ASSEMBLY CELL WITH SCARA ROBOT AND SCANNING 3D OBJECTS

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Abstract

The article describes the project assembly cell for verification and testing of the proposed technical solution automated installation of electrical outlets robotized workplace. Based on the established design documentation was implemented workplace, which is located at the Department of Robotics. The workplace is equipped with robot SCARA control system based on PLC, a pair of vibrating trays and other components robotized workplace.

Keywords: robot, SCARA, camera, assembly cell

INTRODUCTION

The article describes the project assembly cell with SCARA robots and scanning 3D objects, which was built at the Department of Robotics. The project is aimed to develop and experimentally validation the assembly cell with access undirected Assembly Hall. The paper describes the structure and function of cells and the Control robot coordination and the cells of each device based on the information mounting position and orientation of objects on the input conveyor. The dominant feature is a SCARA robot system and two cameras for sensor shape, position and orientation. 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. Monitored parameters achieve minimum time handling - installation cycle.

Realized 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 use Rusos at the workplace by individually practicing of 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. 1a. 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. 1b. 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 illumination.

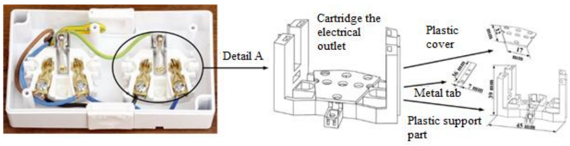

Fig.1 Individual parts Inserts el. drawer – object assembly

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.

1. 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.

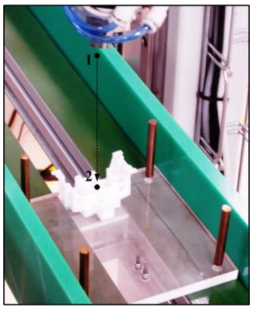

Fig.2 Step 1: fit, transfer and insertion of plastic bearing inserts el. outlet guide pins on the system pallet.

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, Fig.3.

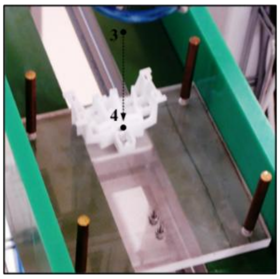

Fig.3 Step 2: fit, move and insert metal tab into the moulded plastic part Reinforcement el. Outlet.

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, Fig.4.

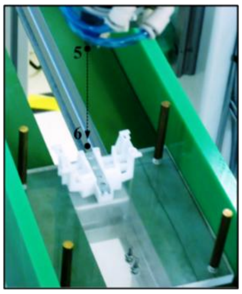

Fig.4 Step 3: fit, transfer and insertion of a metal substrate moulded into a square plastic bearing inserts el. socket

2. REALISATION OF RESEARCH OF A ROBOT WORKSTATION.

The conceptual design of assembly cell can 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. 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.5 Camera system Omron F150-3

Selected parameters of the base and control unit F150-C10E-3 (specific features and functions) are specified as:

1. The number of connectable cameras - 1-2
2. The number of pixels - 512 (H) x 484 (V).
3. The number of shots - 16 (option to back up to a personal computer via serial port.
4. The image storage - max. 23 saved images.
5. Image Processing Method - Gray / Binary.
6. Image filtering - smoothing, edge enhancement, edge extraction, background suppression.
7. The number of digital levels - 256 to one area.
8. The number of measurement regions - 16 reg/ image.
9. Measurement data - binary centre of gravity and surface angle axis correlation value, search positions, position played, debugging, density averaging.
10. The functions of data operations - arithmetic calculation, distance, angle, max / min value, absolute value, etc.

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.

The main components of work:

1. SCARA type robot Industrial YK600X Yamaha.
2. Replacing devices effectors - enables the exchange of effectors as appropriate control system.
3. Input conveyor - conveyor which operates semi-finished products or pallets.
4. Output conveyor - conveyor which operates pallets, semi-finished or finished products.
5. Vibrating tray - used for orientation of components.
6. Palletizing device.
7. Control PLC - control system upper level management attendant robot peripherals, and is able to communicate with subordinate control systems.
8. Camera systems - vision system for robot.

Fig.7 Assembly cell with SCARA robot and 3D object detection

Robot with a camera Omron F150 was built under the project, which was implemented by workstation for laboratory tests SCARA robot for manipulating 3D objects undirected a visual system, Fig. 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 provides two PLC Omron CP1H-type units and CP1E. Camera system connection with the control unit PLC CP1H provided via RS232C PLC CP1L, Fig.8 [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 reverse process 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 are transferred to the input conveyor, which are transported by the camera, where the position captured. Information about position components are sent 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 reverse process system ensures supply of empty pallets and removal of full pallets. The workstation is equipped with replacement system effectors in the event of a change for the workstation.

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.

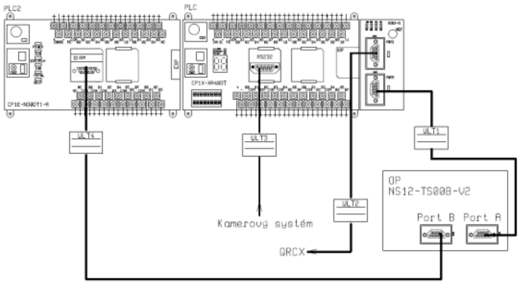

Fig.8 Scheme of the control unit connection to the camera and robot

Conclusion

Assembly robotic workstation enables indefinitely verify the methods and strategies by practical tests under laboratory conditions that simulate production facility. Workplace is designed to assembly of components takes place in the highest possible quality and the lowest possible cost. One of the many advantages is the shortening of time familiarizing students with real operating conditions. Another aim of the work after completion of the work is progressively develop algorithms for cooperation robot camera.

References

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

[2] Corke P.: Visual Control of Robots. 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

[8] Fedák V., Kostelný M., Kaňuch J.: E-learning course on transformers-animation and visualisation of operation / - 2004. In: Low Voltage Electrical Machines : konferencia : Brno, 15.-16.11.2004. - Brno : Department of Power Electrical and Electronic Engineering, 2004 P. 23-32. - ISBN 8021426322

The paper presents results of researches supported by EU within the project RUSOS „Robotics for teachers of secondary vocational schools”, 2015-1-SK1-KA202 - 008970, under the ERASMUS+ Programme. This publication represents only author´s opinion and neither the European Commission nor the National Agency is not responsible for any of the information contained in it.