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SYSTEM FOR ROBOT CONTROL ON THE BASE OF PROGRAMING ENVIRONMENT LABVIEW

The paper considers the use of programming environment LabVIEW for distance robot control with technology of Internet and visual information on robot state. There had been developed the structural diagram and algorithm for system functioning, UML-diagrams and block diagram of the system in the LabVIEW programming environment.

Keywords: remote control, mobile robot, LabVIEW programming environment, UML-diagrams, simulation.

Introduction

Programming environment LabVIEW is powerful and convenient means for designing which is widely used for simulation and design of automation systems and control over different technological processes in industry and scientific research. The convenience of this environment is characterized by use of virtual instruments during the development of control systems, and capacity – by algorithms and technologies, used as descriptions of virtual instruments [1].

At present the programming environment LabVIEW is widely used with educational purposes, including simulation and design of robotics control systems [2].

This paper considers the example of using the programming LabVIEW for simulation and control of robot, operating in harmful environment.

Task setting

Many technological and manufacturing processes are directly on in exceptional cases connected with factors which are harmful for a man. Such situations may appear during breakdown on chemical plants, nuclear power stations, etc. In such cases it is expedient to use robotized technical means with remote control on the base of Internet technologies.

Fig. 1 presents structural diagram of the system for robot remote control on the base of programming environment LabVIEW.

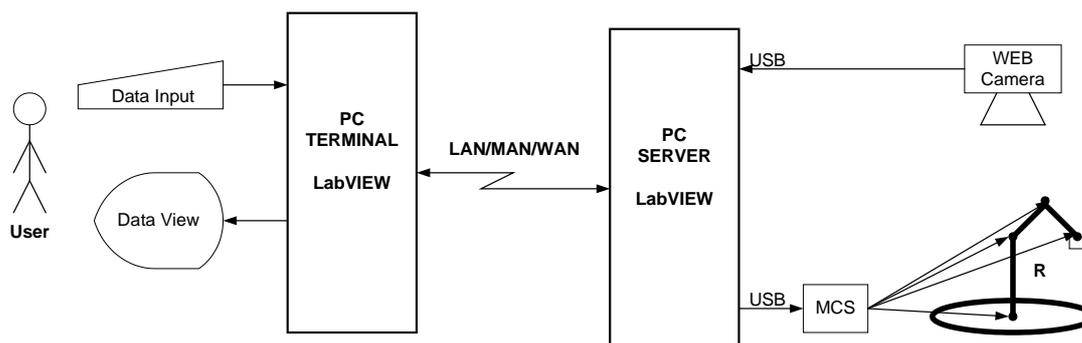


Fig. 1. Structural diagram of the system for robot remote control

Description of system components: **User** – the user of the system; **Data Input** – entering instructions for robot control; **Data View** – robot state visualization; **PC Terminal** – PC terminal – PC with programming environment LabVIEW for remote control; **PC Server** – PC with programming environment LabVIEW, located close to robot under control or process; **LAN/MAN/WAN** – technical facilities for data transfer (Internet); **WEB Camera** – video camera for robot state image input; **MCS** – computer on the base of microcontroller; **R** – controlled robot.

Functionality of the system

Functionality of the system for robot control on the base of programming environment LabVIEW is presented by diagram USES CASE in Fig. 2.

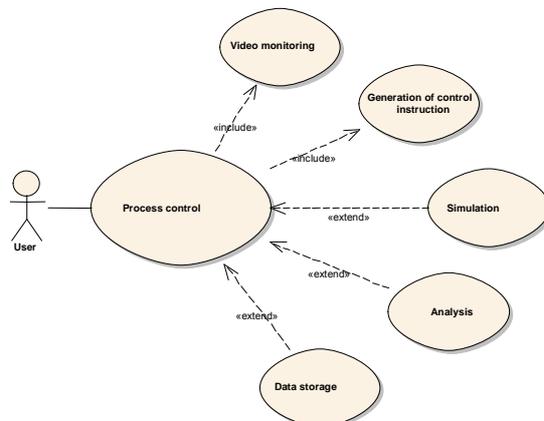


Fig. 2. Functionality of the system

Control over the process implies: **video observation** of robot state, **generation of control instructions** by keying or clicking icons on the window of videomonitor control, and additional functions of **simulation, analysis and data storage**.

Functionality of control instructions is presented by diagram USES CASE in Fig. 3.

Controlling instructions include: **rotation** of robot platform in plane X, **object capture** and **angle change 1, 2, 3**, which change position of capturing device in three-dimensional space.

To verify the system functionality, robot, presented in Fig. 4 was used. The robot contains: **1** – mechanism for rotation in the plane X; **2, 3, 4** – mechanisms for positioning the capture mechanism in space; **5** – capturing device.

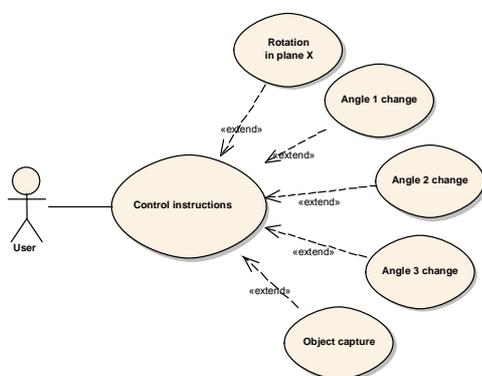


Fig. 3. Control instructions



Fig. 4. Robot, chosen for control

Algorithm for system functioning

Algorithm for functioning of the system for robot control is presented by operating diagram in Fig. 5. **Description of algorithm for system functioning.** The algorithm presents the sequence of actions, executed by user **USER**, **PC TERMINAL**, **PC SERVER**, MCS and robot. **Init Terminal** i **Init Server** – preparation of PC for functioning in corresponding mode; **Server Ready** – verification and information on server readiness; **Server Not Ready** – message on server not readiness and escaping the controlling process; **Input Video Data** – video information input by **PC SERVER** and its transfer to **PC TERMINAL**; **View Status** – users viewing the state of the controlled robot and control decision making; **Input Control Data** – entering instructions for robot control; **Accept Control Data** – reading instructions from keyboard; **Validation & Data Processing** – verification of data accuracy and previous processing by corresponding terminals of the block-diagram; **Control**

Data TCP / IP Send – data preparation transfer for **PC SERVER** through **TCP / IP** protocol;
Control Data TCP / IP Receive – receiving of the data on **PC TERMINAL** via protocol TCP / IP;
Server Data Processing – data processing by server; **Control Data USB Send** – data preparation and transfer through USB port; **Control Data USB Receive** – data receipt by; **MCS Data Processing** – processing data by MCS system and data transferring control signal to electric motor of robot;
Robot System Motion – movement of robot capture device position; **Stop** – verification algorithm end.

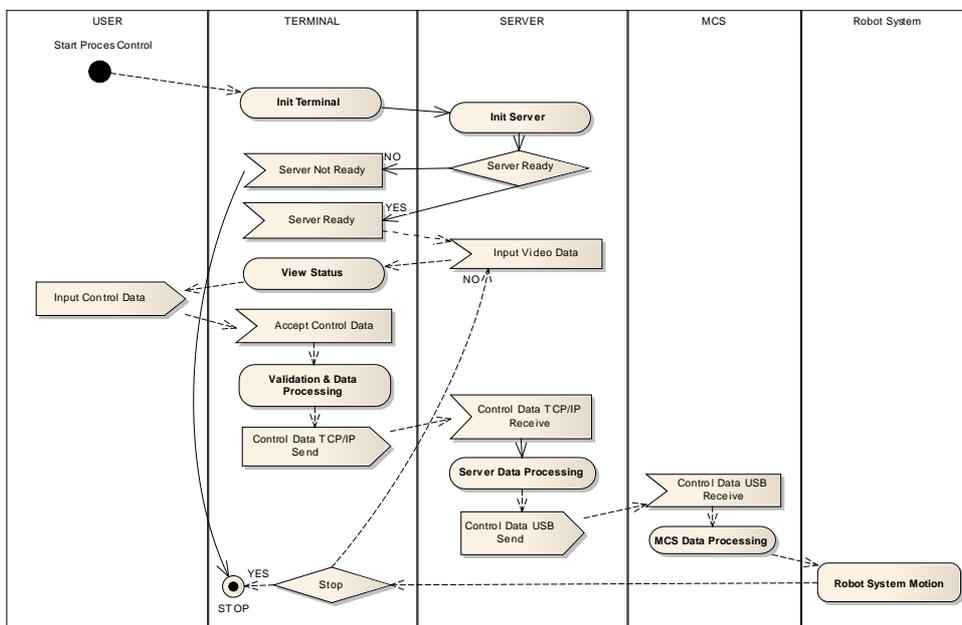


Fig. 5. Algorithm of functioning of robot control system

Block diagram of control system

Block diagram of control system is presented in Fig. 6.

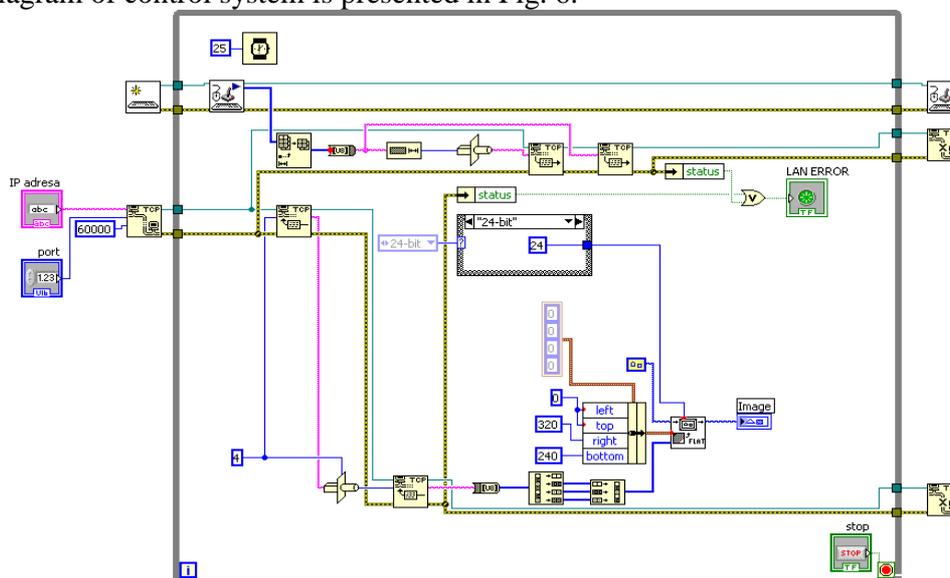


Fig. 6. Block diagram of control system

Description of block diagram of control system

Terminal TCP  is intended for formation of connection via TCP / IP protocol between **PC TERMINAL and PC SERVER**. Formation of connection requires the establishment of the following parameters of the terminal: IP address, port and method for synchronization. For data input from the keyboard , and data input from keyboard is done by terminal . Data preparation and transfer via the net is done by terminal . Terminal  is intended for reading data from TCP/IP port, and terminal  is intended for writing in TCP/IP port. Upon finishing the operation by terminal  the data session via TCP/IP port finishes, and terminal  is closed by entering from keyboard. Terminal  fulfills the synchronization of data exchange.

Block MCS

Block MCS is developed on the base of microcontroller PIC16F4450 [3]. Electrical principal diagram of MCS block is presented in Fig. 7.

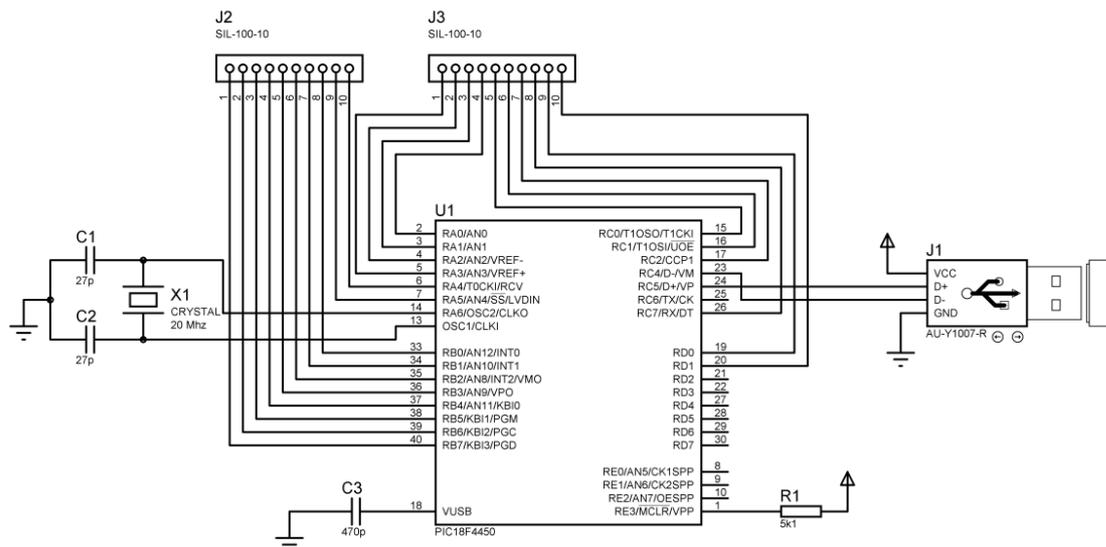


Fig. 7. Electrical principal diagram of MCS block

Functionality of MCS block lies in receiving instruction from PC Server through the USB port and its transformation into control signal of electric motors of the robot.

Conclusions

The paper considers the use of programming environment LabVIEW for remote robot control, using Internet technology and video information on the robot state. The suggested system may be used for controlling robots or technological processes with aggressive and harmful environment, or during breakdowns.

The paper presents the results of designing structural diagram, UML – diagrams, algorithm of system functioning, block diagram of control system and electric principal diagram of MCS block.

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