SIMULATION OF MOTOR VEHICLES INSTRUMENT PANELS IN LABVIEW ENVIRONMENT

Marcin Buczaj, Andrzej Sumorek

Department of Computer and Electrical Engineering, Lublin University of Technology,
Nadbystrzycka Str. 36, 20-618 Lublin, Poland, e-mail: mbuczj@pollub.pl

Summary. The basic task to be performed by the instrument panel installed in the vehicle cockpit is the visualization of technical condition for the basic systems included in the vehicle equipment and the displaying of travel parameters. Actually the cockpits are equipped with many warning lamps and needle indicators informing the driver of the vehicle condition. The concept of electronic instrument panels displaying the readings on the screen has been presented in the paper using the example of the instrument panel installed in FSO POLONEZ motor cars. The operation of the instrument panel of the motor car was simulated in LabVIEW environment.

Key words: motorization, LabView applications, visualization of processes

INTRODUCTION

The use of instrument panel of the motor cars is essential for an increased feeling of safety. Any subjective decisions regarding further actions performed during travel are made by the driver on the basis of objective readings obtained from the installed indicators and individual warning lamps. The more data are received by the driver, the more complete is his knowledge of the vehicle condition. The time of receipt of the information on vehicle condition by the driver is also important. Considering these assumptions from technical point of view, high reliability, legibility of displayed information and the certainty that such information will be received by the driver are the basic requirements to be met by the instrument panel.

In case of contemporary control of cockpits installed in motor cars, the role of mechanical components and of condition indicators provided with the bulbs is essential. The instrument panels provided with electronic displays (particularly mileage indicators, speed indicators, car clocks) are used more frequently and use of the electronic displays with the verbal messages presenting the travel parameters is less frequent. The next feature of the conventional vehicle instrument panels is lack of connection between the individual electric systems enabling data transmission to the cockpit and lack of automatic checking of technical condition for individual indicators and warning lamps. While a damage of speed indicator may be suspected in case of its serious defect on the

basis of watching the actual situation on the road, it would be impossible in case of burnt bulb in the warning lamp. An impossibility to adapt the appearance of the instrument panel to individual needs of the user is the next feature which is not essential in respect of technical considerations but important in respect of aesthetics.

In order to achieve the features of the above-presented conventional instrument panels, the concept will be presented for an integrated instrument panel design with the vehicle condition data and travel parameters of the vehicle displayed on the screen. Any information and signals received by conventional indicators and warning lamps were collected by means of data acquisition device. The application created in LabVIEW programming environment was used for the interpretation of information received from individual circuits and systems of the vehicle.

The purpose of LabVIEW programming environment provided by NATIONAL INSTRUMENTS is to prepare the software for measuring systems to be used for the measurements in real and virtual circuits. LabVIEW environment is a complex program enabling the designing and modelling of simple circuits as well as monitoring of complex manufacturing processes by means of graphical programming languages. The designing and building of virtual devices used in computer aided measuring systems is also possible in LabVIEW environment. Thanks to special equipment (e.g. data acquisition device), the construction of the instrument panel required for testing of the real system under test is also possible.

An unquestionable advantage of correctly prepared and displayed on the screen application (not only in LabVIEW environment) consists in limited possibility of unknown actions of the user in case of erroneous readings and information received from the screen. In the example presented in the present paper, individual analogue indicators and warning lamps were eliminated and their burning or damage is impossible. Any failure in the measuring system can be detected easily, because the information obtained from all signals and readings is contained in the signal transmitted from the data acquisition device to control unit and from the computer to the screen.

The possibility to adapt the cockpit appearance to the requirements of the user is another advantage of the solution in comparison with conventional instrument panels. Any modifications of needles colour, background of indicators and position changes are much easier and direct adaptation of the cockpit appearance to the taste of the user actually driving the vehicle is also possible.

The aim of executed researches was to create a complete virtual instrument enabling the signal detection, analysis of obtained information and displaying of results as well as simulating the operation of a real instrument panel. The next stage of the researches consisted in the comparison of results obtained from an analysis of the received information on the vehicle condition data and travel parameters of the vehicle which are presented in both the measuring systems (i.e. in the real and virtual one).

CONVENTIONAL INSTRUMENT PANEL

The cockpit installed in FSO POLONEZ motor car with the functions to be simulated by means of the application created in LabVIEW and displayed on the computer screen, is used as the conventional instrument panel. The appearance of the cockpit was illustrated in Fig. 1.
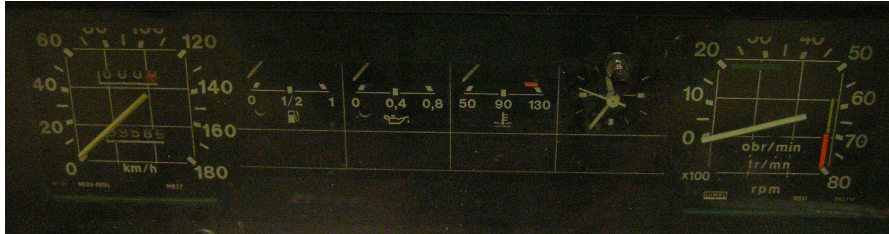
Fig. 1. FSO POLONEZ – Instrument panel

The following needle indicators are incorporated in the instrument panel: speed indicator, engine speed indicator, fuel gauge, oil pressure indicator, coolant temperature indicator, mileage indicators i.e. total mileage indicator and periodical mileage indicator, binary indicators (warning lamps): for braking system, choke control lamp, rear fog lights, rear window glass heating, charge indicator, warning turn signal indicator, headlights, side lights, dipped headlights. The warning lights for fuel reserve, oil pressure and clock are additionally provided in the instrument panel.

The instrument panel is a part of the laboratory test stand built as the master thesis [Wócik 2005] and installed as the equipment of the Motor – Vehicle Diagnostics Laboratory in the Computer and Electric Engineering Department in the Technical University of Lublin. The layout of the laboratory test stand was used to check the functions of the application created in LabVIEW environment and simulation of the operation of the instrument panel made by the manufacturer was illustrated in Fig. 2.
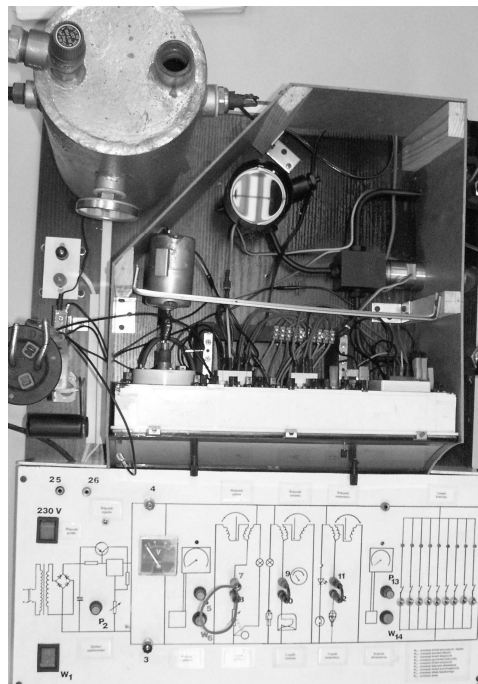

Fig. 2. The laboratory test stand

VIRTUAL INSTRUMENT PANEL

The model of virtual instrument panel performing all functions and tasks of the original instrument panel installed in FSO POLONEZ motor cars was created on the basis of environment LabVIEW (program LabVIEW 7.1) [Nat. Instr. 1998, 2003, Tłaczała 2005]. According to design inputs, the purpose of the developed virtual instrument is to enable the cooperation with the real laboratory test stand provided with the cockpit of FSO POLONEZ motor car made by the manufacturer and to enable the simulation of processes occurring in course of travel and to display their representation on the instrument panel. Using the design inputs assumed for the created application, it was possible to check the convergence of the results obtained from the real instrument panel with those obtained from the virtual instrument panel. However the part encompassing the simulation of real processes occurring in course of travel will enable the use of the created virtual instrument in didactical process as well as in course of further development of the project in order to add the new functions. NI USB-6008 data acquisition device manufactured by NATIONAL INSTRUMENTS was used in order to record real diagnostic signals originating from the instrument panel installed in the laboratory test stand. The data acquisition device is provided with 8 single analogue inputs or with 4 differential programmable analogue inputs, 2 analogue outputs and 12 programmable digital I/O systems. The information received from the inputs or outputs control signals is sent to the control unit (PC) by means of USB line. The signal transmitted between the data acquisition device and PC conforms with full-speed USB standard [Nat. Instr]. The layout of NI USB-6008 data acquisition device was illustrated in Fig. 3 and the block diagram of a test stand was illustrated in Fig. 4.
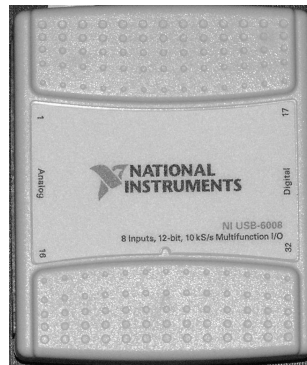

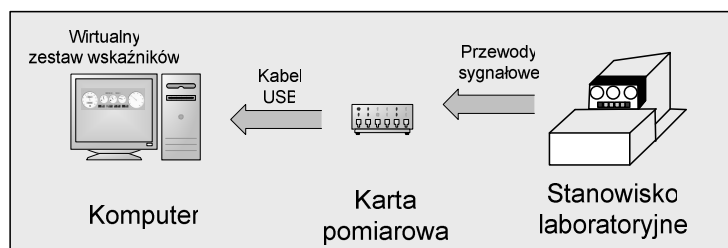Fig. 3. NI USB-6008 data acquisition device

Fig. 4. The block diagram of the test stand

The front panel incorporated in the created virtual instrument panel was illustrated in Fig. 5. In order to make the presentation of the included drawing more legible, the colour concept of the virtual cockpit was not adapted to the real cockpit. Also the needle clock incorporated in the real cockpit was replaced by the digital clock with date display. Two fields with the warning lamps and pushbuttons were provided in the lower part in order to enable the simulation of diagnostic signals.
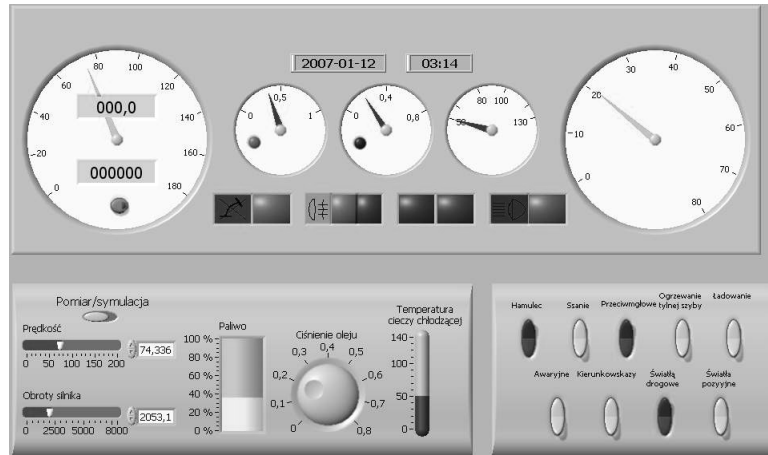
Fig. 5. The front panel included in virtual instrument panel created in LabVIEW program

The block diagram of the created virtual instrument panel analogical to the instrument panel installed in FSO POLONEZ motor cars was illustrated in Fig. 6. In order to improve the circuit diagram transparency, some of its elements were combined into a form of subprograms containing a part of input or output elements, configuration of the data acquisition device ports and performing the conversions required to adapt the input signal parameters to the ranges of indicators and warning lamps. The individual subprograms used in the main simulation program are characterized by precisely specified functions enabling quick connection between individual elements without any necessity to analyse their inner block diagrams.

The virtual instrument enabling the vehicle speed measurement and determining the (total and periodical) distance travelled by the vehicle on the basis of instantaneous values of vehicle speed, belongs to the most important subprograms constituting the part of main program.

After completion of continuous signal quantization in time and amplitude domain in order to convert it into discrete form, the following equation enabling the calculation of vehicle travel was obtained:

$$s = \sum_{i=1}^{n} V_i \cdot \Delta t \,, \tag{1}$$

where:

V_i – speed assumed as average speed in a given period of time;

Δt – time interval (the value assumed in the project amounts $\Delta t = 100 \text{ ms}$).
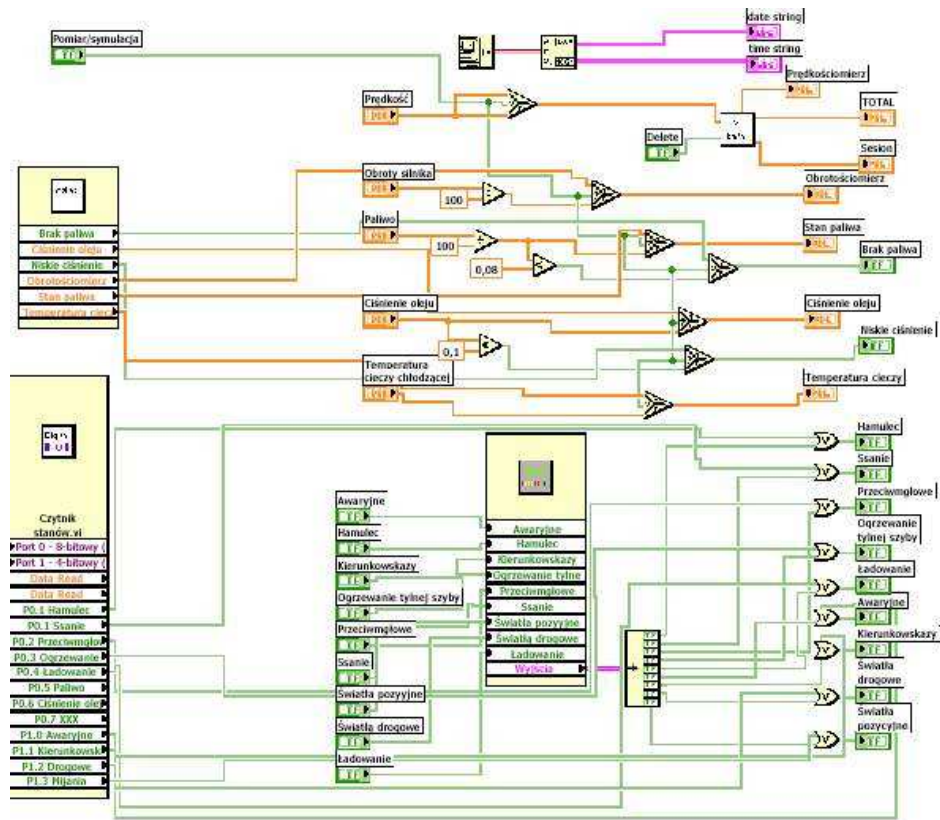
Fig. 6. The window of block diagram for virtual instrument panel

The window of block diagram for virtual instrument panel ensuring the display for the vehicle speed on the indicator and the (total and periodical) distance travelled by the vehicle was illustrated in Fig. 7.
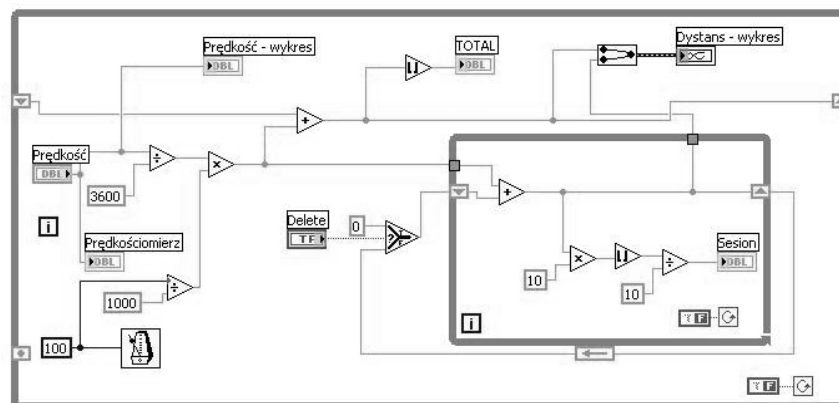

Fig. 7. The window of block diagram for virtual instrument – speed indicator

Owing to the mechanical system for the measurement of instantaneous value of vehicle speed provided in the real system (installed in FSO POLONEZ motor car), the mechanical value (speed indicator cable speed) had to be converted into electrical value. Therefore DC rate generator was used as the speed – voltage converter.

COMPARISON OF REAL AND VIRTUAL INSTRUMENT PANELS FOR FSO POLONEZ MOTOR CAR

The detecting part of laboratory testing stand was used in order to compare the functioning of the real and virtual instrument panels. A part of laboratory testing stand incorporates the real measuring systems in form of sensors being used in course of FSO POLONEZ vehicle diagnosis (temperature sensor, pressure sensor, position sensor). In order to enable function test for individual warning lights, the properly configured switches were used.

In course of comparison of warning lights functioning in the real system with corresponding LED indicators incorporated in the virtual panel, it was observed that the lamps went on and off in both the panels simultaneously. The unquestionable advantage of the virtual instrument panel consists in the fact that the burning of any virtual warning lamp is physically impossible. If the bulb is burnt in the real instrument panel, any reliable information on the condition of the circuit is unavailable for the user. In case of the virtual instrument panels, it is possible to inform the driver of the failure of any system by means of text or voice announcement.

In course of comparison of the functioning of both the types of panels, in case of analogue signal analysis (operation of indicators and clocks), false instruments readings were observed in both the cases in case of voltage variations in the system. However, in case of the virtual instrument panel, it is possible to reduce the influence of voltage changes on the instrument readings by the voltage measurement in the system and proper configuration of the systems using additional correction module. Additionally, such correction process is possible at program level instead of any additional investments in form of auxiliary equipment.

The virtual instrument panel gives the possibility to adapt the appearance of the instrument panel in individual manner owing to possibility of modification of the layout and configuration of the elements incorporated in the front panel window. It is possible to hide and to record certain events which may be useful, for instance when determining the reasons of accidents.

The unquestionable disadvantage of the virtual instrument panel is the necessity to invest significant funds to purchase the screen and control unit being the essential components enabling the application of such solution.

CONCLUSIONS

The following conclusions can be drawn from the executed functionality analyses for both the types of instrument panels incorporated in the control panel of FSO POLONEZ motor car:

Currently used analogue or electronic systems can be successfully replaced by the virtual instrument panels.

Functionality of the virtual systems is higher than functionality of the conventional systems.

Virtual instrument panels systems are characterized by higher reliability (lack of single systems).

Virtual instrument panels enable improved processing of the signals received from individual control systems and sensors and in consequence higher precision of readings.

Virtual instrument panels enable an implementation of new functions and, in consequence, higher versatility of their use. An application of the virtual instrument panel is directly associated with rather high costs of hardware and software installation to be incurred by the user.

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