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[1.] Isak KARABEGOVIĆ, [2.] Sanel KARABEGOVIĆ,
[3.] Ermin HUSAK, [4.] Safet ISIĆ

AUTOMATION OF CONVEYOR LINES IN THE MILK TREATMENT INDUSTRY

[1-3.] University of Bihać, Faculty of Technical Engineering,
dr. Irfana Ljubijankića bb, 77 000 Bihać, BOSNIA & HERZEGOVINA
[2.] University Džemal Bijedić of Mostar, Faculty of Mechanical Engineering,
University Campus, 88 104 Mostar, BOSNIA & HERZEGOVINA

Abstract: *Intelligent systems such as industrial robots are the basis of CIM (Computer Integrated Manufacturing) systems and are increasingly used in the most demanding applications. There are several reasons for implementing the industrial robots in food processing industry. They can replace humans in physically demanding environments and enable continous operation without stopping and with high precision. All of the above reasons are the criteria for their efficiency. The food industry demands high precision robots for packaging transport and stacking of sensitive products such as dairy products. This article presents the automation of the milk transport line, the industrial robot type MOTOMAN EPL 80 which enables high speed rotation around 5 axes and is used for movement, positioning and rotation of the milk box which is then further transported and packed. The criteria for evaluation of the work on the robot is it's precision, speed and accuracy.*
Keywords: *Automation, transport, robotic process industry, economy*

INTRODUCTION

The automatization of processes has its application primarily in the processes of production and operating machines [4]. Industrial robots are automatized systems which use computers as an intelligent part of operating [1]. A robot means a machine that is consisted of mechanisms with different ways of independent movement, which is capable of using a tool or a working object [2]. The automatization of a transport line can include one or more industrial robots at the same time, depending on the complexity and level of the operations carried out by the robot. The industrial robots are equally perfect for monotonous and more difficult tasks [3]. As you can see on the pictures, the robot is a part of an automatized process and its task is to move, position and turn the packages of milk, while the task of other segments of the automatized process is transport and piling packages of milk. Regarding bigger and more demanding capacities, the robots which can move and turn objects faster are developed. Thus, for example, the robot MOTOMAN EPL 80 has a maximum speed of rotation on its axis T of 350^0 per second [7].

THE AUTOMATIZATION OF A TRANSPORT LINE IN THE PROCESS INDUSTRY OF MILK

The figure 1 shows an automatized line for the transport and piling packages of milk. The automatized line for transport in the process industry of milk, as it is shown on the figure 1, is consisted of transport lines in several segments, which are used for transporting packages of milk separated by independent machines, a robot which turns and positions the packages, a machine which prepares the layers of packages and a one-pole machine which piles the layers. Apart from these machines, it is important to say that the process of automatization also includes sensors which signal when and how the mentioned machines in the automatized line will activatepower, improved dynamic indicators and advanced managing algorithms.

The process of the automatized transport line in the process industry of milk is usually described from the end towards the beginning since it is easier to understand the logic of its order this way. The one-pole machine for piling layers, which is used for piling layers of packages for further transport to *the warehouse, has a built-in sensor S8 which controls the height of a pile.*

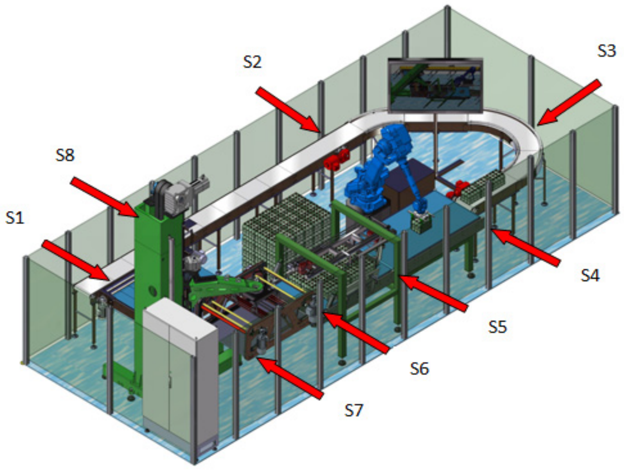

Figure 1. The automatization of the transport line for packaging milk [8]

Figure 2. Paletizer for for piling packages [8]

That means, when a certain number of layers is piled, the sensor S8 signals that the machine for piling layers should be temporarily stopped and quit piling further layers until the piled packages are transported from the place of piling layers to another pile and until another pile is positioned in the right place where we should get the signal from the sensor S1. As soon as the sensor S1 signals that the empty pile holder is positioned, the process of piling continues to be carried out by the machine for piling layers.

Figure 3. Transport rollers for transporting piles with sensors [8]

The layer of packages is taken from the transporter which is used for delivering layers as soon as the machine for piling packages gets a signal from the sensor S7 showing that the layer is ready to be taken. There is the built-in sensor S6 on the transporter for preparing the layers of packages, which, followed by the sensor S5, signals to the robot where and how the package should be positioned. On the transporter for preparing the layers, the packages are positioned according to the logic and order of an imaginary layer of packages. Moving a prepared layer of packages from the transporter for preparing layers onto the transporter for delivering layers, is signalled by the sensor S6 which should get a signal from the sensor S5 that the layer is ready to be delivered as well as a signal from the sensor S7 that there is an empty space on the transporter for delivering layers. When these conditions are fulfilled, a layer can be positioned on the transporter for delivering layers of packages.

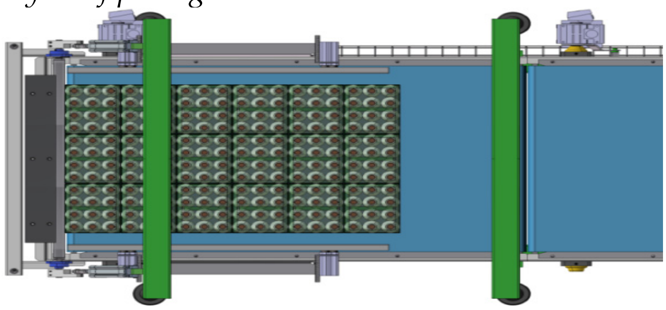

Figure 4. A prepared layer of packages on the transporter for preparing packages [8]

In case that the sensor S7 signals that the transporter for delivering layers of packages is not empty because there is a layer of packages still positioned on the transporter for delivering layers of packages, the process will be automatically stopped temporarily until there is a signal that it can be restarted. Working of the robot, and that is positioning and, if necessary, turning packages towards one of the three possible positions, regarding that a layer is consisted of three rows, depends on getting a signal from the sensors S5 and S4. Having positioned one carton, the robot comes back to its zero position from which it starts to move in order to turn or move another package. This zero position is usually near the place where the packages are taken, especially when they are big, and then it is essential not to waste time and energy. If the robot gets a signal from the sensor

S5, that means that the line from the robot onwards is full. At that point, the robot is stopped and waits for the next information. Of course, in that case, the transporters for delivering packages are also stopped. The robot is in its zero point until the moment when it gets a signal that the line is empty and that the package can be positioned.

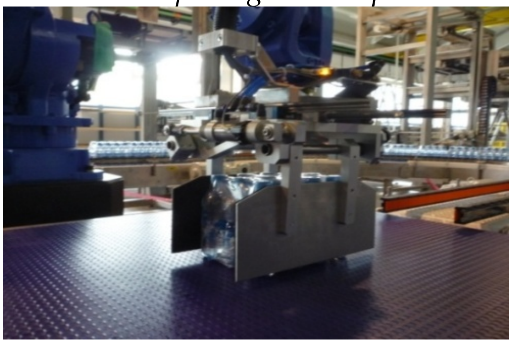

Figure 5. A robot with package holder is positioning a package on one of the three possible positions [8]

The robot takes packages from the delivering transport line which moves when there is a signal from the sensor S4 that the packages can be put on the transporter for positioning of packages. Sensor S4 is also used for counting packages which means that firstly the value of needed capacity should be typed in and then, after a number of packages is counted by a shaft of light of the sensor S4, the delivering transporters are stopped since they get a signal that the capacity has been achieved. In case that the sensor S5 signals that the prepared layer of packages on the transporter for preparing layers is full, the sensor S4 signals that the transporter for positioning packages should be stopped. The delivering transporter for packages keeps working and the packages are gathered for the so called layer reserve until the number of packages needed for the layer reserve is achieved. Then, the sensor S3 signals that the layer reserve is made and then the delivering transporter is stopped.

Figure 6. Transport and the prepared reserves of layers of packages [8]

After getting a signal from the sensor S3 that the layer reserve of packages is full, the transport line in front of it is automatically stopped and there the sensor S2 gets a signal and forwards it requesting stopping transport of packages. Electro motor powers of the transport lines and all other machines of the automatized lines are also equipped with frequency transformators which are used to control achieving capacity (by increasing and decreasing frequency from the standard 50 Hz) and to lessen sudden stopping and moving of the transport lines and other machines, which is very important for transport and piling milk and dairy products. We can notice that all the commands for the machines in the automatic line are signalled by sensors. Here, the indirect optical sensor SICK is used and its working is based on reflection beams. That means that a sensor is put on one side of the transport line and a reflection mirror is put on the other side. By activating the sensor, it casts a shaft of light on the mirror and gets back another shaft and that is the way it functions. When a package comes and cuts the shaft of light, the sensor gets a signal and forwards it as a signal that it has got a package. When the package passes, the shaft of light between the sensor and the reflection mirror is restored again waiting for another package.

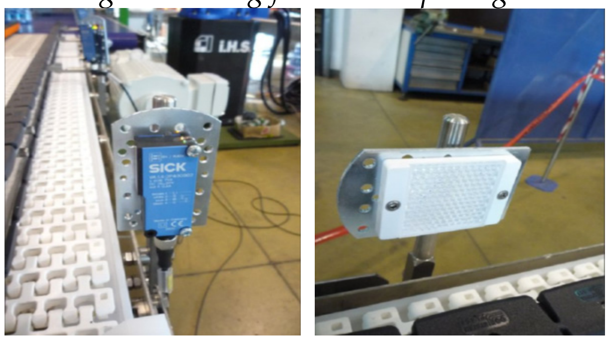

Figure 7. The sensor SICK WL 11-2F2430S04 and a reflection mirror [8]

One of the most demanding tasks on this automatic line is the one of the robot. Its task is to achieve the capacity, and that is to manage to position and turn the packages and to adopt to the type of layer. The picture 4 shows a type of layer, but any other layer is piled in different way so that the piled packages don't break up during the transport. That means that the packages on other layers are turned 90° in relation to the layer shown on the picture 4 in order to get more stable pile of packages by covering them. For bigger capacities, e.g. 3600 *packages/h or even more, the robots are necessary. That is because they are tireless machines which react to the signal while performing their tasks. On this example, we can see that a package after package is taken and positioned. However, for bigger capacities, the layers are combined so that the robot positions two or more packages at the same time, depending on the size and shape of the package.*

CONCLUSION

Considering all this, we can say that robots today are necessary for performing demanding tasks, such as achieving big capacities in piling packages in the process industry of milk, piling units up in packages and other difficult tasks (4). The automatization means transfering human's job to the machines, usually through a technical advance (5). The main advantage of robots over a human is their tireless and precise working, not depending on time, while a human is capable of working precisely only for some time, and after that he loses his concentration and precision and gets tired both physically and mentally (6). When choosing robots, we should take care to choose a suitable and optimal robot considering its capacity, speed, using energy, etc. Nowadays, there is a tendency towards optimizing processes and that is where robots have advantage and usefulness. There is a constant need for increasing exploitation of machines and profit as well as decreasing expenses, or better to say, for making economies. The robot we were talking about has a very demanding task and that is positioning packages in one of the three possible positions and turning them when necessary. Regarding its precision, it fulfills the field of tolerance in piling packages. For the lines like these, it is common to align all sides of the layer on the transporter for preparing layers before putting it on the transporter for delivering layers. This alignment is done by pneumatic boards on all the sides at the same time. In this way, the layer is in ideal position for further process.

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