Mechatronic Systems and Materials VI

Part 1

Edited by
Algirdas V. Valiulis, Olegas Černašėjus
and Vadim Mokšin

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Preface

Selected papers of the 9th International Conference "Mechatronic Systems and Materials – MSM 2013", which was held in Vilnius, Lithuania, from 1 to 3 July 2013 are presented in two volumes. Conference was organized by Vilnius Gediminas Technical University in collaboration with Kaunas University of Technology (Lithuania), Opole University of Technology (Poland), Bialystok Technical University (Poland), Lithuanian Academy of Sciences, IFToMM National Committee of Lithuania.

The aim of the conference was to provide an opportunity for the scientists to share information and facilitate co-operation in mechatronics, new materials and engineering technologies and dissemination of current research results in this multi-disciplinary field. The task of the Conference was not only to acquaint participants with the works of scientists from different countries, but to expand their collaboration in the future.

The Committees

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Analysis of the Dynamic Properties of the Mechatronic Integrator of Control Procedures of the Vehicle Driven by Persons with Disabilities

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Keywords: Control system, mechatronic system.

Abstract. The simulator of behavior of a disabled person driving the car is especially useful equipment. Mainly, the hands and the face of a driver are observed in order to determine facial expressions, slow-motion of the head and eyes, which according to the description of the simulation indicate disturbances of concentration and, in extreme cases may lead to nausea, or even loss of consciousness [1]. So, in the realization phase of the configuration the control system, the need to maintain high standards of safety was taken into consideration. The main problem described in the paper was measuring the acceleration and frequency of vibration during the operation of the simulator [2, 3, 4]. This analysis will help to determine whether any particular circumstances during crash simulations do not exceed the acceleration limit while the driver still feels its effects. It is also important to examine the frequency of vibrations, which during long driving simulator can cause nausea, dizziness or loss of consciousness. This analysis is a part of widely applied CAx analysis performed using special computer platforms that should be properly organized [5] and helps to expand the range of investigations [6].

In addition, the dynamic testing of the simulator has been carried out to determine the similarity between the motion parameters estimated in the virtual test and the parameters of the real simulator. Measuring the physical parameters and acquisition of information transmitted to the control system are carried out using the RT-NI CompactRIO real-time computer manufactured by National Instruments. This computer has an open architecture, what greatly facilitates the synchronization of measuring the real accelerations with the reference values of the virtual reality. The use of two separate devices would require the use of special hardware equipment. The modular design also enables an appropriate selection of computer hardware. In this case, the NI9234test module and built-in Ethernet network are used. The NI9234 module is the 4-channel AC transducer intended to measure the acceleration and sound. It has the built-in 24b element running at 24K samples. This module is used to measure the acceleration of different accelerometers. Ethernet module allows viewing the network traffic and selecting only the data about specific traffic parameters. The results of the measurements are saved in a file. Their analysis will be discussed in detail in this paper. One can also analyze data in real-time; however, it requires a reduction of the sampling frequency.

The simulator was elaborated in the framework of the N R03-0005-10 project supported by the National Centre for Research and Development (NCBiR) in the years 2010–2013.

Preparation for Measuring Dynamic Quantities of the Simulator

The final stage of the elaboration of a mechatronic device is verification of the correctness of both the designed control system and the execution system. For this purpose, it is necessary to compare the values of the accelerations transmitted from the virtual model to the control system and the values measured using sensors in the case of a real object. Measurements of physical quantities and read control data has been carried out, inter alia, by using real-time computer RT–NI CompactRIO. The computer has an open architecture. In its slots, it could be located up to eight modules such as:

- digital inputs and outputs at different voltage standards, such as TTL, industrial, etc.,
- analog inputs and outputs allowing plugging accelerometers, thermocouples strain gauge bridges, etc.,
- network modules.

Data Transmission

For data transmission, the special architecture of information system that allows exchanging the data between the components of the proposed system of the car simulator has been developed.

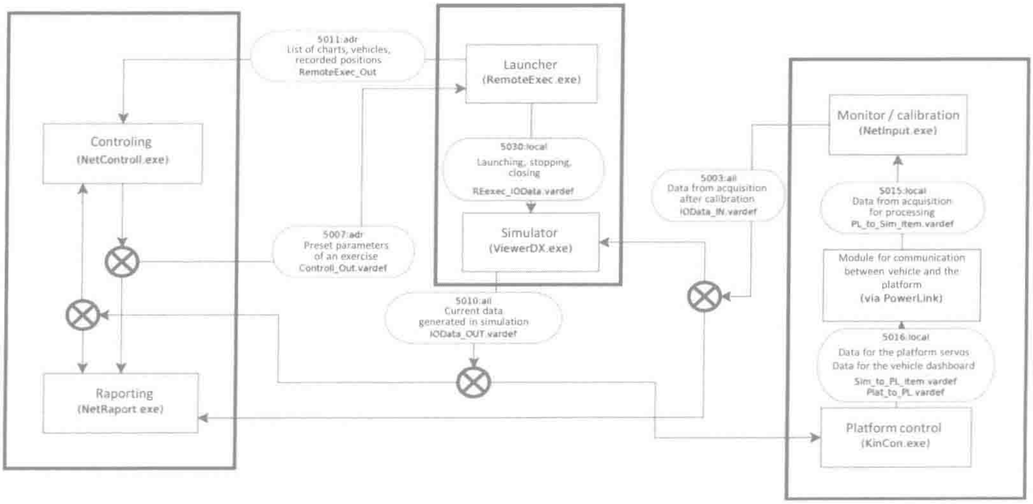

Fig. 1. Scheme of data transmission

The Figure 1 presents the schematic diagram of the information flow between computers and the ports using which the information is sent to. The elements of the system are grouped into three main subsystems: the system control, the program control and the platform control. The first one is responsible for controlling both the simulator and its control system. The program control supervises the process of simulator operating. The last is related with the Stewart platform and is used to control its activators. These subsystems contain all the information needed for the operation of the mechanical simulator including: the motion parameters, the information about the state of the counters and the status of controls. The Figure 2 shows the translation of an exemplar data packet sent to the host computer.

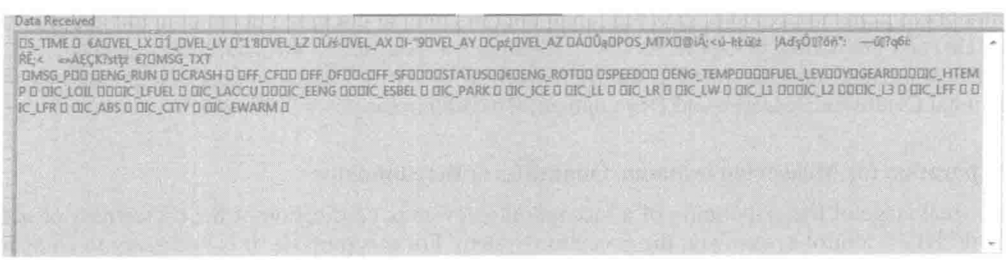

Fig. 2. Sample frame captured during the operation of the simulator

Table 1 shows the names and types of variables required for reading the motion parameters. Only the presented variables are needed to determine the motion of the Stewart platform during the simulation process. Other variables are not analyzed.

Table 1. The list of selected information sent by the UDP protocol

No.	Description	Symbol	Type	IDX 8x	Idx	Size
1	Inter-frame time of simulation	S_TIME	REAL32	0	0	4
2	Linear velocity along the axis X	VEL_LX	REAL32	0	4	4
3	Linear velocity along the axis Y	VEL_LY	REAL32	1	0	4
4	Linear velocity along the axis Z	VEL_LZ	REAL32	1	4	4
5	Angular velocity along the axis X	VEL_AX	REAL32	2	0	4
6	Angular velocity along the axis Y	VEL_AY	REAL32	2	4	4
7	Angular velocity along the axis Z	VEL_AZ	REAL32	3	0	4
8	Vehicle location	POS_MTX	ABYTE	3	4	64

Program for Measurement Path of Acceleration

The important element of the presented control system of the car simulator is the program for controlling the acceleration of particular actuators. This program is based on the information from sensors mounted on the vehicle. The measuring circuit includes:

- RT NI CompactRIO computer,
- NI 9234 module,
- PCB accelerometer.

The Figure 3 shows the view of the project of the measurement program. The main element is the file *target-rate multi-variable-fileIO.vi* directly in the RT computer memory. Current values of the accelerations are measured in the NI 9234 module. They are downloaded from the UDP protocol, then are queued and sent according to the FIFO rule. The RT computer loads collected data from the queue and enables them for further processing such as: recording and analysis.

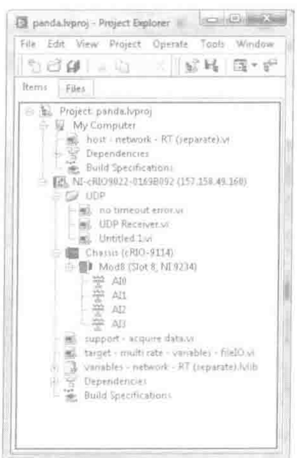

Fig. 3. View of the project window

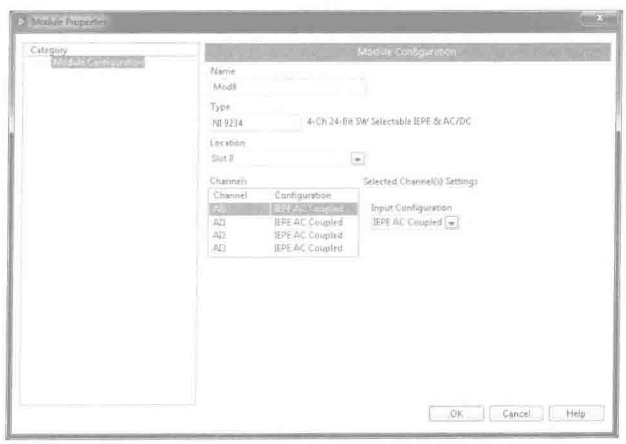

Fig. 4. Window of sensors settings

The Figure 4 presents the configuration of the accelerometer that allows reading the acceleration of the accelerometer. This process is very important because it directly affects the safety of persons involved in using the simulator.