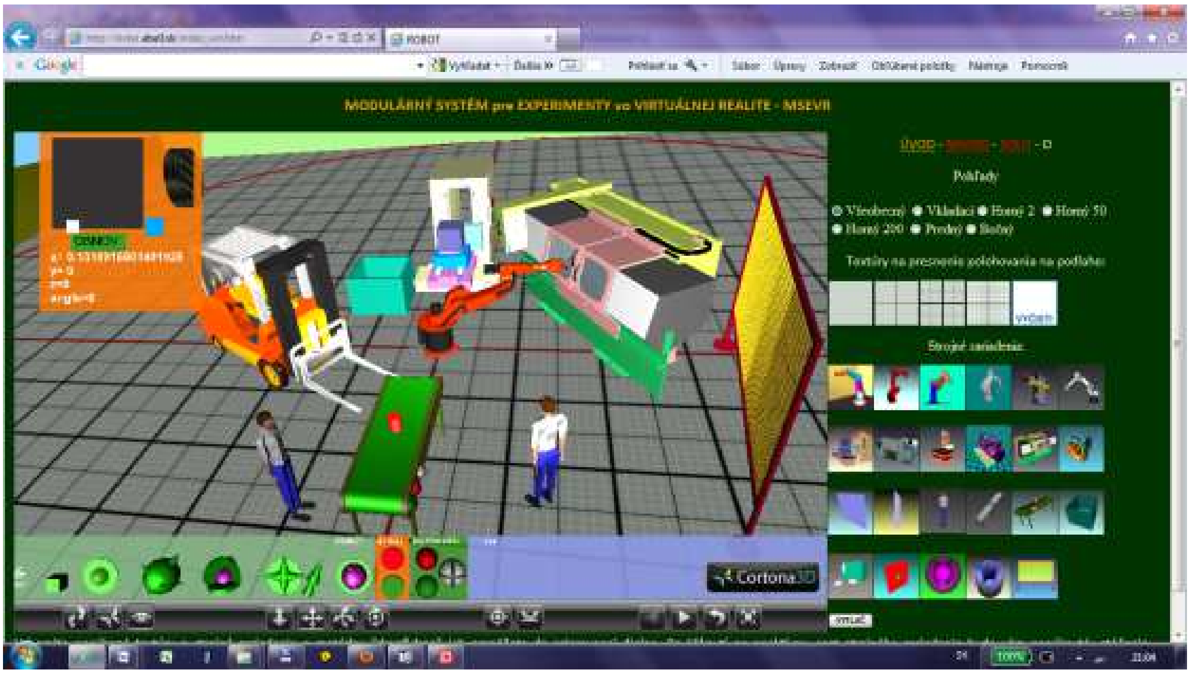

Fig. 5 Virtual laboratory to education of teachers

The second system for virtual reality using a webcam. Tag-based displays the relevant type of robot and according to the selected program will perform the required operation. In this way, we can model the arbitrary workplace without the actual components and verify the deployment of workstation and its function, Fig.6.

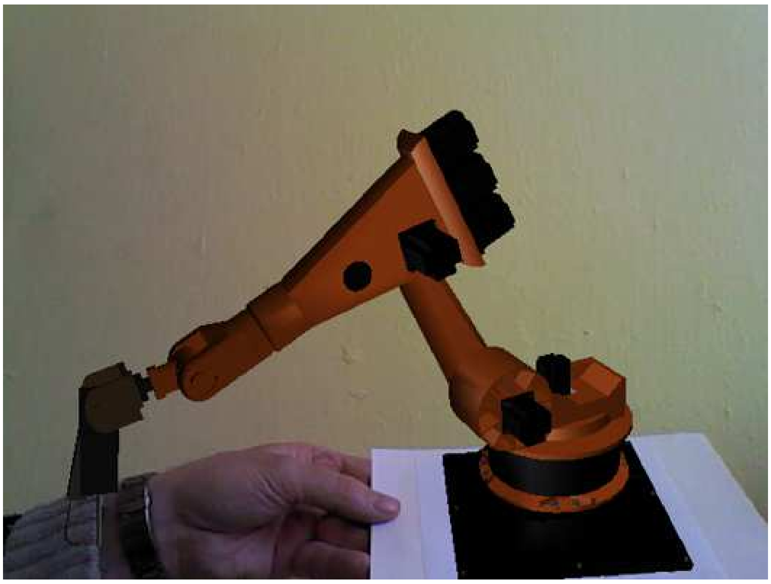

Fig. 6 Virtual reality based on recognition of special signs

Conclusion and future work

Assembly workplace with SCARA robot is tested and adjusted the algorithms for cooperation robot - camera. Gradually improves Palletizing system. In the virtual Laboratories updated with new buildings and improve the algorithm functionality of equipment. Recognizing brands through the camera and display objects are trying to use CAD drawings from different manufacturers. Gradually we build the project website RUSOS. Getting started create e-learning lessons for teachers.

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References

[1] Bryan, A.: Co-evolution of product families and assembly systems, The University of Michigan 2008

[2] Corke P.: 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, ISBN 978-1-60805-310-0

[4] 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, ISBN/ISSN 0 – 8493 – 0994 – 8

[5] Sukop M., Hajduk M., Baláž V., Semjon J., Vagaš M.: Increasing degree of automation of production systems based on intelligent manipulation. In: Acta Mechanica Slovaca. Roč. 15, č. 4, 2011, s. 58-63. - ISSN 1335-2393

[6] Sukop M.: Proposal of algorithms for cooperation among devices in aplication with robot. In: Transfer Inovácií. Roč. 29, 2014, s. 1-3. ISSN 1337-7094

[7] Sukop M.: Modification and improvement of image processing algorithms of robot soccer for other uses. In: Transfer Inovácií. Roč. 30, 2014, s. 1-3. ISSN 1337-7094