

Model of Control and Visualization of Work of Belt Conveyors

Prof. Zbigniew Łukasik, PhD, DSc, Aldona Kuśmińska-Fijałkowska PhD, Jacek Kozyra PhD

Technical University of Radom, Radom, Poland, z.lukasik@uthradom.pl, a.kusminska@uthrad.pl, j.kozyra@uthrad.pl

Abstract – Systems of continuous transport and material handling perform well, where key role plays high productivity. Belt conveyors, thanks to simple structure, high reliability, relatively small energy consumption, are basic means of material transport. Model of control and visualization of work of belt conveyors is presented in this article. Significant for the structure of model was to program GE Fanuc's devices, that is, PLC driver and operator's control panel and depiction of work process of conveyors, using visualization software In Touch.

Keywords – conveyor belts, visualization.

INTRODUCTION

The issue of transport in the industry is a key element of productivity of almost each factory or mine. It is also important in the agriculture and food industry. [18,12] Nowadays, conveyor belts are from a few meters to a few kilometres in length, and their productivity is about 4000 tons of transported materials within one hour. [4,2,11] Chain conveyor (where the function of tension member fulfils a chain) and linear conveyor (where this function fulfils system of steel lines) are types of tension memberless conveyors, often additionally equipped with fasteners, scrapers or closed containers. [3, 5]. Sometimes chain plays a role of tension member for the trucks moving on the track attached the ceiling of a building. [16] The so-called overhead conveyor allows to get to each place of a factory hall, what considerably speeds up the cycle of production. [10].

1. Structure of model of control and visualization of work of belt conveyors

Model of a group of belt conveyors consists of two parts: (Fig1.):

1. Four conveyor belts and elevator, which operates one of conveyor belts.
2. Control cabinet and doors, where we can find control buttons and operator's control panel.



Fig.1. Model of control and visualization of work of belt conveyors.[17]

- *Sensors, actuators*

The inductive sensors XS1N30PA349 (detection of cubes) (Table 1.) and Ni10U-M12-AP6X-H1141 (presence of an elevator) were used to build a model (Table 2). They detect the presence of metal elements. [14,15] Transported details were made of wood and steel sheets, therefore, the sensors detect them in a moment when cube is within their reach. [7,9,8]

Table 1. Parameters XS1N30PA349

Parameters	Value
Nominal range– S_n	20mm
The range of useful	0mm - 16mm
Dimensions	M30 X 40,5 mm
Type	PNP, NO
Supply Voltage V (V)	10...38 VDC
Maximum switching frequency (Hz)	5000 Hz

Table 2. Parameters Ni10U-M12-AP6X-H114□□

Parameters	Value
Nominal range– S_n	10mm
The range of useful	0mm - 8mm
Dimensions	M12 X 52 mm
Type	PNP, NC
Supply Voltage V (V)	10...30 VDC
Maximum switching frequency (Hz)	5000 Hz

In order to drive a model, engines with reducers SG-545124500-60K were applied, supplied with the voltage 12VDC. Angular speed of the engines is 50 rpm. The drives take a current $I = 500$ mA.

The model uses the GE Fanuc PLC VersaMax Micro IC200UDR164 (Fig. 2.). The PLC must be matched to a particular control by introducing into its memory algorithm desired operation of the plant. The algorithm is written in a programming language dedicated controller. You can change the algorithm by changing the contents of program memory. The controller is provided with a corresponding number of input systems collect information about the state of the object and the service requests with the appropriate number and type of output devices connected to the actuators, signaling, or data.



Fig. 2. Appearance GE Fanuc PLC VersaMax Micro IC200UDR164 used in the model

Table 3. Parametry PLC GE Fanuc VersaMax Micro IC200UDR164 [6]

Parameters	Value
Supply Voltage	120/240 VAC
Range	100 (-15%) ÷ 240 (+10%) VAC
Inrush current	2.5 A at a voltage 30 VDC
Current consumption	0.2 A at a voltage 30 VDC
Input Power	26 VA

The model uses the GE Fanuc PLC VersaMax Micro IC200UDR164 (Table 3) and written programs:

- Program MAIN to the PLC in language LAD

- Program TASM_1 to the PLC in language LAD
- Program TASM_2 to the PLC in language LAD
- Program TASM_3 to the PLC in language LAD
- Program LIFT to the PLC in language LAD (Fig.3)

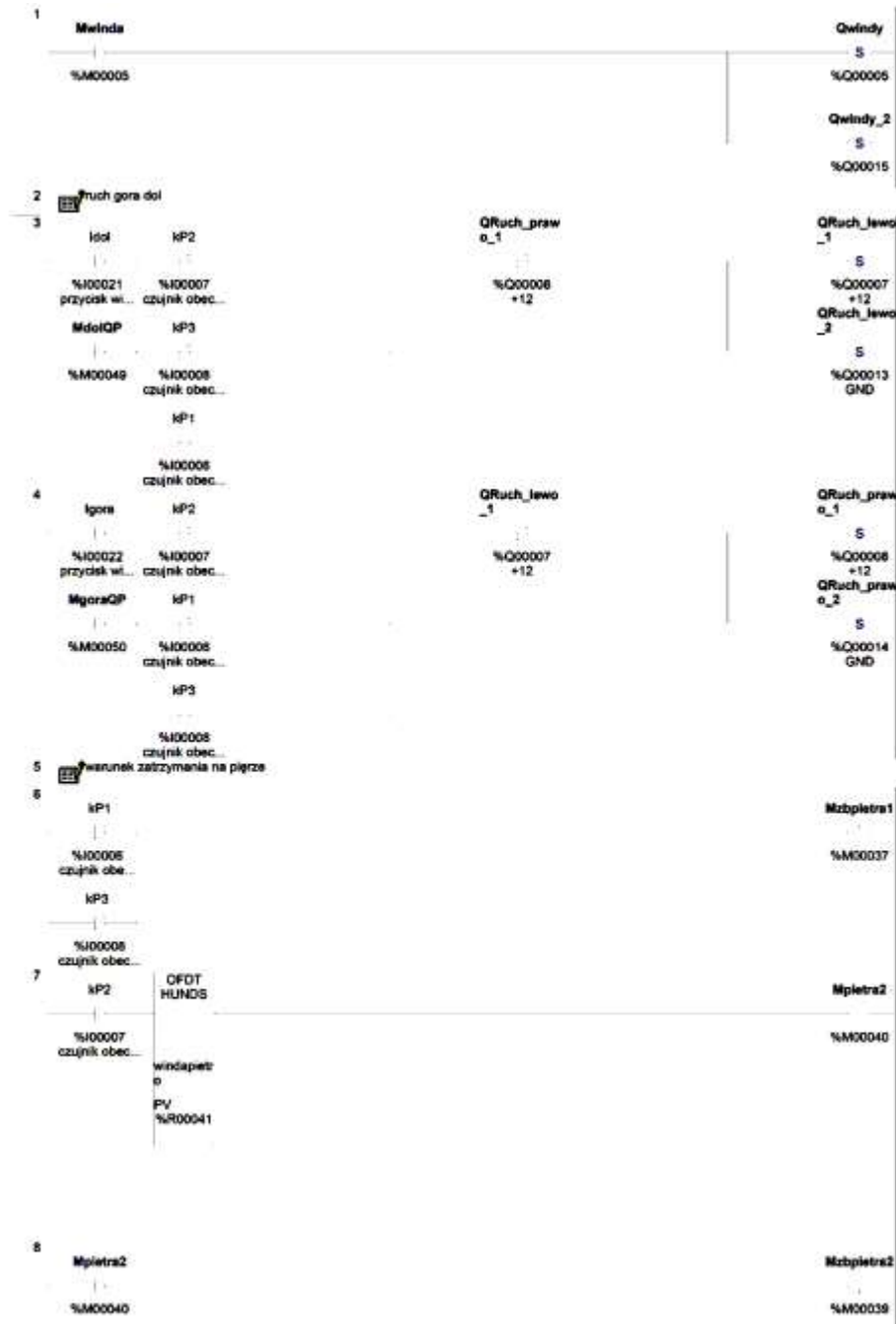


Fig. 3. Program LIFT to the PLC in language LAD

2. Control and visualization

The buttons on the doors, operator's control panel and Application InTouch – Window Viewer are used to control the work of conveyor belts.[1,19] To start work, you must log on in QuickPanel View, choose the floor which you transport

the cubes, press the button *ELEVATOR*. The buttons *DOWN*, *UP* are used to control the elevator. The elevator will automatically move to different floor. When elevator is between the levels, you can use the button *ELEVATOR* to stop it, and then choose direction (*DOWN* or *UP*) (Fig.4.).

In order to transport a cube from the floor of a conveyor belt to elevator's conveyor, we choose one of the buttons: *CONVEYOR BELT 1*, *CONVEYOR BELT 2*, *CONVEYOR BELT 3* (you can choose a conveyor standing next to the elevator). Then, a lamp *ELEVATOR* turns off and chosen button turns on. If there is one cube in the elevator, it can be transported with the use button *LEFT*. In order to transport a cube from a conveyor to an elevator, we choose *RIGHT*.



Fig. 4. Conveyor belt control panel

- *Control - operator's control panel*

Operator's control panel starts automatically during activation of a control cabinet. [6, 8] The user starts his/her QuickPanel View from logging on. Then, we go to *Main Menu*.

Screen is divided into two parts. In the first one, there is a view of model of a conveyor belt. In the second one, there are buttons to move from one window to another (Fig. 5.)

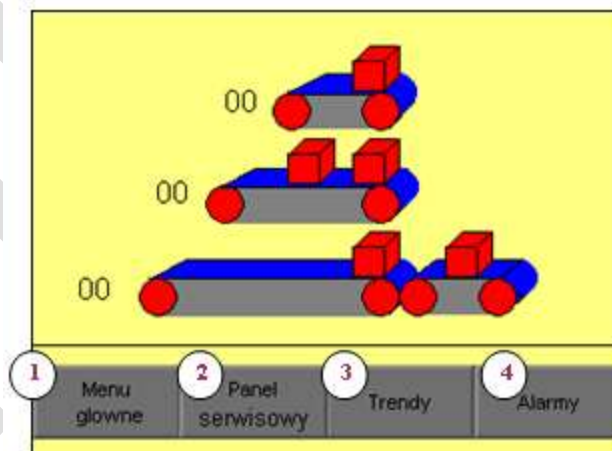


Fig. 5. QuickPanel View – Main menu (1-Main menu, 2- Service panel, 3- Trends, 4-Alarms)

Firstly, we should choose the floor, by touching the object showing an elevator. The panel, which replaces bottom belt, opens up (Fig.6) Choice is confirmed by pressing the button *Elevator control*.

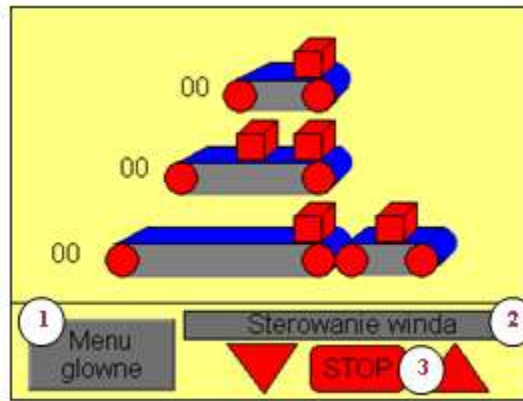


Fig.6. QuickPanel View – elevator control (1-Main menu, 2- Control lift, 3- Stop)

Touching conveyor belt on the Panel, we activate belt to control of conveyor belt (Fig. 7). Choice of a conveyor belt is confirmed by pressing the button *Conveyor belt control 1*.

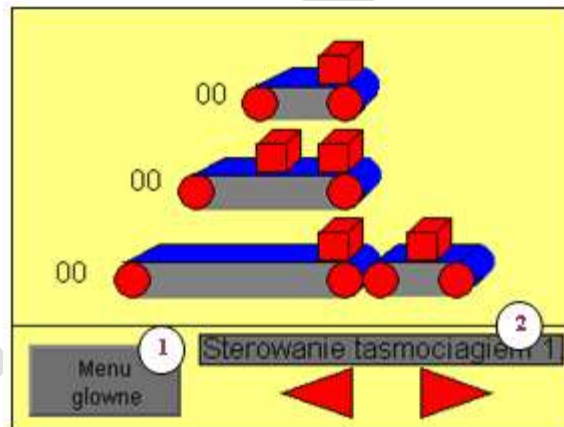


Fig.7. QuickPanel View – conveyor belt control (1- Main menu, 2- Control Conveyors 1)

User has a possibility to work in a manual mode (Fig 8.). Service panel can be activated by an *administrator*.

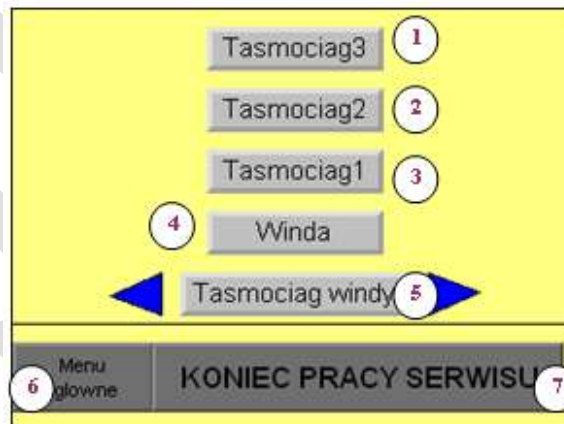


Fig.8. QuickPanel View – Service panel (1- Control Conveyors 3, 2- Control Conveyors, 2- Control Conveyors 1, 4- Lift, 5- Conveyors lift , 6- Main Menu, 7 – End of the service Work)

In a manual mode, operator can move each drive. To do this, we must choose drive of the object, that we want to have control on, for example, conveyor belt of an elevator. Then, we can choose direction of a movement. Next to active drive, there are triangular buttons used to choose direction. In order to return to service of a position in a semiautomatic mode on the operator’s control panel, we go to *END OF SERVICE WORK*.

Visualization of conveyor belts were also made in the software In Touch. (Fig 9)

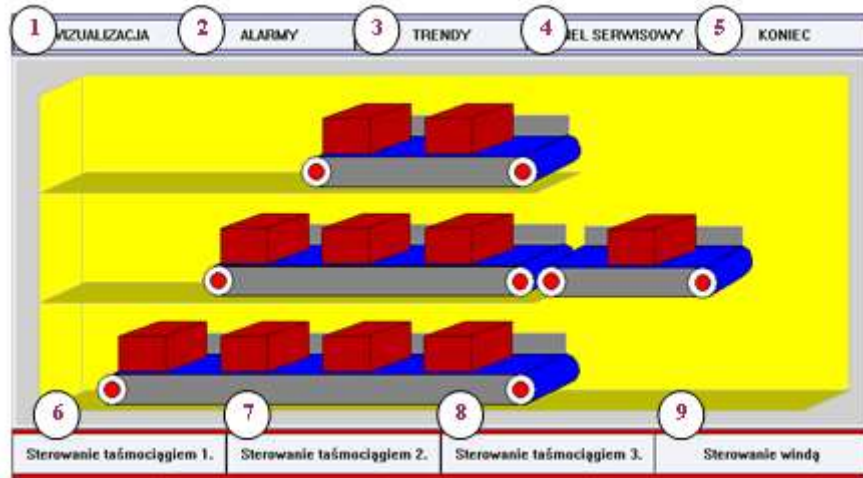


Fig.9. In Touch Application Manager (1-Visualization, 2-Alarms, 3- Trends, 4- service panel, 5-End, 6- Control Conveyors 1, 7- Control Conveyors 2, 8- Control Conveyors 3, 9- Control Lift

The application uses the following types of scripts:

- Application - covering the whole of the application. (Fig. 10.)
- Windows - referring to the window.
- Conditional - combined with the discrete or discrete expression.
- Data Change - associated only with variable and / or field variable.

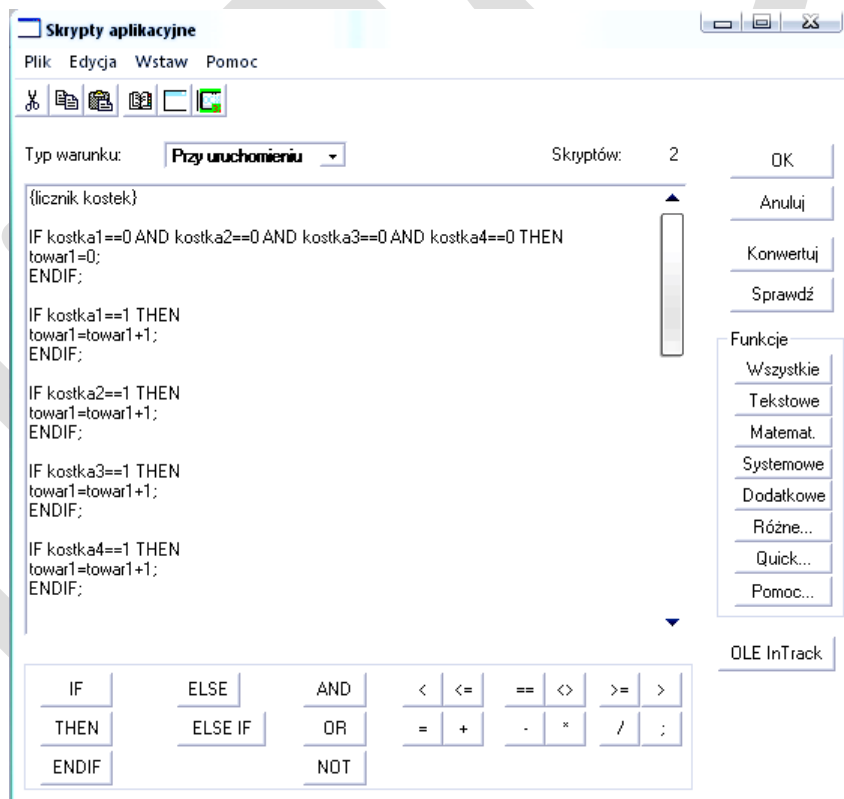


Fig.10. Scripts Application- meter cube

CONCLUSION

Building of presented work model of belt conveyors included: mechanics, electrics, automation, visualization, as well as ability to design mechanical construction. Significant for the structure of model was to program GE Fanuc's devices, that is, PLC driver (VersaMax IC200UDR010) and operator's control panel (QuickPanel View). In order to do this, it was

necessary to learn how to use Proficy Machine Edition. The next stage of work was, drive software, as well as structure of visualization application, with the use of operator's control panel and visualization software, In Touch. Note the use of two HMI (Human Machine Interface), which is the operator and In Touch. These solutions reproduce their function. The combination of Wonderware applications and the operator is not often used in reality, so this post will give you the opportunity to compare the two applications.

REFERENCES:

- [1] Automation Bulletin 2/2000 article. "REPORT - visualization software."
- [2] Fiscor S., Carter R.A.: Conveyor technology rolls ahead to keep pace with industry demands, Engineering & Mining Journal, November 2007
- [3] Gładysiewicz L.: Conveyors. Theory and calculations. Ed outbuilding. Wrocław, University of Technology, Wrocław, 2003
- [4] Gładysiewicz L., Kawalec W.: The possibility of reducing the power of the main drive belt conveyor, Transportation Industry, 1(7) / 2002
- [5] Hardygóra M., Bajda M., Gładysiewicz L.: Effect of rubber on energy consumption transport conveyor. Transportation Industrial 3 (29), 2007
- [6] <http://www.astor.com.pl/custom/catalogs/GE/QuickPanel>
- [7] http://www.astor.com.pl/custom/catalogs/GE/VersaMax_Nano_Micro
- [8] <http://www.astor.com.pl/wonderware/products/wonderware-intouch.html>
- [9] Legierski T., Kasprzyk J., Hajda J., Wyrwał J. PLC programming. Publisher Jack Skalmierskiego Computer Lab, Gliwice, 2010
- [10] Krajewska R., Łukasik Z.: "Managing logistics projects in the power plant", Journal of Logistics 3/2014, pp. 3236-3246, ISSN 1231-5478.
- [11] Kozyra J.: "Production of renewable energy in Poland and the European Union". Proceedings of the VI National Seminar on "Renewable energy sources". Radom 2010, ISBN 978-83-7204-882-0
- [12] Kozyra J., Kuśmińska-Fijałkowska A.: "Linear elements used in securing logistics facilities explosive", Journal of Logistics 4/2014, CD1, pp. 572-580, ISSN 1231-5478
- [13] Łukasik Z., Kuśmińska A.: "Potential applications of information visualization systems and logistics bases", Journal of Logistics No. 2/2004
- [14] Łukasik Z., Kuśmińska-Fijałkowska A.: Computer simulation laboratory automation systems. Radom: Publisher UTH 2013, ISBN 978-83-7351-528-4
- [15] Łukasik Z., Kuśmińska-Fijałkowska A. Laboratory automation and visualization processes. Radom: Publisher UTH 2013, ISBN 978-83-7351-527-7
- [16] Łukasik Z., Nowakowski Waldemar, Kuśmińska-Fijałkowska A.: "Critical Infrastructure Security Management", Journal of Logistics 4/2014, CD1, pp. 758-763, ISSN 1231-5478
- [17] Development of the Department of Process Control UTH Radom 2011
- [18] Przerembel S., Krzyszkowski A. "The organization of transport logistics service production facility", Journal of Logistics 3/2012
- [19] Wonderware InTouch User's Guide