

Interaction of Real and Embedded Devices for Intelligent Control of City Electric Transport

A. POTAPOVS^a, M. GOROBETZ^b, A. LEVCHENKOV^b

^a Faculty of Power and Electrical Engineering, Riga Technical University, 1, Kalku Street, LV-1658, Riga, Latvia,

^b Institute of Industrial Electronics and Electrical Engineering, Riga Technical University, 1, Kalku Street, LV-1658, Riga, Latvia,

EMAIL: Andrejs.Potapovs@rtu.lv

ABSTRACT

The interaction of real and virtual devices is an important point in the design and development of control system. The central part of an embedded control system is a controller and it needs input devices and output sensors for realization of the control. The proposed approach allows using a real controller with its specific programming tools and languages for intelligent software development and virtual measurement and sensor devices realized in a computer environment. Different wireless compounds are necessary for intelligent embedded devices for transport system control. For this reason a wireless communication network is needed to ensure the data transmission between the controller and supervisory control and data acquisition system. The purpose of this paper is to propose an approach for interaction of real, embedded and virtual devices in electric transport control systems.

The main tasks are: to analyze objects and functional dependencies of an electric transportation control system, to develop a control algorithm with the interaction of real and virtual devices, to ensure a wireless connection for the data transfer from the controller to the supervisory control and data acquisition system, to define the method of transmitted data processing. Computer and practical experiments, with real and embedded devices, and the results analysis will be described the paper.

KEYWORDS: electric transport, embedded systems, intelligent control

1. Introduction

Real and virtual interaction devices are an important point of recently developed control system design, as it is often used in various types of computer programs and have created a meter, which increases levels of automation and modifying the system itself. Often there is a place for different wireless connections, which are used in transportation systems, dynamic systems are very important to direct wireless connections, where the transfer takes place. Therefore, a question

arises related to the wireless data transmission such as sending the data to the controller, or reading the data from it.

1.1. Purpose and tasks

The purpose of the paper is to present the Interaction of Real and Embedded Devices for Intelligent Control of City Electric Transport.

The main tasks are to:

- Create a management system for electric vehicles;
- Choose the transfer of necessary parameters;

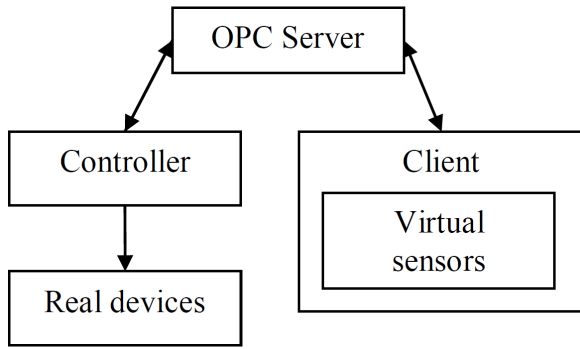


Fig. 1. Data flow chart
Source: [own work]

- Take a wireless connection to transfer data from the controller to the Matlab program model;
- Describe the data handling process.

1.2. System description

After several urban electric transport developments of a control algorithm using programmable controllers, a need arose to expand the research possibilities of this direction by creating a possibility of visual data control and further online processing. It was therefore decided to use a program environment, enabling to differentiate between the data processing and graphical monitoring. A conclusion was drawn that the main compatible object in this system is the controller program, which will make the tram traffic visualization model, and that a server is required to transfer the data.

Real devices are:

- Electrical engine E
- Traffic light L_1
- Traffic light L_2

Virtual sensors are:

- Engine rotation speed w
- Traffic light L_1 coordinate X_{L1}
- Traffic light L_2 coordinate X_{L2}
- Traffic light L_1 lighting light g_{L1}
- Traffic light L_2 lighting light g_{L2}

To gain an insight into the nature of the data transferred a small survey of electric transportation management system and the tram traffic management program should be considered.

The control program action comprises:

The controller enters the management program of the tram model (un-engine), simulating the movement on the tram route, the route comprises traffic lights and stop – L, P (Fig. 2.). An electric vehicle T shown in the figure consists of components such as an electric motor E and controller C.

The management principle was highlighted in the traffic

safety promotion, first in putting brake prohibitive light signals and points to the corresponding braking acceleration. Management program provided to speed the admission of the stops, or parking at the denying light signal.

After a successful management program launch there was a need for visual observation of this process in motion that would allow evaluating fuller the developed control algorithm and detecting possible improvement algorithm stages. It should be mentioned that the visual graphical analysis of the parameters was really fruitful.

As the next point we can see all the objects and components that will be involved in the control system, as well as the variables that characterize these objects.

- The main objects that will be used for our tram management model:
 - › Tram (T);
 - › Passenger stop No 1;
 - › Passenger stop No 2;
 - › Passenger stop No 3.
- Components which include the above-mentioned principal objects:

The tram:

 - › Positioning sensor (P_d);
 - › Rotational speed sensor (A_d);
 - › Speed sensor (A_{ad});
 - › Completed road sensor (V_{cd});
 - › Braking distance sensor (B_{cd});
 - › Transmitter (R).
- Variables corresponding to the above attractions:

The tram:

 - › Coordinate X_T ;
 - › Engine speed w ;
 - › Speed V ;
 - › Completed road S_T ;
 - › Stopping distance at the current speed S_{br} .

A passenger stop:

 - › Coordinate X_p .

1.3. Task solution

As the program, which will be used for data processing, the Matlab environment was chosen because it provides a great opportunity for data receiving and processing.

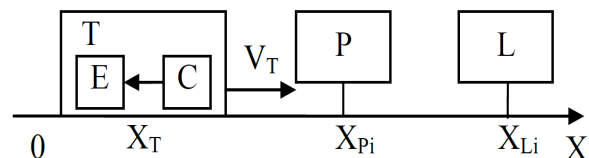


Fig. 2. General structure of the system
Source: [own work]

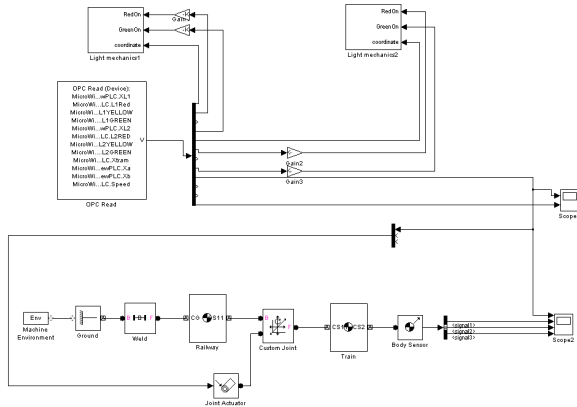


Fig. 3. Visualization Model
Source: [own work]

Name	Address	Data Type	Access
XL2	VD104	REAL	RW
XL1	VD100	REAL	RW
Xb	VD112	REAL	RW
Xa	VD108	REAL	RW
Speed	VD26	REAL	RW
L2YELLOW	Q0.6	BOOL	RW
L2RED	Q0.5	BOOL	RW
L2GREEN	Q0.7	BOOL	RW
L1YELLOW	Q0.3	BOOL	RW
L1Red	Q0.2	BOOL	RW
L1GREEN	Q0.4	BOOL	RW

Fig. 4. Data entry in PC Access program
Source: [own work]

Then the PC Access program was selected for setting up a Data Transfer server.

The challenge program explained was created in a Matlab visualization model (Fig. 3.) Processing the next data received from the controller:

- X_{L1} – The first set of traffic lights coordinate
- G_{L1} – The first set of traffic lights (red, yellow or green)
- X_{L2} – The second set of traffic lights coordinate
- G_{L2} – The second set of traffic lights
- X_p – passenger stop
- X_T – tram coordinate

These are the most important system parameters, because they are characterized by direct tram running processes and the influences acting.

Similarly, there was an opportunity to read any parameters, which are stored in a controller, by entering the address of the PC Access program building a server (Fig. 4).

As the next step, we run the program controller, or propose a tram run along the route, have an opportunity to visually monitor it and, where necessary, to process the data received from the controller parameters.

It should be noted that inserting the Matlab program model, in addition to the OPC Write block, got a chance to enter the necessary parameters, or change the existing

online mode, i.e. to run the model studied remotely using a wireless connection. The model with the maximum was created simply to allow monitoring the tram routes, traffic lights, the lights on and the tram itself.

One of topic developments planned is to completely withdraw from the wi-fi use for the data transfer, and use the GPS and GSM, which will be connected to the controllers who will control the motor and traffic lights.

A simplified block diagram for this case is shown in Fig. 5.

The block diagram used the following blocks:

- P – Satellite
- C – Controller
- E – Electric engine
- M – Measuring instruments
- L – Traffic lights
- GPS – GPS antenna
- GSM – GSM antenna

This addition will require the use of aerial control program development, but at the same time, the system capacity will increase the future, maximally close to the actual working conditions. The data visualization is also possible

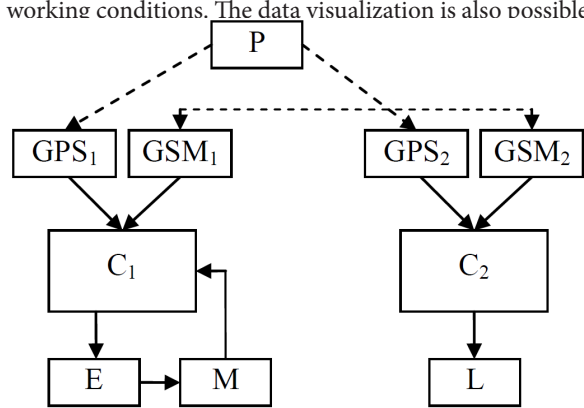


Fig. 5. Electric transport and traffic light interactions using built-in intelligent systems
Source: [own work]

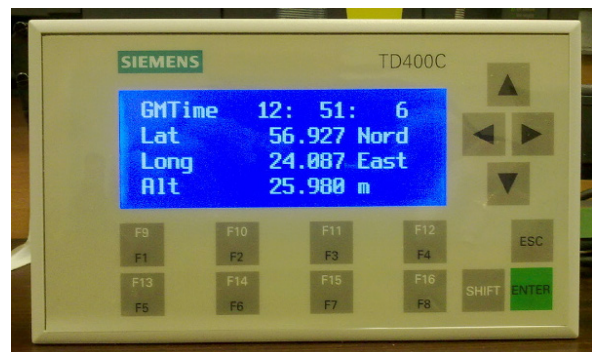


Fig. 6. Siemens TD 400 monitor displays the controller coordinates and altitude above sea level
Source: [own work]

using devices directly connectable to the controller, such as various boards, which can output a variety of emergency messages, electric transportation coordinates, engine parameters, speed of electric transportation, other electric transport speeds and coordinates, etc.

1.4. Experiment

The real algorithm for the equipment checking was situated in a stand (Fig. 7.), comprising an industrial programmable controller for Simatic 224 xp (1), “ethernet” block (2), the power supply unit (3), fuse (4), router (5) providing the only wireless connections to computers, two traffic lights (6), DC motor (7).

During operation, the “Step-7” program was connected to the controller and the program loaded up. “Simulink” medium was prepared by the open model, which graphically depicted different parameters, both at the tram movements (Fig. 8.).

It was possible to depict graphically the data received, showing as they change in time. Figure 9 shows the speed on the tram route and stops depending on changes of time.

In this way, we can send the data to controllers in a real world of urban electric transport.

For a bench operation, the engine control was used in the controller output, which generates a voltage with variable pulse width. This was practically the only size that was controlled and registered in reality; in other calculations the values required were obtained directly from the removal of this parameter. In reality, parameters such as the path covered by the tram, speed, etc. will be received from various sources, but in our model

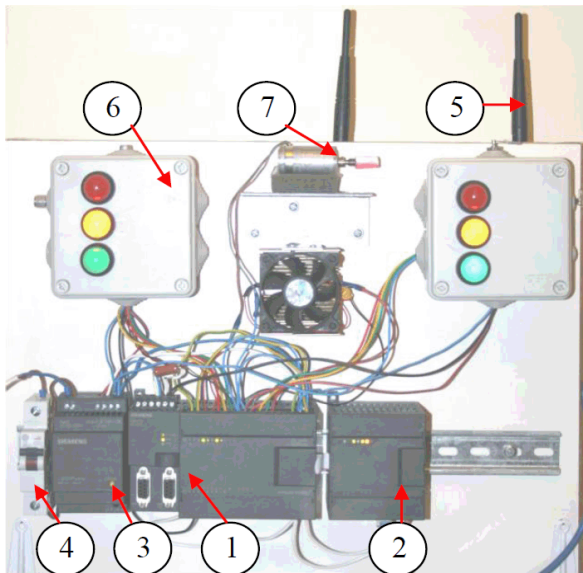


Fig. 7. Stand
Source: [own work]

the relevant parameters need to be calculated by the control program itself.

2. Conclusions

The developed control algorithm also provides tram stops and braking before the traffic lights with a specific set of acceleration.

With regard to the data transfer process it can be concluded that the data transfer was stable and accurate, as well as fast enough. This gave the opportunity to work in a sufficiently precise visualization model.

It was possible to develop algorithms that will involve a real device, such as GPS and GSM antenna for transmitting the data, which enabled to transfer the data at such distances, which are required for electric transportation routing time.

Overall, we can definitely say that in the future the built-in intelligent systems will be applied for further improvement to real objects in urban or interurban electric transport, increasing the safety, accuracy and efficiency.

Bibliography

- [1] RIBICKIS L., VALEINIS J. Elektriska piedzina mehatronikas sistemas. Riga, 2008. – 287 lpp.

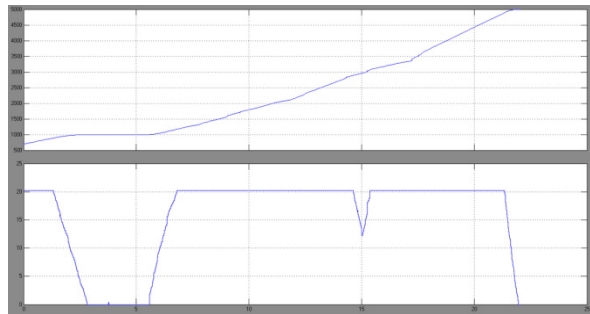


Fig. 9. Covered path and speed graphical display
Source: [own work]

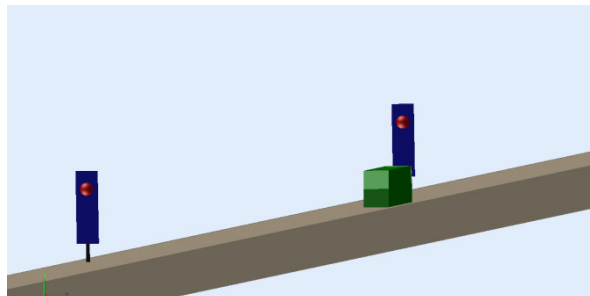


Fig. 8. Visualisation model
Source: [own work]

- [2] RIBICKIS L., LEVCENKOV A., GOROBETS M. Sistemu teorijas pamati industrialas elektronikas modelesana. Riga, 2008. – 95 lpp.
- [3] KOLESOV, J. B.: Object-oriented modelling of complex dynamic systems. Saint Petersburg, 2004 – 232 p.
- [4] BRIAN R., et all.: Guide to Matlab for beginners and experienced users. University Of Cambridge, 2008. – 351 p.