

## PROGRAM FOR MANAGING AN AUTOMATED CONVEYOR FOR PACKAGED FOOD PRODUCTS AND 3D SIMULATION OF ITS WORK

**Abstract:** Under the new requirements, human intervention in food production is increasingly avoided. Automated systems in the food industry provide the required sterility of production. Such a conveyor is designed and presented in the given work. A programmable logic controllers program has been set up and has been simulated. The software is used by PLC manufacturer software. The simulation is done through specialized next-generation software.

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### Abbreviations:

I/O – input/output  
OB1 – Organization block 1  
PLC – Programmable logic controller  
PLC Sim – PLC simulation  
TIA – Totally Integrated Automation

### 1. Introduction

With the development of the industry, the creation and configuration of manufacturing units have become a top priority for each enterprise. Proceeding from this, the current report is based on building a virtual 3D conveyor.

The choice of development is based on the fact that many companies rely on the conveyor as the main device for transferring objects along the assembly lines.

Defining the main problems, connected to the technological process of the production, proposing methods to overcome them, as well as the optimization of processes for control are really a complicated task for the people, who develop such kinds of systems.

The implementation of design automation techniques into the engineering practice allows to transition from the traditional method of creating a model of the developed equipment to modeling with the help of personal computers. Furthermore, using PCs, it is viable to carry out the entire design cycle from start to finish [1], [2], [5].

Similarly, to its use, the current issues come to the fore: “How effective would it be?” and “How much faster would the production process speed up?”. The goal through 3D visualization is to assist companies (enterprises) with a ready-made movement device with safe-to-use mechanisms. The development will be made using a Siemens S7-1200 class controller, including a major part of the TIA programming software. In terms of its visualization, a wide range of simulation software is available. Essential for this action is PLC Sim, which in this report will be overlooked at the expense of the more innovative FACTORY I/O.

## 2. Factory I/O

Factory I/O is a 3D simulation software for testing programs designed on STEP7. It works with a large set of Siemens controllers.

It has a large selection of common industrial parts! It allows its creative users to design not only a single 3D device but a whole multitude of them. After purchasing and licensing the product, the user is given some scenes, along with sets for beginners.

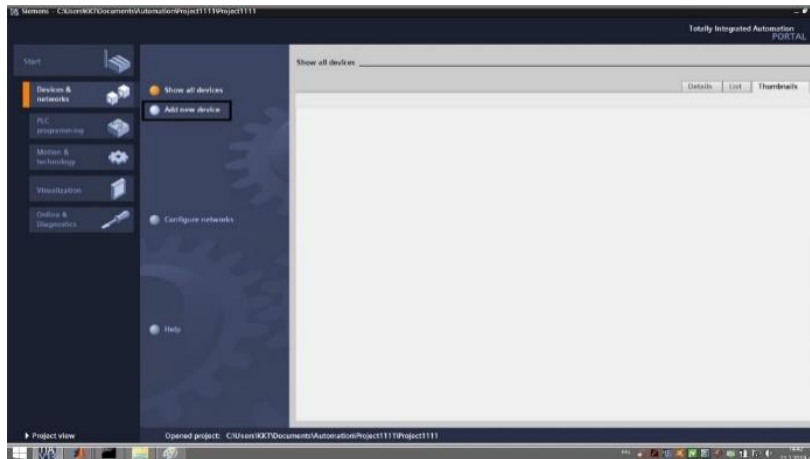
The system requirements for this software are moderately high (Table 1).

**Table 1.** Program system requirements

Hardware/Software	System Requirements
CPU	Intel Core i3 – 2.8 GHz, similar or better
RAM	2 GB
HDD free space	2 GB free space for drive C
Operation system	Windows 7
	Windows 8
	Windows 10
Graphics card	1GB VRAM or better
	126-bit or more
Resolution	1920 × 1080

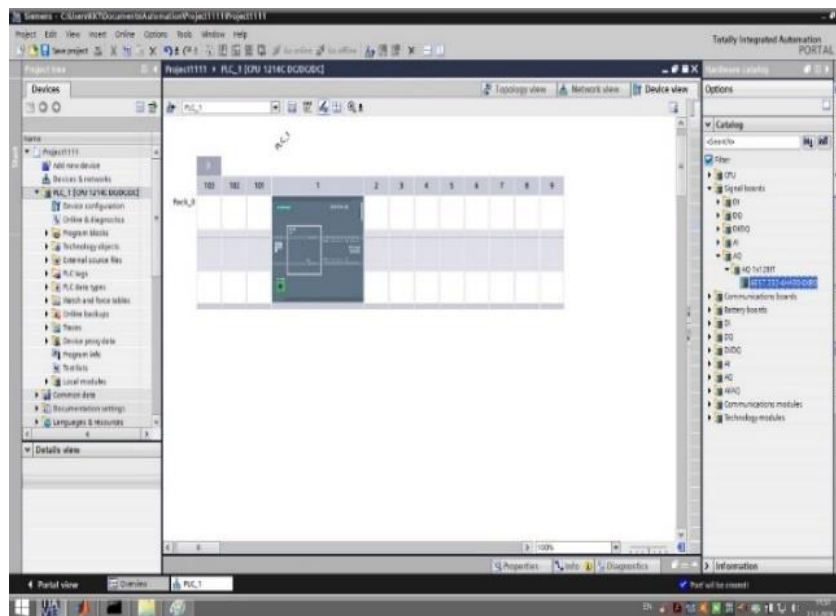
## 3. Developing the program with TIA Portal

To write the program, we first start up the TIA Portal v.13. From the task panel, we click “Create new project” to start the new project. After we write a name for the project and pick a drive to save it to, we click on “Create”. The new project is now created and we can configure it by clicking “Configure Device”. A dialog box appears, and we click on “Add new device” to add it. This action is shown in Fig. 1.



**Fig. 1.** Adding a new device

A wide catalog of processors is available when choosing a device. Now, we chose Unspecified CPU 1200 in the 4.1 version. The processor appears in the workspace as an empty box. In the meantime, a “Detect” button appears, which shows the processor. A new window opens where the “Start Search” function finds the required controller over the network. We click on it and select “Detect”. Then the program connects with the controller and retrieves information. After the connection is established the controller shows up in the workspace, as shown in Fig. 2.



**Fig. 2.** The processor after the information is retrieved

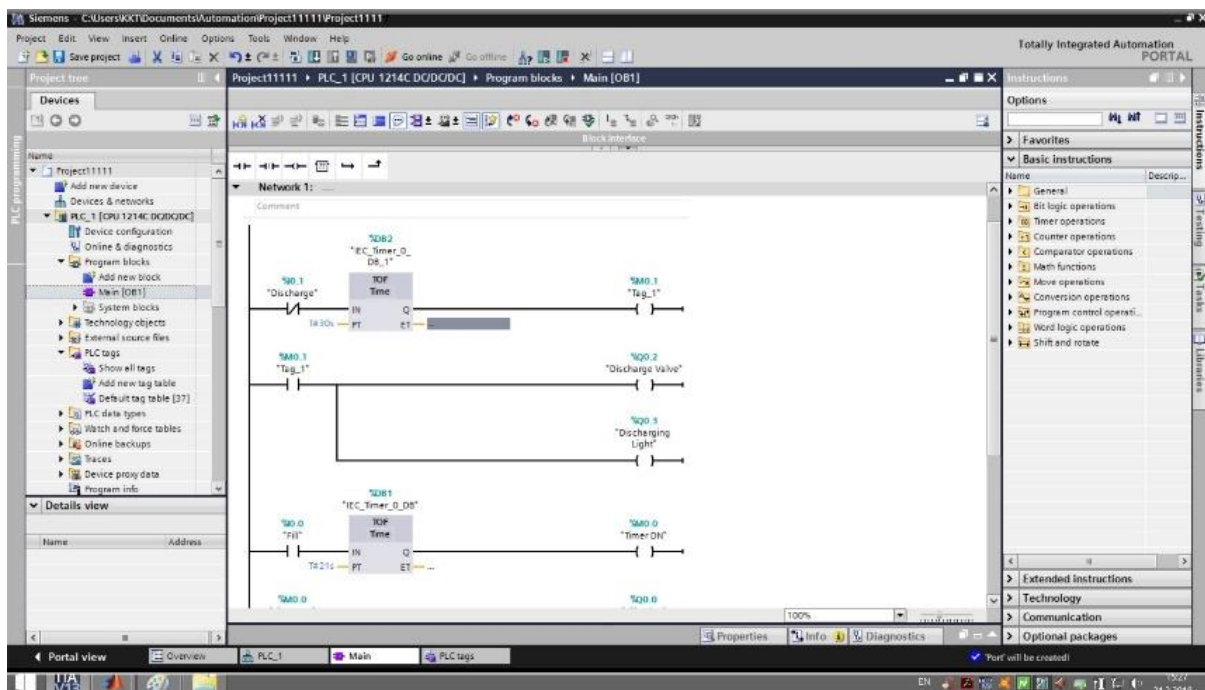
Now, when the controller is ready, it’s time to create the electric and control circuits. This is achieved through the “Project Navigator”. We pick the controller’s processor and select “Main (OB1)” from the drop-down menu in “Program blocks”. By default, creating the electric circuit is done in Network 1. Depending on the complexity of each scheme, the environment allows more than one network to be used. The programming language is LAD – the language used by default in this visualization software. To place an item in the workspace, select the bar and click on the desired item in the FAVORITE category. It is necessary to make a parallel connection of an element. To do this,

we use the “Parallel” button. More specific detail is the timer. Usually, it is created using the "Create box" function. To turn it into a timer, we click on it with the right mouse button to open its properties. We now have full access to the element and its options. We choose the desired TOF timer, and it automatically takes the place of the box.

The circuit comprises of two parts. The first part is responsible for the cutoff. It is composed of Normal close contact, which works as a button, a timer to clock the time, assignment contact–working as an outlet, a Normal open contact, controlling the switch-off button, and a signal indicator for the button. The second startup part is built up similarly.

Once the circuit scheme is done, it is time to set the values and correct the tags. Tag correction is an important element helping us to map the scheme and to visualize it better. Tag correction is made from the “Project Navigator”. We choose the “PLC Tags option”, which reveals “Show all” tags. Each tag name and value can be adjusted from here.

All input data is set to %I and a numerical value, while the outputs are set with %Q and a numerical value. The result is displayed in Fig. 3.



**Fig. 3.** Final circuit scheme

Up till now, it is possible to check the program's construction and set values. This is achieved by using the “Compile” function.

To find it, we enter the Project navigator and right-click the controller’s processor (PLC\_1). We chose the “Compile” option from here. When “Compile” is highlighted, many features appear, but the ones needed are Hardware (rebuild all) and Software (rebuild all blocks) after. The first option checks whether the controller hardware is identical to the device hardware, and the second option tests the software design and values. After compiling the program and passing the check, we proceed with the "Download to device” operation. By doing so, we can upload the completed program to the stem’s hardware device, as shown in Fig. 4.



**Fig. 4.** Hardware stem and a controller

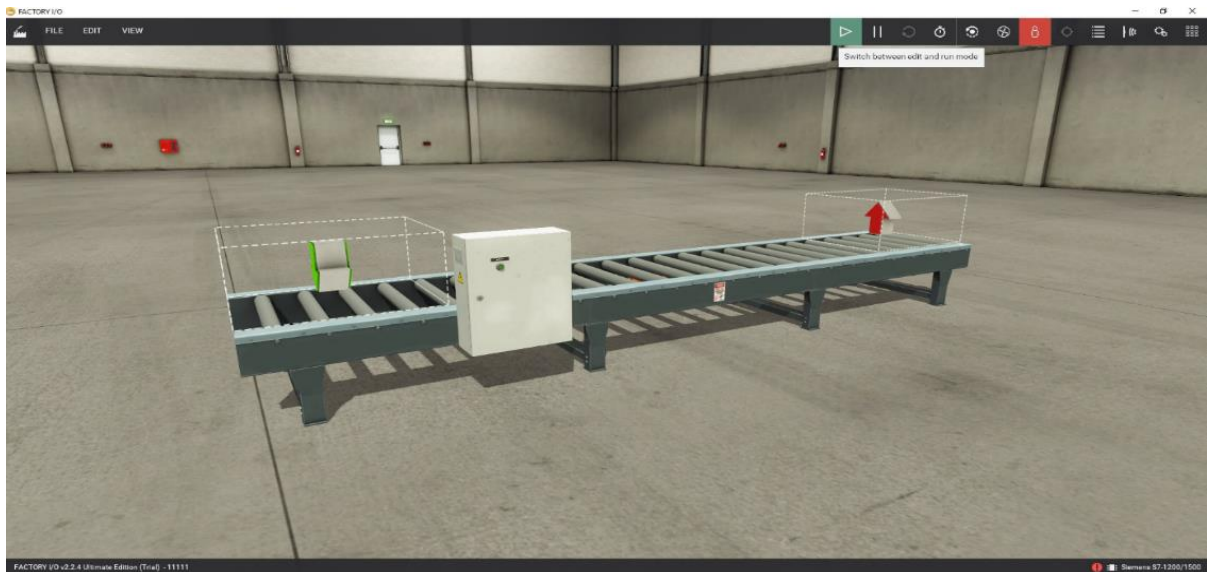
#### **4. Visualization**

Moving through all the steps of this project now comes the moment to visualize the device. We start the Factory I/O program and click on the “New Project” option to begin our work. What’s new at first glance, is the visualization environment. Unlike the classic visualization HUD, we see a 3D model of a workshop (warehouse). Here, the mock-up model is visualized in 3D to show how it will look in a real environment [3], [4], [6], [7].

To create the mock-up model, we click on “All” from the drop-down menu, which shows us a collection of libraries with construction elements. We pick the “Stations” library. Here, we can find the desired conveyor. To add it to the workspace, we click on it and drag it to a specified location. After inserting the conveyor, it is time to insert another important element, namely the control panel. We click on the “All” menu again and pick the “Operators” library. To add the element to the workspace, we drag it close to the conveyor.

The next step is the visualization of the buttons on the panel board. They are also in the “Operators” library. We need two controllers - a green Start, and a red Stop button. To add them from the library to the workspace, we drag them to the desired location. They will be placed near the panel board and automatically merged in. After the actions are performed, the 3D mock-up model is shown in Fig. 5.



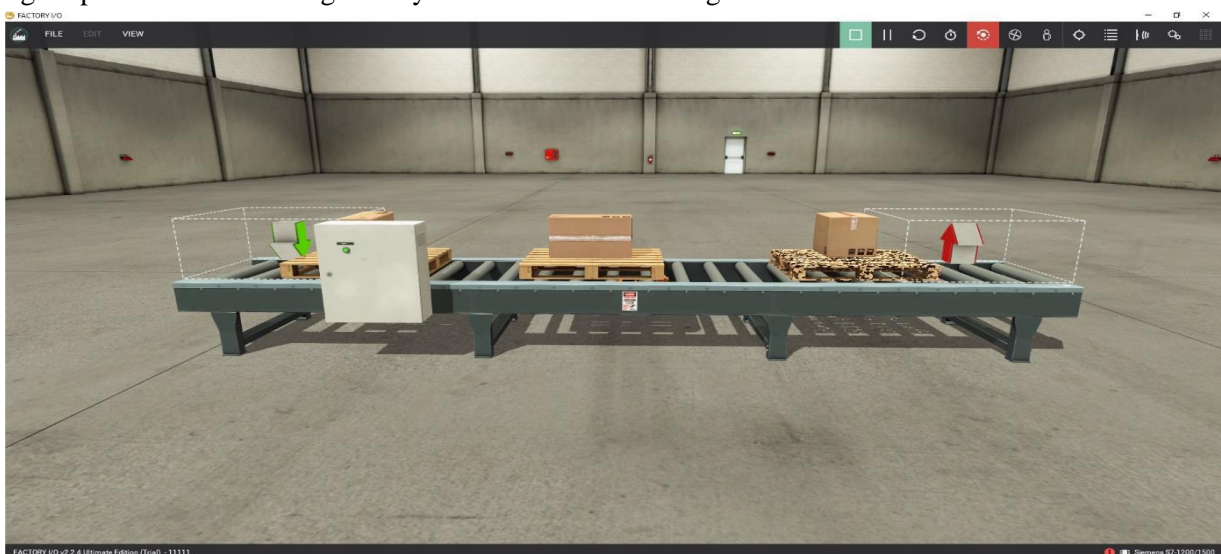


**Fig. 5.** 3D visualized conveyor

We can now move forward to the wiring. From the drop-down menu, we click “File” and then “Driver” to connect a controller in Factory I/O. Similarly to TIA, here we also use an S7-1200 class controller. It appears in the center of the screen ready for wiring. On the left side are the inputs, there are ON and OFF, and Factory I/O (running), which regulates the controller. On the right side are the outputs, which are the ON and OFF Lights. To create an operation for the animated controller, it is necessary to click on the operation and drag it to the location. After ending the wiring, it’s time to create an IP assignment line in the program to connect Factory I/O with the hardware controller and extract from it the previously created wiring diagram [3], [4], [6], [7].

### **5. Work on the conveyor**

To start the 3D environment, we click on “Play”. After pressing the ON button, it lights up green. The conveyor belt starts its movement by moving the pallets from the starting point to the end. To stop the movement, we press the OFF button, on the side of the panelboard, and the button will light up in red. The working conveyor is demonstrated in Fig. 6.



**Fig. 6.** Movement of pallets from their starting point to the end

## 6. Conclusions

This report is dedicated to Programmable Logic Controllers. The main purpose of the development is to assist companies (enterprises) with a ready-made device for movement with a mechanism for safer use. Implementing the proposed conveyor allows transporting a variety of different products and raw materials in all industrial sectors.

### References:

1. **Georgieva, I., Gebov, V., 2005.** Systems and methods applied in controlling the technological process at the fodder production. Conference ELECTRONICS' 2005, Sozopol.
2. **Lalev, H., Tsankov, Ts., 2008.** Synthesis of simulink modules. Scientific Conference, dedicated to the 105th anniversary of the birth of the pioneers of computing John Atanasoff and John von Neumann, Shumen, ISBN 978-954-577-540-6.
3. **Lalev, H., Tsankov, Ts., 2008.** Synthesis on computer systems to work on real time. Scientific Conference, dedicated to the 105th anniversary of the birth of the pioneers of computing John Atanasoff and John von Neumann, Shumen, ISBN 978-954-577-540-6.
4. **Lalev, H., Tsankov, Ts., Georgieva, Ts., 2016.** Application computer vision systems reverse engineering. Scientific Conference MATTEH 2016, Shumen, ISSN 1314-3921.
5. **Lalev, H., Tsankov, Ts., Nikolov, I., 2010.** IP management technology projects. Scientific Conference MATTEH 2010, Shumen, ISSN 1314-3921.
6. **URL:** <https://factoryio.com/>
7. **URL:** <https://new.siemens.com/>