V. Demianiuk, Bachelor student
M. Bohdanovskyi, As. Prof., research advisor
A. Ostapchuk, Lecturer, IRD Senior Expert, language advisor
Zhytomyr State Technological University

VIRTUAL MODEL OF A ROBOTIC BOTTLE PALLETIZING COMPLEX DEVELOPMENT BASED ON KUKA.SIM PRO SOFTWARE

Rapid development of robotics in the industrial sector is presupposed by the productivity increase, better economic performances and higher product quality due to robotic technologies implementation. Expenses on automation of production due to industry robots (IR) are especially justified on the separate labor-intense stages, one of which is the primary packaging of a wide range of products. The packaging process includes product unit arrangements and their placement according to the adopted scheme on the standard-sized pallet by forming intermediate levels to the height defined by the transportation and integrity conditions with the film packaging. This process is called palletizing and serves for convenient transportation and products quality preservation [1]. In the modern production of beverages performed by the companies such as “Myrhorodska”, “Morshynska”, “Cola-Cola” etc., beverages packed into the plastic bottle containers according to the main technological process by using automatic loaders, semi-automatic and automatic palletizers (stackers), positional elevating machines and rarely industrial robots due to the novelty and the initial difficulties in robotic technologies implementation [2].

However, the experience of the industrial companies in the field of special-purpose equipment certifies that flexible workcells have a range of advantages such as ability to manipulate separate large-sized loads, flexibility in servicing a few production lines simultaneously, products grab adaptation to the size and shape of packaging, multitasking of single and group production processes servicing, rapid introduction of new equipment into the packaging process.

In order to accelerate the process of robotic technologies implementation, modern software implements Virtual Reality Technologies (VR) at the stages of robotic tasks efficiency estimation through modeling and further programming. With the help of VR it is possible to recreate the model of technological equipment units functioning and implement the PR programming through the teaching method preventing syntactic errors.

The aim of the paper is to develop a robotic system for palletizing bottled products and packaging for transport and storage production systems. The automation object is the area of packaging. The packaging area consists of assembly lines for transportation of beverages in plastic bottles, pallets transportation, and two dispensers for empty pallets and items for packaging products. The packaging area is separated by a protection net according to the IR working area. Plastic bottles of the same geometric parameters, 5 litres each, are moving along the assembly line by two. The objects, arranged in a row, are sent to the robot’s loading area by means of a linear positioner and the presence of soldering in the IR gripping the packaging element – installing the product’s packaging element- products placement on the pallet (second layer) loading area is monitored by means of an infra-red sensor of the object’s presence. Soldering by

two bottles is a technological solution for palletizing taking into account geometric parameters of the pallet where they are separated from the main batch using a limiter. In order to increase productivity two unloading areas of the IR with two pallets are used. Each of the pallet is loaded into three layers of bottles and then it is forwarded to the automated stretch-firm packer with the help of a roller assembly line. Due to the successive operations the total amount of time for products packaging is decreasing.

On the first stage of robotic technology implementation, the process scene of VR space is planned according to the defined scheme and drawing of the basic and additional equipment placement taking into consideration geometric and kinematic characteristics. VR gives an opportunity to estimate and clarify their placement in order to prevent collisions and IR inaccessibility to the equipment's working areas. KUKA.Sim Pro software is one of the most advanced means in VR reproduction for creating robotic complexes. KUKA.Sim Pro is designed for autonomous and virtual KUKA robots programming, allowing analyze the cycle duration and generate programs for industrial robots, establish real-time connection to KUKA.OfficeLite being a virtual control system for KUKA IR [3]. A working space for the packaging area was created in the result of using KUKA.Sim Pro, depicted in Figure 1.

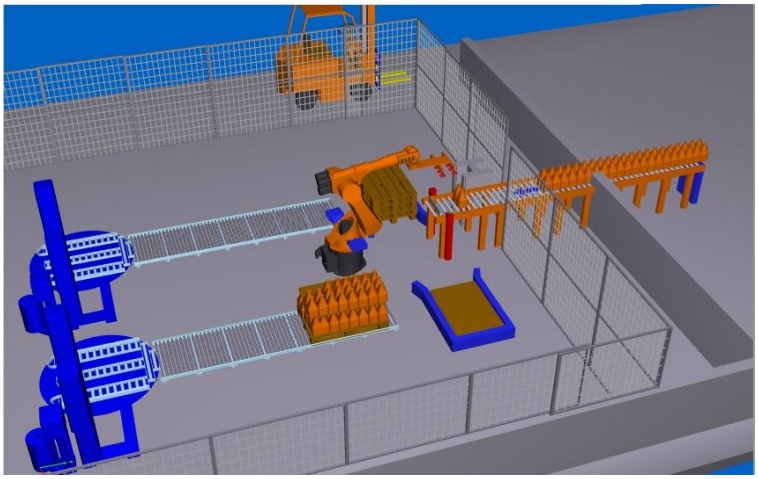

Figure1.1. Working space of packaging area

The equipment parts are selected from the software visual components library according to specification and are located in the scopes of the IR KUKA KR60 working area by using the coordinate's system binding. IR KUKA KR60 has a high accuracy of positioning, repetition, mobility and is the fastest model in its caliber [4]. Selection of a gripping device (GD) compatible with the console and IR control system was performed in order to manipulate soldering of bottles by two.

Gripping device with pneumatic mechanical heads allows grip the bottles and packaging elements softly from within or without, reliably holding them horizontally [5].

The IR performance is arranged in the following cycle: the grip of an empty pallet from the dispenser – installing the pallet on the roller assembly line – waiting for the product in the loading area of the robot – gripping the product – placing the product on the pallet according to the provided in advance palletizing scheme – products placement on the pallet (first layer) – gripping the packaging element – installing the product's

packaging element – products placement on the pallet (second layer) – gripping the product – gripping the packaging element – installing the product's packaging element – products placement on the pallet (third layer). As soon as the cycle is over on the first line, the pallet is moving to the automatic packaging equipment in order to finish the packaging process while the IR is performing its cycle on the second line.

To imitate the technological process, first and foremost, it is necessary to assign a control device for each IR OUT output port to interact with in the future. For instance, the assembly line object is installed according to the OUT6 and True/False can be chosen. Then a new Sequence object is designed reproducing a set of IR movements. All of the similar objects will take place in the Main cycle. Interface, depicted in Figure 1.2., allows create two types of movements: LIN (linear motion) and PTP (motion from the initial to the given point the fastest possible way). In order to set a new direction it is enough to define the coordinates of the final point and set up 6 parameters X,Y, Z, A,B, C.

There are two ways to define the final point coordinates: manual enter in the specially designated fields or moving the GR with the help of the mouse. The first way is more exact and the second one will be helpful when the final coordinates are not defined yet. Between the points P46 and P47 it takes movement along the line, and between the points P47 and P48 – the arc movement; between P41 and P46 IR performs a WAIT command – waits for the object moving along the assembly line to reach the loading area of IR. The process is controlled by means of the discrete signal; between P52 i P53 GD is closing and in figure it looks like the process of gripping the product and the block's parameter acquires "1" meaning; between P50 i P55 GD is opening and it defines the stage of placing a product on the pallet, the block's parameters acquires its "0" meaning.

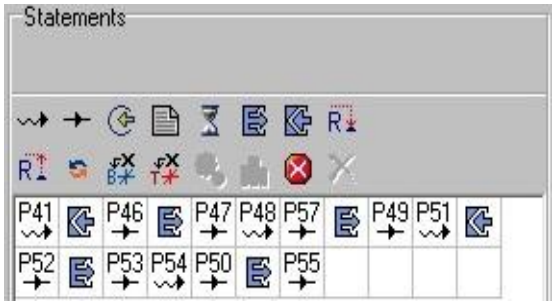

Figure1.2. Sequence object interface

The main advantage of the GD is its simple graphic components import technology. The project development technology is understandable through easy-to-use interface and its graphic programming language IL based on the VR library of commands and parameters. Convenient design and recreation in VR space of working area with the help of electronic catalogue.

REFERENCES

1. Business Dictionary. URL: http: // www.businessdictionary.com / definition/ palletization.html (accessed 03 April 2019).

2. Tara Robotic Automation Extraordinary Engineering Company (2016). URL: http://www.tararobotik.com/en/water-bottle-palletizing applications.html (accessed 05 April 2019).

3. IWKA Group company. URL: http: // www. gspnexus.com/brochure/ 22_eng.pdf (accessed 10 April 2019).
4. KUKA robots. URL: http://www.xpert-meca.com/web/pdf/4.pdf (accessed 11 April 2019).
5. ANVER Corporation. URL: https://anver.com/BottleHeadGripper (accessed 11 April 2019).