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INTERACTIVE SYSTEM CONTROL OF OVERHEAD CRANE

Abstract: This paper presents an interactive control system of overhead crane, carried out with the use of advanced software PLC. It allows the realization of a wide range of transport tasks with visualization of the crane and its workspace.

1. Introduction

Modern handling equipment, including cranes, are usually equipped with propulsion and control systems capable of achieving the required operating parameters: lifting speed, capacity, etc. Device are equipped with control systems capable of performing more complex tasks than conventional cargo handling. They are built based on microprocessor controllers and have the ability to communicate with the environment (for example: the master system) to exchange measurement and control signals. Software with graphical user interface allows to visualize the unit with a control of crane parameters.

2. Overhead crane control system

Laboratory overhead crane is equipped with individual gear motors powered and controlled with inverters and system to control the device manually using the control panel (there are two possibilities: wired and wireless) and automatically using the PLC controller. Beckhoff controller (CX1000) used with the necessary modules to send and receive control signals and the acquisition of measurement signals from transducers installed on the crane. The measuring system is equipped with a transducers identifying: the crane loads: lateral forces, the weight of the load (strain gauges), location and kinematic parameters of the crane and load unit (incremental encoders with inductive proximity sensors).

CX1000 controller, used in the system, is a classic representative of this group of industrial controllers. Modular design (DIN rail mounting) for easy set-up and modification as needed. The device runs on the Windows CE operating system and allows to communicate with the environment using Ethernet (default) or RS-232C serial interface. On the laboratory crane is installed WiFi router to enable wireless communication with the PLC controller.

An integral component of the control system is the software that enables to implementation the required functions. Beckhoff, like other manufacturers of PLC, offers a development environment (TwinCAT PLC Contol [1]) allows to generate programs for 6 ways. The

package of tools are available to support start-up and testing of the generated code (eg debbuger), the emulator of controller and software utility for testing and maintaining a hardware (TwinCAT System Manager [1]). TwinCAT enables the creation of user interfaces which allow to visualize the state of the object and the operation of the program with the typical elements: buttons, dialog boxes, etc.

Designed control system, like SCADA systems, can interactively operate the crane system using visualization screens that allow the implementation of various planned functions. The main screen "User Interface" (Fig. 1) allows the run of software (1), access to all the features (2) as well as the simulation mode (3), useful for learning and testing and the stop button (4) to turn off gear motors of crane. Available menu features are implemented through successive screens visualization (all descriptions on screens in Polish). The most important of these are:
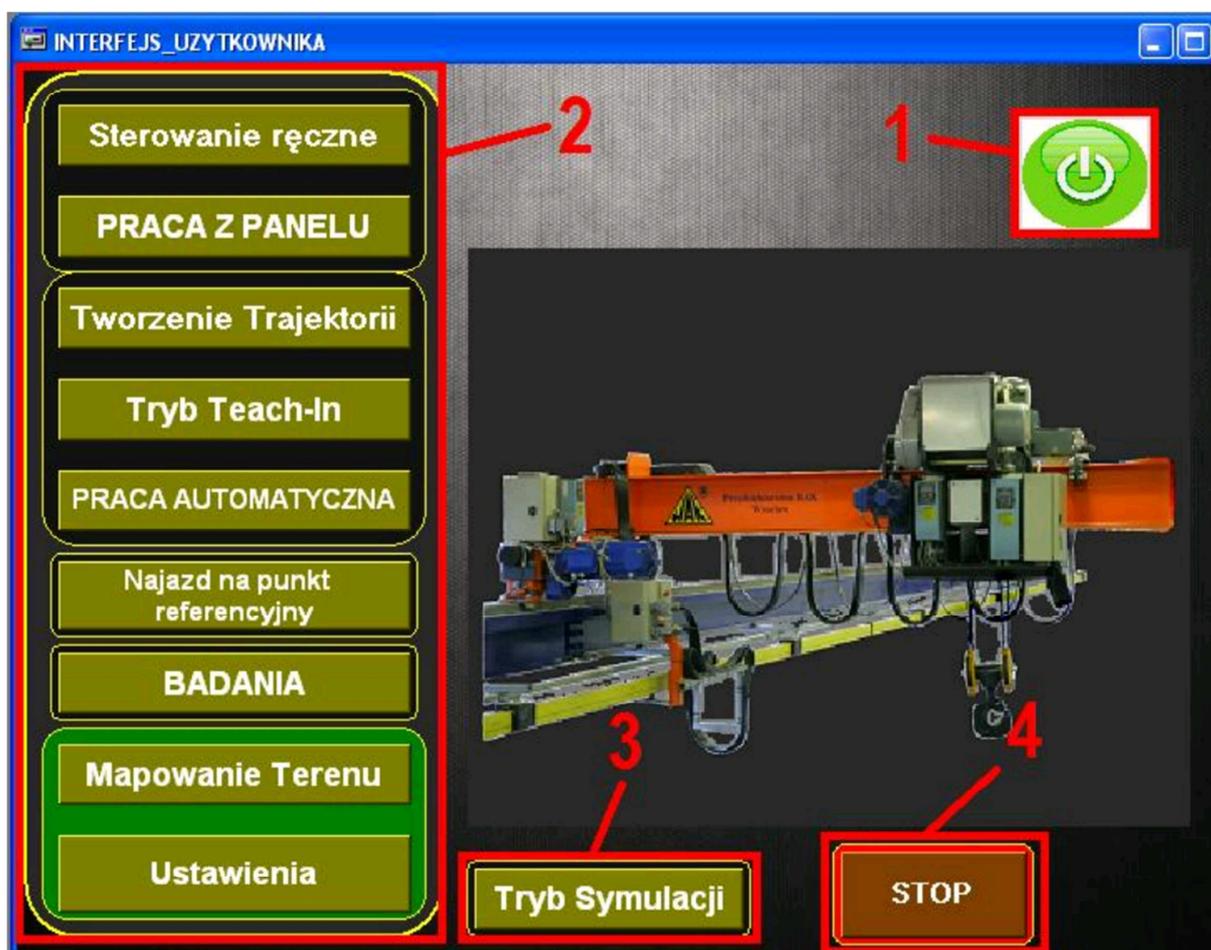
Fig.1. The main screen (1-push button switch, 2 - menu, 3 - simulation mode switch button, 4 - stop the operation of the program)

- Manual control - is possible to control of the crane using the keyboard and the mouse pointer, at the same time is visualized the location of the load unit and selected parameters of crane (Fig. 2). Is possible activation of the control panel;
- Working with the control panel - activate this feature disables the ability to control with the mouse and/or keyboard, according to the Machinery Directive [2];

- Creating a trajectory - a procedure allowing automatic search for optimal trajectories between the entered points: the start and end (Fig. 3). Is possible: check the resulting trajectory in simulation mode, modify and save;
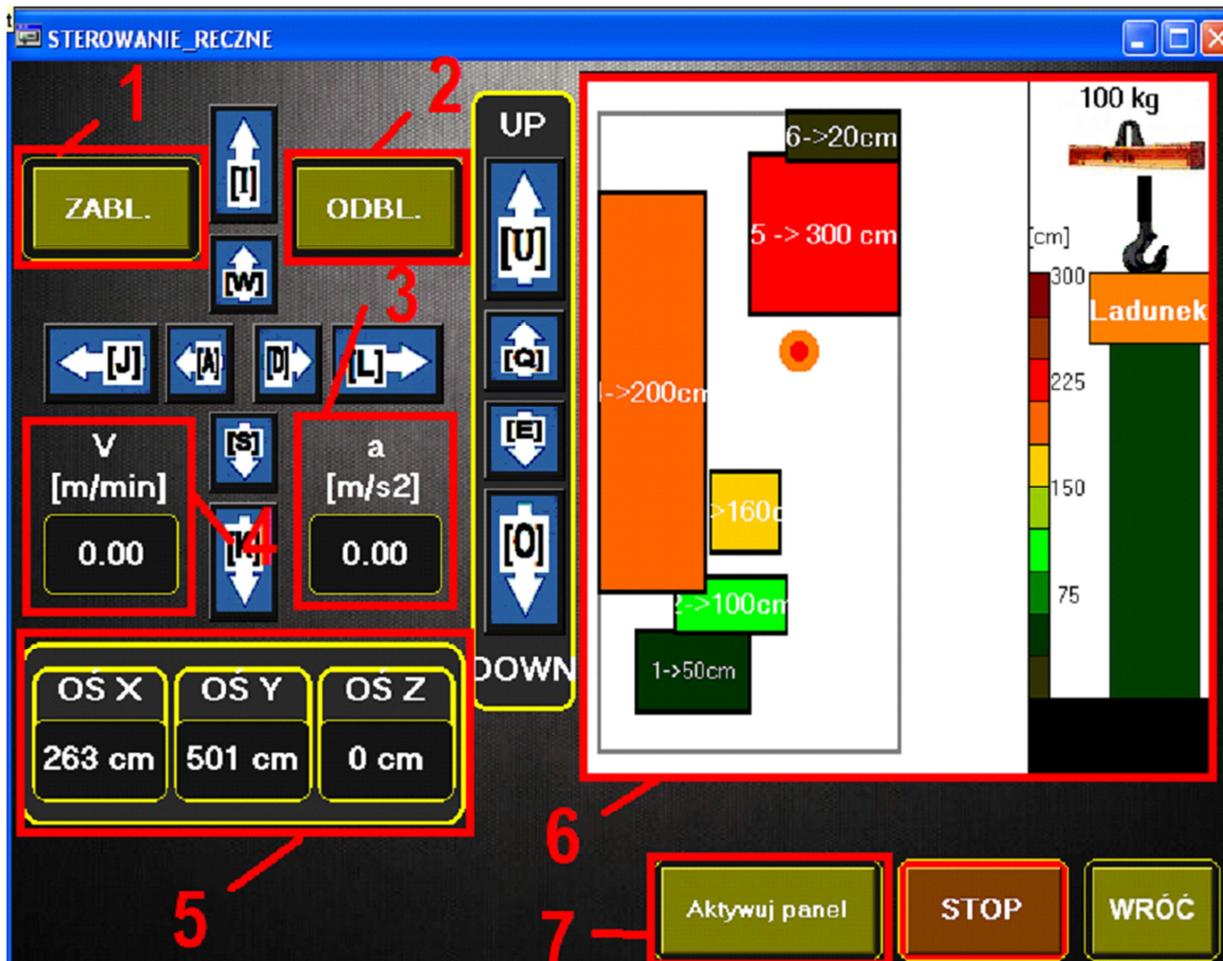
Fig.2. Manual control screen (1 -drive lock, 2- unlock the drive, 3- current acceleration, 4- current speed of the crane, 5-current position of the crane, 6-visualization workspace, 7 - activation button operation from the control panel)

- "Teach-in" mode - is another mode of development trajectories in an interactive manner, with the ability to record various positions with automatic step;
- Automatic mode - allows to load a saved trajectory and implementation of load unit movement in automatic mode with simultaneous visualization of the position of the load and the crane parameters (Fig. 4);
- Move to point of reference - to reset the counters of the positioning of the load unit;
- Research - allows the acquisition of crane parameters during testing;
- Mapping of the crane workspace - edit maps virtual workspace used by the crane control program (Fig. 5);
- Settings – is possible to enter and modify data necessary crane geometry, parameters for the simulation and interpolation; addition, to write to the input file, load a previously saved configuration and load the default configuration;
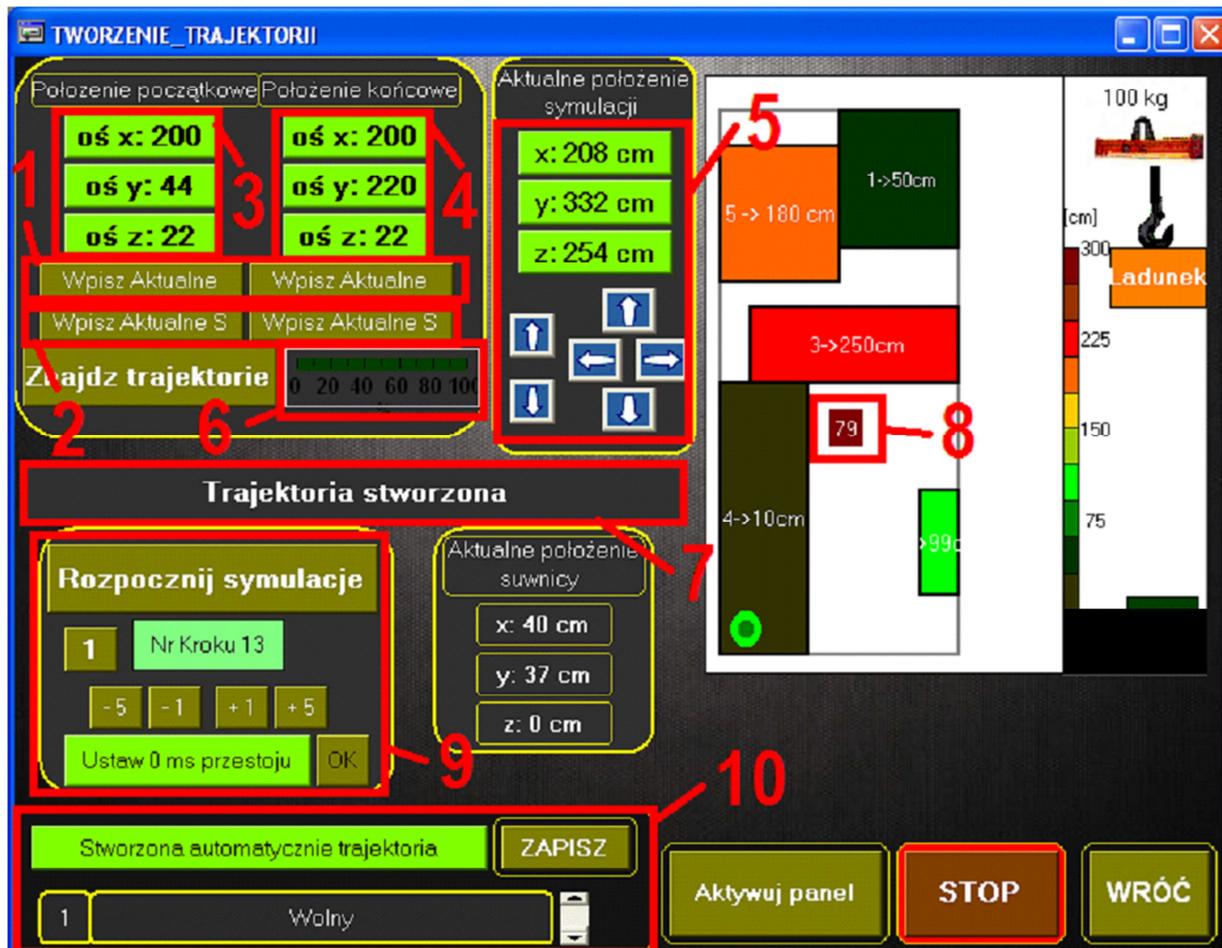
Fig.3. Creating a trajectory (1-button assignment crane current position, 2- enter the location of the simulation, 3-edit fields of starting point, 4- edit fields of final point , 5-position of the edit box simulation, 6-bar progress created simulations, 7-field displays the current messages, 8-marker of the simulation, 9-edit field of simulation, 10-box for store of created trajectory)
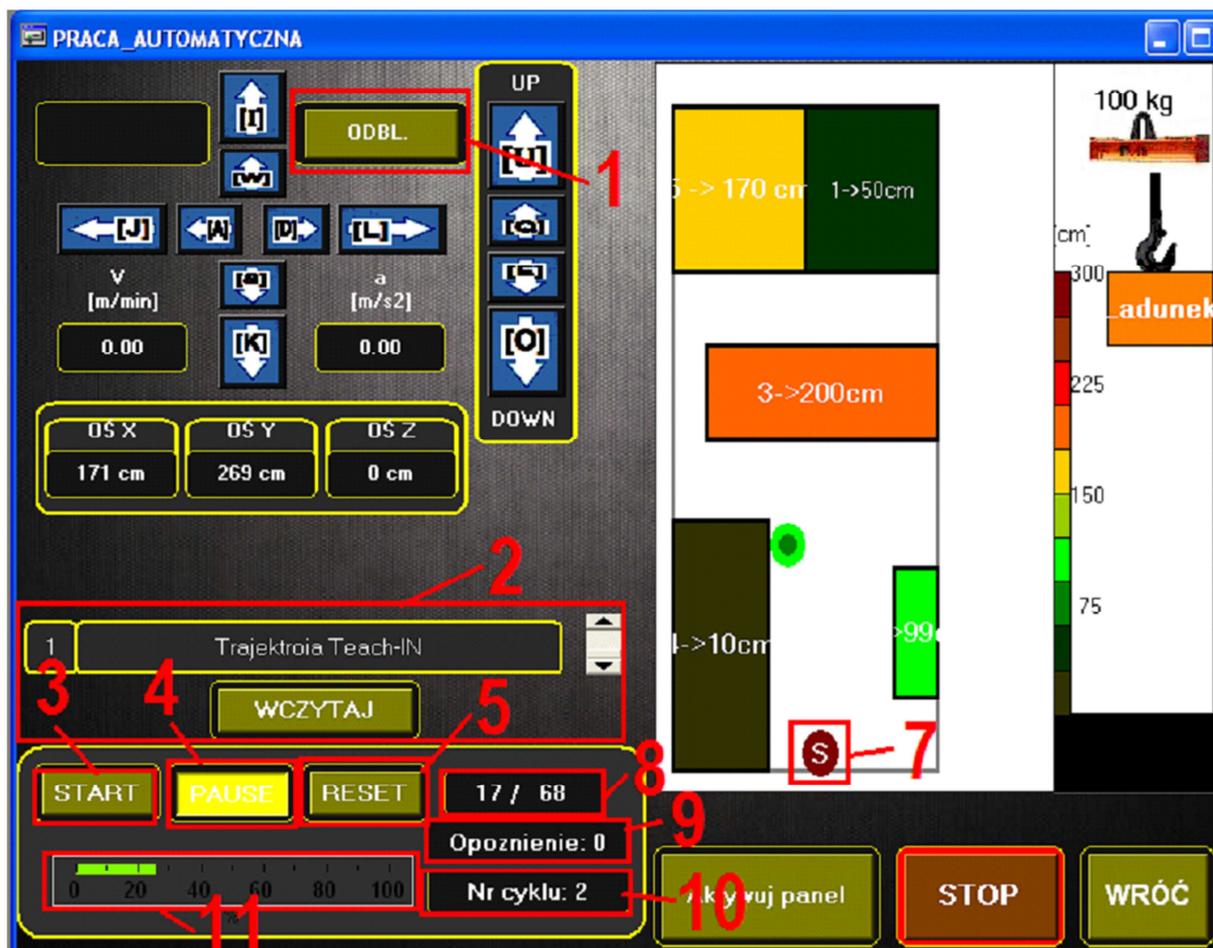
Fig.4. Screen of automatic mode (1-disable of drive lock, 2- loading of trajectory, 3-running of loaded trajectory, 4-pause button, 5-reset progress of automatic mode, 7- starting point of loaded trajectory, 8-current step / number of steps, 9-delay in the current step, 10 - no of cycles,11-made status bar)
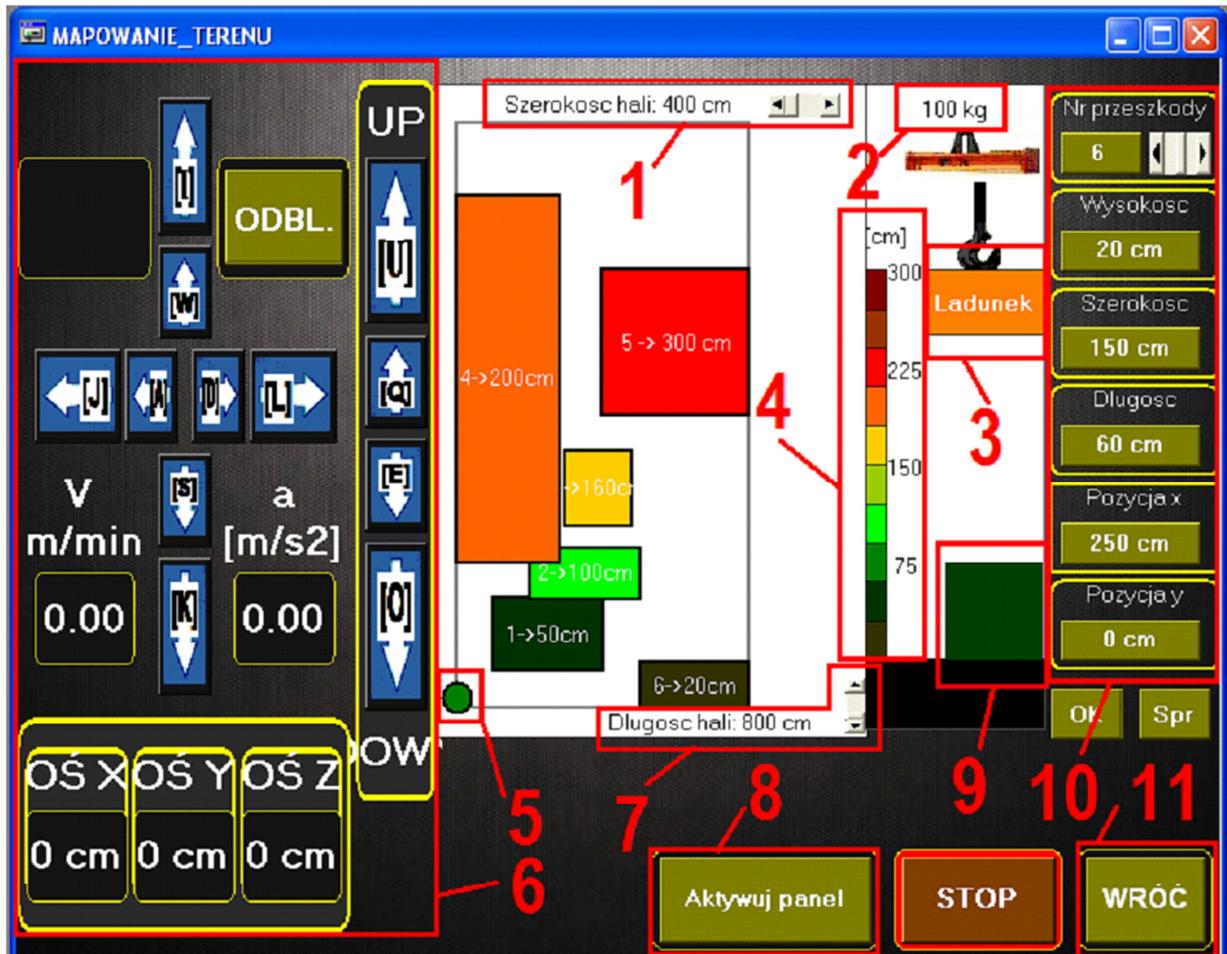
Fig.5. Mapping screen (1 - width of the workspace (horizontal), 2 - the weight of the load,3-visualization of the size of the load, 4-legend on the amount of obstacles, 5-visualization of the current position of the crane, 6-nested visualization for manual, 7- length of the workspace (vertical), 8-activation of work with the control panel, 9-visual obstructions over which is a crane hook, 10- edition field of obstacles, 11 - the return to the main screen)

3. Conclusion

Presented an interactive control system significantly extends the capabilities of the crane bridge enabling: a graphical visualization of the position of the crane and the load, the operator monitoring, reduce the risk of collision, automated tasks, the search for optimal trajectories of moving load units in the workspace. Further extension of the control system can rely on the subsystem implemented to enable recognition of obstacles and associate it with a virtual map of the proposed work area overhead traveling crane.

References

1. Beckhoff - manufacturer's website http://www.beckhoff.pl/ (date of access: 26.12.2011)
2. DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, Official Journal of the European Union, 2006.