Information and Control System of Traverse and its Integration into Cybernetic Centre

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Introduction

This paper deals with the features of hierarchical information and distributed control systems in education and research in general. It presents analysis and realization of local and remote process and supervisory control of a specific controlled system - traverse, too. Every laboratory model implemented in the Cybernetic centre was developed not only for research laboratory purposes but for education purposes, as well. Students study topics such as robotics, supervisory and control systems, intelligent control networks, control system elements, intelligent sensor systems etc. where many of them require contact with real, simulation or at least virtual applications. The final controlled and control system of the mentioned traverse model was integrated into Cybernetic centre at the Department of Cybernetics and Artificial Intelligence, from the distributed control point of view and from the education point of view. It contributed to the improvement of education and research activities in our community.

Conception of the Distributed Control System and E-Learning System of the Cybernetic Centre

The present conception of the Distributed Control System (DCS) of Cybernetic centre is distributed into three basic levels. The basic, technological level, consists of real models, sensors, actuators and controllers. The middle, supervisory, level is represented by DDE/OPC communication gateways, process databases, visualization clients and applications. On the third, information control level, are located the database servers, information servers, web servers which present processed data for thin clients. Interconnection of e-learning with models of control applications (even remote, simulated or virtual) is very necessary in case of Control Engineering. We practice the concept of three way model approach, whose idea is to provide three forms of models: real model, simulated model and virtual model. There are thirteen real models at present in our department. Simulation models are realized through Matlab simulation or in PLC controller model, where control data are only simulated and simulated data cell values are acquired by supervisory and database applications. The virtual technological processes are interconnected with real control systems (PLC), but these models are not connected to the real process, so every user can work on its own copy of the virtual application. The advantage of simulation and virtual models is that they enable multi-user access. On the other hand, real models do not enable multi-user access, but a very good property of remote models is that they are connected to the real systems, so students have real feedback (not virtual).

Distributed Control System of the Traverse Model

The Traverse real model represents controlled process of a steel ball moving on the inclined plane, where the control task is to move the steel ball to the required position (in x and y axes) by a suitable plane angle. The traverse real model is implemented in the DCS Laboratories at the Technical University of Kosice, the Department of Cybernetics and Artificial Intelligence, which has been created to teach modern systems concepts to students and to address the knowledge required to integrate and troubleshoot automation devices.
Logical model of the traverse.

1. Process (technological) control level – the controlled system is the traverse ball position is controlled by tilt of surface. It has the following features:
   - sensing the ball position;
   - control the ball position.
2. Supervisory control level – on this level is located the control of technological process of the traverse on PC based programs. It has the following features:
   - the process is shown to user in graphical form, respectively "Live view" through the web cameras;
   - allows to change the value of process variables in real time;
   - allows manual control in real time;
   - informs by alarms about failures;

- provides the historical data.
3. Information control level - this level is based on database systems and its role is to provide runtime and historical data. It has the following features:
   - provides runtime data for application clients;
   - makes available historical data for managers, analysts, planners, on which they can carry out the analysis of historical data;
   - provides data for effective planning of production;
   - allows managers to track the status of technology and production through the Internet.

Physical model of traverse.
1. Process (technological) control level:
   - Hardware – inclined plane, a ball, sensor of the ball position, two incremental sensors Kubler 5805, two frequency converters with process controller VONSCH VQFREM 400M, two three-phase motors with electromagnetic brake, two communication modules RS485-RS232, two communication modules RS232-USB, PAC automaton ControlLogix with I/O modules IF16 and ENBT, communication module LINKSYS Network Storage Link;
   - Software – program tools PAC (RSLogix 5000), used for programming of the PLC controller;
   - Communication – through RS485 interface communicates the frequency converter with two communication modules, through Ethernet communicates two communication modules with PAC controller.
2. Supervisory control level:
   - Hardware – control computer based on IBM/PC;
   - Software – RSLinx communication software, used for communication with controller, InTouch software for supervisory control, FactorySuite Communication Gateway;
   - Communication – through Ethernet communicates the RSLinx program and PAC controller, through OPC protocol communicates FactorySuite Communication Gateway and RSLinx programs, through SuiteLink protocol communicates InTouch FactorySuite Gateway programs.
3. Information control level:
   - Hardware – Intel based server;
   - Software – process database InSQL, SuiteVoyager Portal, FactorySuite Communication Gateway;
   - Communication – through SuiteLink data acquisition is carried out into the InSQL server using FactorySuite Communication Gateway and data acquisition into the InTouch application using FactorySuite Communication Gateway.

Information and Education Systems of the Traverse model

Supervisory control is carried out on the information level by thin client connected to the SuiteVoyager portal using XML object export from the InTouch application as well as on supervisory level by the thick client InTouch application. These software products are installed on the following server within the cybernetic centre: http://cybervirtlab.fei.tuke.sk/cybervirtlab.

InTouch software has been used for the development of two versions of application for local and remote supervisory control of the model. The developed SuiteVoyager and InTouch applications are used for the following purposes:
1. supervisory control purpose – for local control of the model;
2. education purpose – within the course "Control and visualization of processes";
3. demonstration purposes – promotion of the department laboratories and student branches to secondary school students.

Local Application based on the InTouch program

SCADA/HMI (Supervisory Control and Data Acquisition/Human-Machine Interface) software Wonderware InToucFor is used for local supervisory control and visualization purposes of the traverse model.

There are two pre-defined user InTouch security accounts, „None" and „Administrator", in the InTouch application. If user is not authenticated, so the account is „None", he can run just a demo presentation of the model and may not control the model. If the user is logged in as „Administrator", he has full control within the model as well as can change the controller parameters.

This application consists of the following parts:
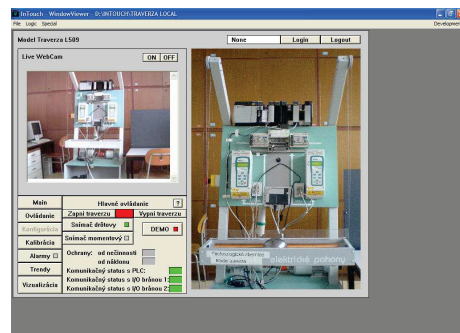1. *The main window* provides basic information about the state model.

Fig. 1. The main window

2. *The control window* allows to set the required ball position (graphically or numerically).
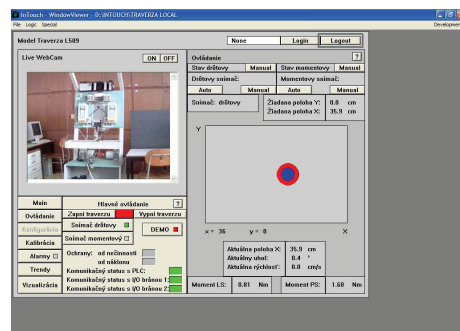

Fig. 2. The control window

3. *Configuration window* is used for adjusting the controller parameters of speed and position controllers. *Calibration window* used for traverse calibration.
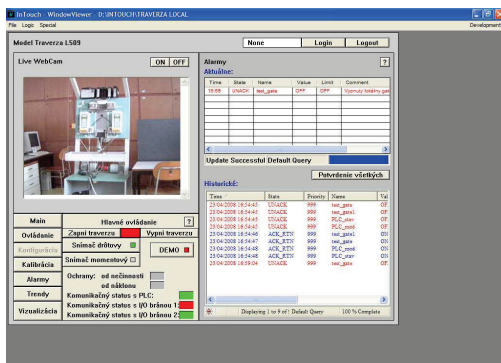4. *Alarm window* displays the real and historical alarms acquired from the model.

Fig. 3. Alarm window

5. *Trend window* provides the real and historical trends of model data.
6. *Real-time visualization* of the traverse.
7. *Application guide* for using of individual windows of the local application (realized by ActiveX components of Adobe Reader).

Remote Application based on the SuiteVoyager portal

Plant information portal Wonderware SuiteVoyager is used for remote supervisory control, visualization and e-learning education purposes of the traverse model. It is possible to access the traverse model though thin client, but SuiteVoyager portal supports just Internet Explorer with allowed ActiveX.

Security of the portal is ensured by user access accounts in the operating system on server side. There were created four accounts for these purposes on the portal:

- **svDemo** – the user is provided just with demo applications Real models[DEMO], can control just demo applications.
- **svEng** – the user is provided just with real applications panel Real models[MAIN], can carry out full control of all real models including the traverse model.
- **svAdmin** – the user is provided with demo as well as real applications: System, Real models [DEMO] and Real models [MAIN]. The svAdmin user has rights of the portal administrator, can control and configure all demo and real models.
- **Traverse** – the user is provided just with demo and real traverse panel.

The SuiteVoyager portal consists of the following education parts:

1. *Model description* – there is detailed information about the model in this window, function description of the model, logical and physical description of the model levels.
2. *Supervisory control* – it is described how to control the application, description of the control

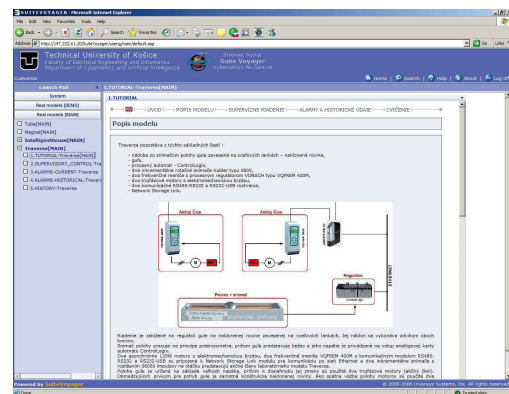buttons. There are attached video samples of the control functions to some items.

Fig. 4. MAIN supervisory control window of the Traverse

3. *Alarms and historical data* – describes alarms, historical data and historical trends.
4. *Exercises* – displays a window with exercises focused on traverse model control with possibility to test their knowledge by control of a real model. The user should control the traverse model and acquire process data from the database after completing all exercises.

The SuiteVoyager portal consists of the following control parts:

1. *The main window*, which integrates control of traverse, real trends, visualization, calibration for traverse model control: (1) real model, (2) demonstration model.
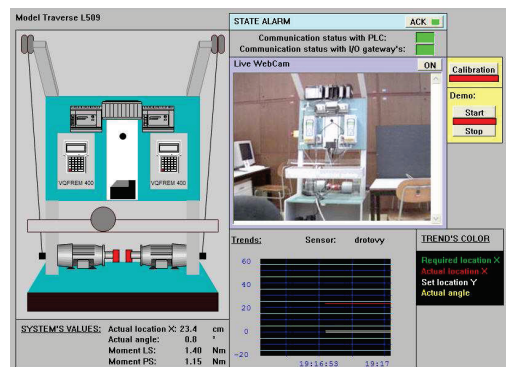

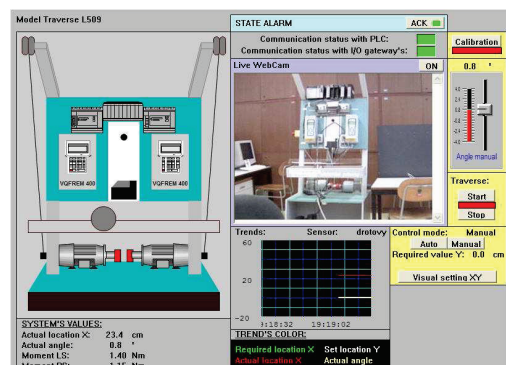**Fig. 5.** DEMO supervisory control window of the Traverse

Fig. 6. MAIN supervisory control window of the Traverse

2. *Alarm window* displays the real and historical alarms acquired from the model Fig. 7a.
3. *Historical trend window* provides the historical trends of model data Fig. 7b.
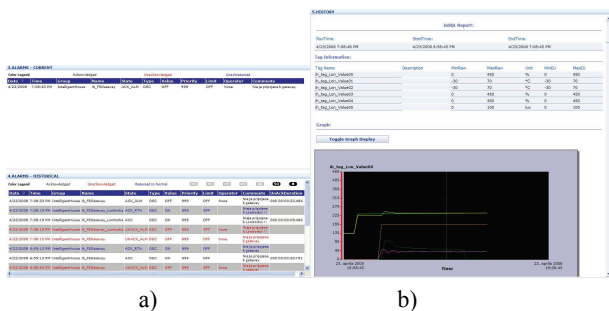

a)   b)

Fig. 7. Real and historical alarms (a); historical trends (b)

Conclusions

Interconnection of e-learning with models of control applications (even real, simulation or virtual) is highly necessary in case of Control Engineering. Based on experience gained in teaching subjects in this field, students work more actively with active participation in the learning process if there exists feedback from the control system. The paper summarizes the implementation of the traverse system into the DCS of the Cybernetic centre at the Department of Cybernetics and Artificial Intelligence of TU Košice, Slovakia. At the same time, the e-learning module for the traverse system was developed, where students can study the model, control algorithms and train through practical exercises.

References

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J. Liguš, I. Zolotová, P. Karch, J. Ligušová. Information and Control System of Traverse and its Integration into Cybernetic Centre // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010. – No. 6(102). – P. 147–150.
This paper deals with the features of hierarchical information and distributed control systems in education and research in general. It presents analysis and realization of local and remote process and supervisory control of specific controlled system - traverse, too. Logical and physical models of architecture were applied for control of real laboratory system and implemented by professional tools. The final controlled and control system was integrated into Cybernetic centre at the Department of cybernetics and artificial intelligence. It contributed to improving of education and research activities of our community. Ill. 7, bibl. 6 (in English; abstracts in English, Russian and Lithuanian).

Ю. Лигуш, И. Золотова, П. Карх, Ю. Лугушова. Интеграция поперечной информации и систем управления в кибернетических центрах // Электроника и электротехника. – Каунас: Технология, 2010. – № 6(102). – С. 147–150.
Описываются иерархические системы и системы контроля в процессах обучения. Предлагаются физические и архитектурные модели для разнесенного контроля успеваемости студентов. Созданная система внедрена в кибернетическом центре факультета. Ил. 7, библ. 6 (на английском языке; рефераты на английском, русском и литовском яз.).

J. Liguš, I. Zolotová, P. Karch, J. Ligušová. Skersinės informacinės ir valdymo sistemos integracija kibernetikos centre // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 6(102). – P. 147–150.
Apžvelgiamos mokymuisi ir tyrimams taikomos hierarchinės informacijos ir paskirstytosios kontrolės sistemos. Aprašoma vietinių ir nutolusių procesų kontrolė, taip pat loginiai ir fiziniai architektūros modeliai, taikomi realiai veikiančiai laboratorinei sistemai. Kibernetikos ir dirbtinio intelekto fakulteto kibernetikos centre buvo įdiegta galutinės kontrolės ir kontroliuojamoji sistema, kuri prisideda prie mokymo ir tyrimų veiklos tobulinimo. Il. 7, bibl. 6 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).