FACTA UNIVERSITATIS
Series: **Mechanical Engineering** Vol. 9, N° 2, 2011, pp. 203 - 214

A NEW GENERATION OF PORTABLE MEASUREMENT AND DATA ACQUISITION SYSTEM FOR ANALYZING DYNAMIC CHARACTERISTICS OF VEHICLES *

UDC 620.17.05   625.215   629.113

Miloš Milošević, Dušan Stamenković, Aleksandar Stefanović

University of Niš, Faculty of Mechanical Engineering, A. Medvedeva 14, Niš, Serbia
E-mail: mmilos@masfak.ni.ac.rs

Abstract. *On-line condition monitoring of the entire system or individual components can be used After the first generation, the second generation of a portable measurement and data acquisition system for analyzing dynamic characteristics of vehicles has been developed as a result of the cooperation between the Faculty of Mechanical Engineering and EUROGENYX, Niš, Serbia. As the previous one, the new device has also been used in order to improve ride quality that affects passenger comfort, to explore quality parameters of traffic infrastructure, as well as to analyze environment of products during their transport by recording vibrations in three orthogonal axes, speed and geocoding position. The new system consists of six sensor modules equipped with triaxial accelerometers, a module for determining global position and a communication module for synchronization of all mentioned modules and for connection with the measuring computer with a special software application for collecting and processing measuring data. The developed system has been proved as a very effective device for exploring dynamic conditions of exploitation of railway vehicles. This paper discusses the usage of the new generation of the portable measurement and data acquisition system on an example of analyzing dynamic characteristics of a passenger vehicle. In this way the realized equipment leaves the possibility for usage in any transportation or technical systems for similar dynamic tests and for further research.*

Key words: *Ride Quality, Vibration, Acceleration, Measuring, Vehicle*

1 INTRODUCTION

For the sake of safety improvement, environment protection, increased transport convenience and reduction of costs of transport and maintenance of traffic infrastructure, as well as tracking of products during the transport new technologies have been increasingly used. Demands for better ride comfort and controllability of road vehicles have motivated

Received January 20, 2011
* **Acknowledgements**.This research has been supported by the Ministry of Education and Science of the Republic of Serbia (Project TR 35005 – *Research and Development of New Generation Wind Turbines of High Energy Efficiency*).

many automotive industries to devote more attention to public transportation means design. Extended periods of high levels of vibrations on lengthy trips have revealed that ride quality considerations are of major importance for such systems. However, insufficient quantitative or descriptive information exists on ride quality since ride is affected by a number of circumstances. The difficulty in developing ride criteria stems from problems of measuring, recording and analyzing the dynamic characteristics associated with vehicles and environment [1 - 7].

For the purpose of identification of influential parameters that affect the design dynamic characteristics of spring elements of electric locomotives and other rolling stock containing suspensions with rubber-metal elements, as well as examining techno-exploitation characteristics of Serbian railway lines, at the Faculty of Mechanical Engineering in Niš, Serbia, within the project TR 14007 – Improving of primary suspensions of electrical locomotives for difficult working conditions supported by the Ministry of Science and Technological Development of the Republic of Serbia, in cooperation with the firm EUROGENYX from Niš, Serbia, the first generation of the portable system with GPS for measuring ride quality and vibrations of vehicles has been developed [8]. The developed system had proved to be a very effective device for researching dynamic conditions of railway vehicles on the railway lines of Serbian Railways [9 - 12]. Moreover, the device has been effectively used for examining the effect of vibrations on human comfort by conducting field measurements of ride vibrations at other transportation systems [13], as well as other technical systems. During the usage of the first generation of the portable measuring device the need is felt for further improvements of the developed system. Namely, what is felt is the need for using more sensors since the first generation has only one triaxial acceleration sensor; more sensors are needed to measure accelerations at many points thus giving us the possibility for analyzing simultaneously more points of interest. Also, the starting analyzing software should have been extended to enable to present ride environments in terms of statistical parameters such as power spectral density, standard deviation values and histograms, because international regulations and standards on ride quality indicate them as most important statistical parameters in qualitatively defining dynamic characteristics of riding. Because of that, the next generation of the portable measurement and data acquisition system for analyzing dynamic characteristics of vehicles has been developed at the Faculty of Mechanical Engineering and EUROGENYX. The new system consists of six sensor modules equipped with triaxial accelerometers, a GPS (Global Position System) module for determining global position and a communication module for connecting all mentioned modules and with a measuring computer. In that way the developed system is able to measure vibrations in the three orthogonal axes at six different locations of a vehicle, record running speed and determine geocoding position during traveling. In addition, a special software application has been written which enables for the measuring data to be collected and processed in real-time, permanently stored in a database, filtered and sorted according to a selected criterion, graphically or tabularly reported, as well as exported to different formats. Immediately following each test run, the data can be processed through a FFT (Fast Fourier Transform) real-time spectrum analyzer to provide the PSD (Power Spectral Density) of acceleration and the RMS (Root Mean Square) value of the PSD (in units of "g") for the frequency range of vibrations. The developed system has also proved to be a very effective device to explore dynamic characteristics of railway vehicles and railway infrastructure. It will be shown in this paper how this device can effectively be used for examining the effect of vibrations on human comfort by conducting the field measurement of ride vibrations at a passenger vehicle. The purpose is to present the method and appliance employed for measuring, analyzing and interpreting vibratory accelerations associated with vehicles. Furthermore, the paper describes the instrumentation system used in acquiring the field measurements and it presents the procedure used to obtain results in meaningful forms.

2 Description of Measuring and Recording System

The measurement and recording of vibrations which affect passenger comfort present unique instrumentation requirements. The vibrations causing the greatest discomfort to human occupants in most transportation vehicles are generally characterized by low frequencies in the range from 0 to 25Hz. The basic requirements of a measuring and recording system are that the system should be portable, self-contained, capable of measuring frequencies in the range from 0 to 25Hz, and capable of measuring acceleration amplitudes in the range to 0.5g with the resolution of 0.01g (Ride Evaluation according to the Power Spectral Density Criterion [1]).

The new, second generation of the developed portable measurement and data acquisition system for analyzing dynamic characteristics of vehicles consists of six sensor modules, a GPS module and a communication module for synchronization of all mentioned modules and for connection with the computer with a special software application for collecting and processing measuring data, according to Fig. 1. The system has been dynamically calibrated and rechecked periodically to ensure its accuracy. The device works on 220V, so a voltage converter from 12V to 220V has to be used in situations where there is no 220V power supply.

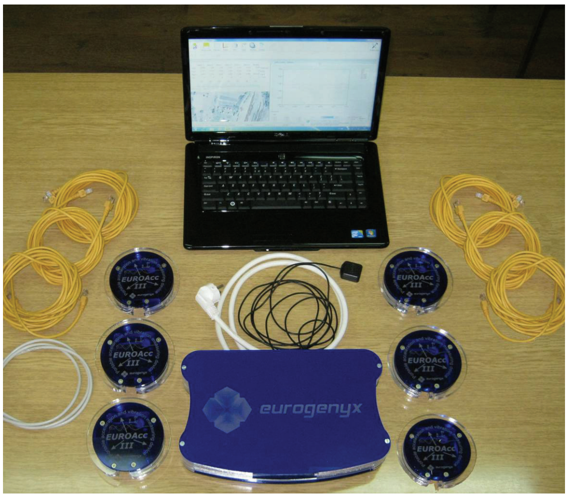


Fig. 1 The developed portable measurement and data acquisition system for analyzing dynamic characteristics of vehicles

The base of the sensor module EUROAcc III is a microcontroller labeled PIC18F67J60. Its function is to collect data from the acceleration sensor and to send them to the communication module through the LAN connection. The most important part of the measuring module is a triaxial linear acceleration sensor labeled LIS3LV02DQ. Although the synchronization of data from analog sensors is easier, in this case the digital sensor was selected. The analog retrieval of data in situations where the environment has a lot of electromagnetic interferences, as it is the case with vehicles, would be impossible and collected information would be almost useless. The another advantage of the digital signal processing is collecting signals from all three axes simultaneously, unlike the analog technology where the influence of vibrations is measured firstly in the first, than in the second and finally in the third axis, which causes a delay of a few milliseconds per axis. Further, the digital output format is ready to be stored or sent to the computer, while the processing of analog signals needs subsequently usage of processor resources. This triaxial acceleration sensor is very small and light. It is made by MEMS (Micro-Electro-Mechanical Systems) technologies process that allows high level of integration. It uses a capacitive principle for measurement of the displacement of an inertial mass that is not sensitive to the effects of electromagnetic interferences. The silicon sensitive element has a mass that does not exceed one gram. It does not affect the dynamics of the measuring system and very accurately monitor changing of the acceleration generating a signal that is transmitted via the I2C serial interface. The measurement ranges of the sensor are ±2g and ±6g, while the frequencies of changes that can be registered are over a bandwidth of 640Hz for all three axes. There is a built-in feature of its own testing for checking the system. The sensor is sealed with the plastic and mounted in an aluminum chassis. It is designed to be used over the temperature range from -40°C to +85°C.

The GPS module for global positioning is based on the SirfStar III chipset, enabling the determination of the geocode information, that is, the current location and speed of the measuring object. This module is integrated at the printed board of the communication module, so that only the antenna is visible.

The essential part of the communication module is a synchro interface with a differential line through which a distributed differential synchro signal is sent. It is important to perform the synchronization of all modules. Without this interface there would be the latency, that is, a delay in the communication between modules, which may lead to the incompatibility of measuring results and the inability of their comparison. This interface of the communication module provides the tact for simultaneous measurement to all sensor modules. This enables canceling of the delay in the communication and getting a uniform measurement of all the sensors at a time. The applied distributed differential synchro signal is excellent for the use in all environments, even in systems polluted with electromagnetic emissions, which is not the case with the traditional distributed synchro signal or custom USB signal. The communication between the communication module and sensor modules are done through a LAN switch by the network protocol. The further connection of the communication module to the measuring computer is also done by the network communication of 100Mb/s.

For collecting the measuring data in real-time, temporary storage and synchronization, processing in real-time, and permanent storage in the database of eighteen components of accelerations of six triaxial accelerometers, speed and longitude and latitude positions from the GPS and information about real time a special computer application EUROLocoRun has been developed by the firm EUROgenyx and installed on the measuring computer. With this application it is also possible to follow the FFT analysis of the preselected variables in real time and to see the movement of the measuring object on the Google map on preloaded maps or maps that use on-line connection over the Internet. The easiest way is by using the mode with predefined folder CacheOnly which then allows for autonomy in work and is independent of Internet communications. Moreover, the software application EUROLocoRun allows us to sort recorded measuring data by time, position, speed and magnitude. It also enables displaying of the selected results in real-time graphically and tabularly. It is also possible to generate reports, export selected data to Excel CSV file and print form this application.

3 Measuring Procedure

Prior to the installation of the instrumentation on a particular vehicle in the field, the vertical axes of the thiaxial accelerometers should be calibrated statically. It is essential to place the sensors on the measuring places in such positions that the accelerations in the vertical directions are equal to the value of -1g which corresponds for the steady state of the vertical gravity acceleration of 9.81m/s^2. The rest two axes of accelerometers should be aligned with the lateral and longitudinal directions of the vehicle in the horizontal plane, so the accelerations for these axes should be zero. Before the measurement, it is also necessary to set up the threshold for data storage and adjust the real-time clock.

For the testing of dynamic characteristics and determining ride quality by measuring accelerations in the three orthogonal directions (longitudinal, lateral and vertical) of a passenger car the acceleration sensors are located at several locations on the vehicle, on different levels of suspensions. Proper installation of the sensor units requires that the sensors are leveled on a solid frame. This is accomplished by neodymium magnets attached to the bottom of the sensor units. The three acceleration sensors are placed on the passenger car Honda Jazz 1.2, production year 2003, mileage around 100.000km of which around 40.000km on the roads of Serbia, with a petrol engine of 1246cm^3 and 57kW. The first sensor labeled S_2 is placed on the frame of the suspension on the bottom of the car, Fig. 2 a), the second sensor labeled S_4 is on the bottom of the driver seat, Fig. 2 b) and the last sensor labeled S_6 is mounted on the roof of the cabin where the antenna of the GPS module is also located, Fig. 2 c). The communication module and the measuring computer are located in the back seat, Fig. 2 d). The attention is mostly focused on vibrations and accelerations changes during traveling over rail crossings and holes in roads, through curves as well as at sudden braking and accelerating of the vehicle. The measurements are carried out on streets in Niš, Serbia. The sampling frequency is 200Hz. The sensor modules are so oriented that the X, Y and Z sensor axes are directed along longitudinal, lateral and vertical axes of the car.

Fig. 3 shows the layout of the developed computer application EUROLocoRun visible during the measuring in real time. In the window Statistics the measuring data of three sensors (three times three axes of acceleration sensors - a total of nine values) are shown. There is also information about the real time. In the window GPS the number of satellites is registered, GPS fixation, latitude, longitude, altitude, GPS time and GPS speed. In the window Graphics graphs of acceleration variables and their FFT analysis are shown in real time. There is also the speed diagram from the GPS. In the window Map the movement of the test car is displayed on the Google map.

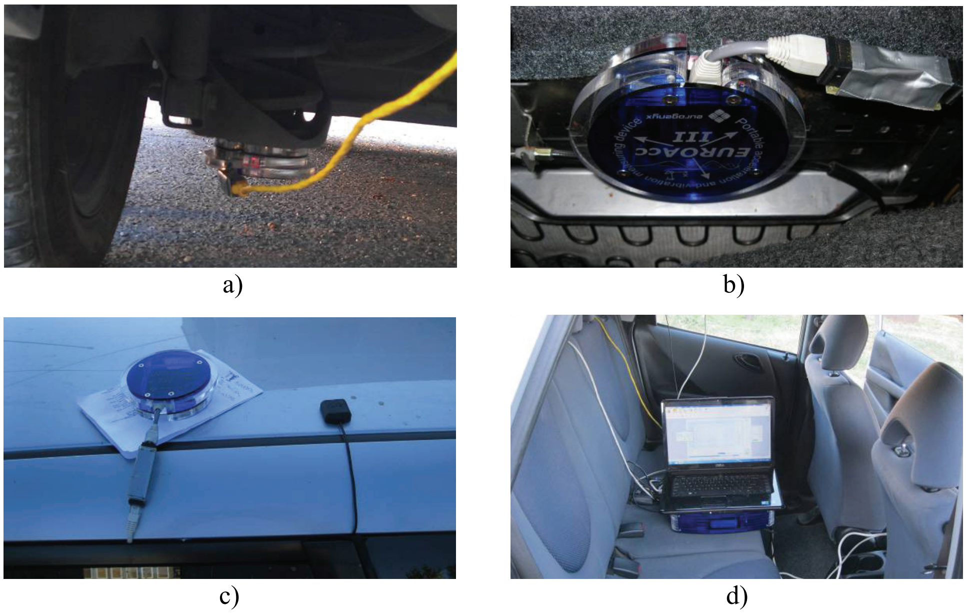


Fig. 2 The installation of the measuring equipment on the test car

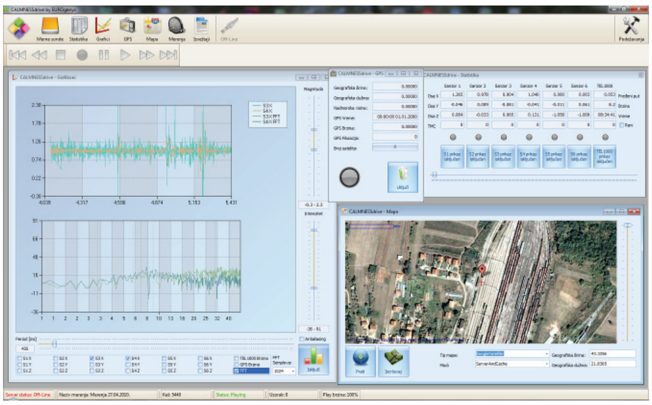


Fig. 3 Measuring layout of EUROLocoRun

4 Discussion of Measuring Data

Fig. 4 shows the layout of the window Report of the application EUROLocoRun for graphical and tabular display of measured results with options for sorting data by time, position, speed and magnitude. There are also icons for making reports, exporting data to Excel CSV file and printing.

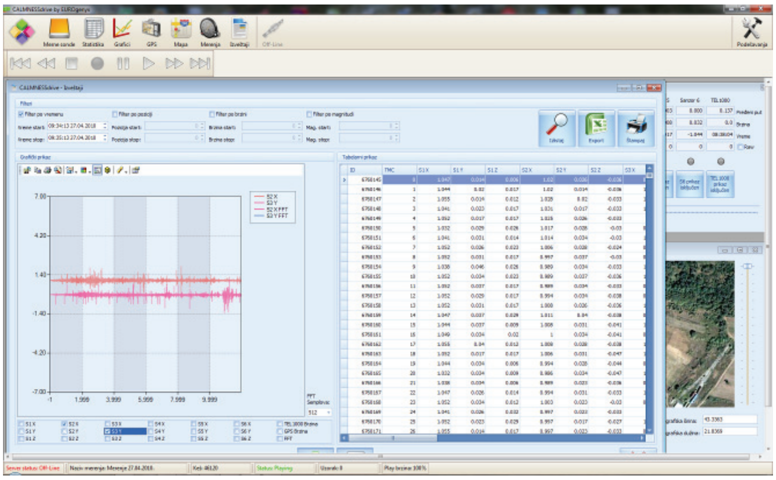


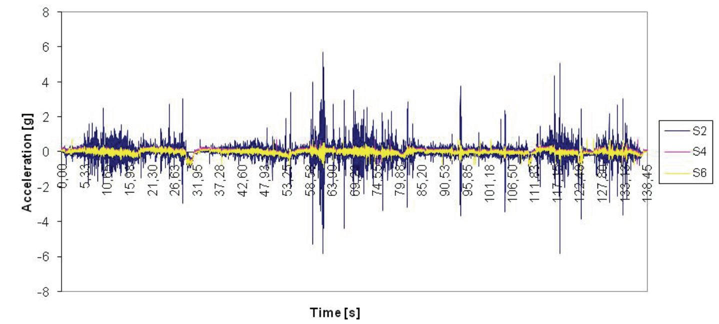
Fig. 4 Reporting layout of EUROLocoRun

Measured values, real time accelerations in X, Y and Z directions of three thiaxial accelerometers S_2, S_4 and S_6, Latitude, Longitude, Altitude and speed of the test car and the measured time, recorded during the test driving of the time interval of 2.3min and for a traveled distance of 3.7km are tabularly stored. A part of the table is presented in Fig. 5.

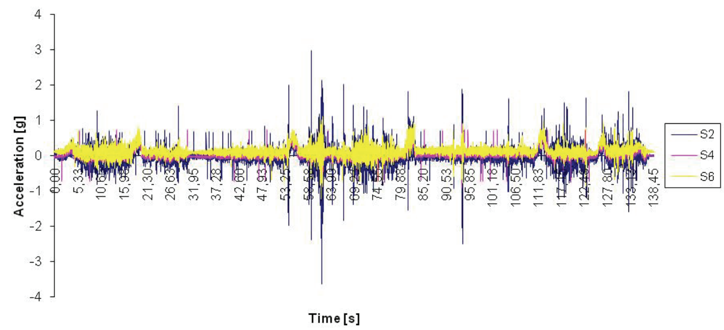
S2 X	S2 Y	S2 Z	S4 X	S4 Y	S4 Z	S6 X	S6 Y	S6 Z	Geografska širina	Geografska dužina ▲	Nadmorska visina	GPS Brzina	GPS Vreme
0,129	0,531	0,491	0,043	-0,237	0,969	0,17	0,173	-0,977	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,193	0,142	0,251	0,023	-0,275	0,983	0,105	0,13	-0,843	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
-0,162	0,176	0,746	-0,011	-0,242	1,043	0,133	0,09	-0,939	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,076	-0,176	1,47	-0,011	-0,275	0,918	0,042	0,078	-0,82	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
-0,084	-0,085	1,033	-0,003	-0,218	1,043	0,116	0,046	-0,916	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,14	-0,128	1,538	0,017	-0,237	0,94	0,113	0,055	-0,956	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
-0,087	0,139	1,08	0,009	-0,226	1,074	0,147	0,009	-0,956	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,022	-0,151	1,198	-0,034	-0,229	1,077	0,241	0,012	-1,055	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,076	0,116	0,834	-0,009	-0,234	1,02	0,21	0,058	-1,061	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,106	0,327	0,808	0,017	-0,24	1,099	0,241	0,066	-1,061	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,101	0,29	0,598	0,057	-0,215	1,006	0,144	0,107	-0,953	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...
0,006	0,25	0,811	0,02	-0,253	1,062	0,159	0,113	-1,02	43,3317413330...	21,8953895568848	206,100006103516	27,746660...	15:44:59 2...

Fig. 5 Tabularly listed measured values of the test run

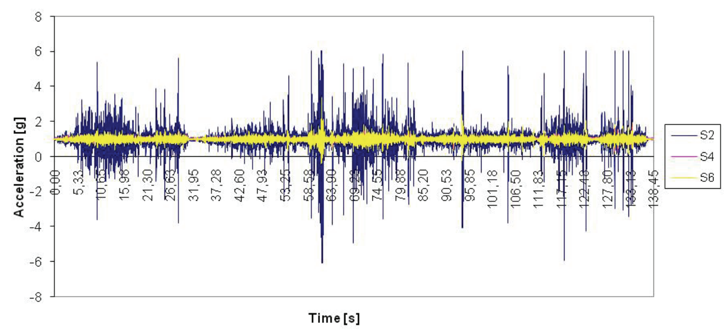
In order to use this table for data analyzing some columns for acceleration values of certain sensors axes are shifted and reoriented, so that, for all sensor modules the positive X axes are directed toward the front end of the car for the longitudinal accelerations, the positive Y axes are directed toward the right side of the car for the lateral accelerations and the positive Z axes are directed vertically upward for the vertical accelerations. After these corrections the graphic presentation of acceleration values in the longitudinal (X), lateral (Y) and vertical (Z) directions (unit g) as functions of time (unit s) are shown in Figs. 6 a), b) and c) respectively. In some segments the car does not move so there are no acceleration values. These are manifested in short straight lines in the acceleration graphics. The acceleration values in the vertical direction (Fig. 6 c)) take into account the steady-state effect of the gravity acceleration that is always present in the vertical direction so it is necessary to correct them by subtracting 1g.



a)



b)



c)

Fig. 6 The graphic presentation of measured the longitudinal (X), lateral (Y) and vertical (Z) acceleration values of the sensor modules S_2, S_4 and S_6 over time

A continuous time code, based on the real-time clock, is included during the data recording. This time code is used as the primary reference in the analysis of the data. It is normally used for controlling the starting and stopping points of the graphical reviewing, and also for specifying sections of interest during analyzing.

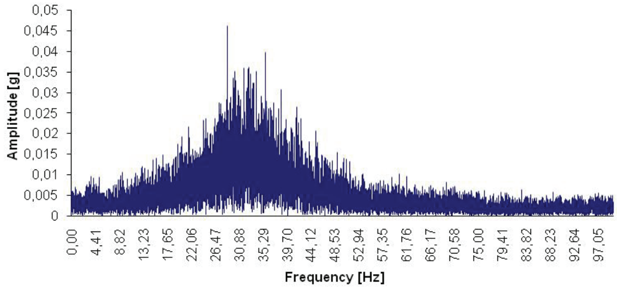


Fig. 7 Results of the FFT analysis of measured vertical (Z) acceleration values of the sensor module S_2

Despite the fact that this test run lasted only 2.3min it contains a large number of data that are very complex for analysis. The analysis of longer driving from the aspect of ride quality, in order to qualitatively define dynamic characteristics of a vehicle, needs the recorded measuring data to be processed through a FFT real-time spectrum analyzer to provide the frequency range of human perception. The results should be then compared to vehicle ride quality acceptance levels. The FFT diagram of measured vertical (Z) acceleration values of the sensor module S_2, mounted at the most excited part of the vehicle, shows on Fig. 7 amplitude vibrations in vertical direction over the range of frequencies for the whole test driving.

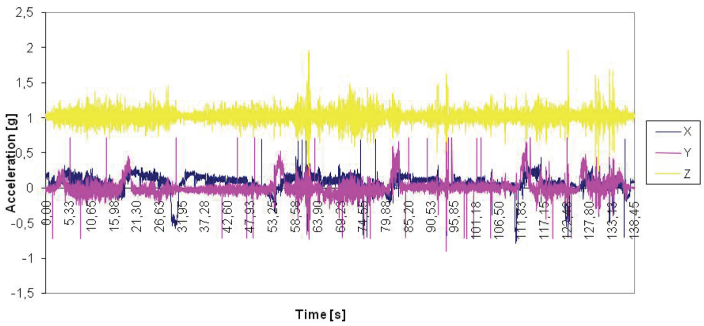


Fig. 8 The graphic presentation of the measured longitudinal (X), lateral (Y) and vertical (Z) acceleration values of the sensor module S4 over time

From the graphic presentation of the measured real time longitudinal (X), lateral (Y) and vertical (Z) acceleration values of the sensor module S4 mounted on the driver seat, Fig. 8, it is possible to determine the maximal and minimal acceleration values over the given time for all three axes that the driver perceived during the drive. During the test drive the maximal real time acceleration values are: upward and downward vertical accelerations (yellow) 0.957g and -0.832g, right and left lateral accelerations (purple) 0.915g and -0.903g and forward and backward longitudinal accelerations (blue) 0.702g and -0.785g.

Table 1 Velocity and real time maximal acceleration values for different test conditions

No	Event	Time (s)	Longitudinal acceleration (g)	Lateral acceleration (g)	Vertical acceleration (g)	Speed (km/h)
1	Curve	8.36	-0.099	-0.724	0.011	34.8
2	Accelerating	59.36	0.7	0.224	0.292	32.7
3	Rail	61.945	-0.05	-0.236	0.957	39.5
	crossing	61.955	-0.046	-0.307	-0.832	39.5
4	Accelerating	77.72	0.702	0.046	0.08	63.9
5	Traffic line changing	94.31	0.124	0.915	0.094	74.1
6	Braking	110.71	-0.785	0.082	-0.094	59.5
7	Hole	122.925	0.074	-0.148	0.949	43.8
8	Hole	130.28	-0.358	0.036	-0.764	31.2
9	Hole	132.385	0.364	0.216	0.685	23.1
10	Braking	136.24	-0.7	-0.011	0.068	10.1

From Fig. 8 it is also possible to determine the maximal real time accelerations that the driver is subjected to in some events during the test drive. These real time values for sudden braking, traffic line changing, accelerating and driving over holes or rail crossings are shown in Table 1 together with the value of the current velocity of the car at that moment.

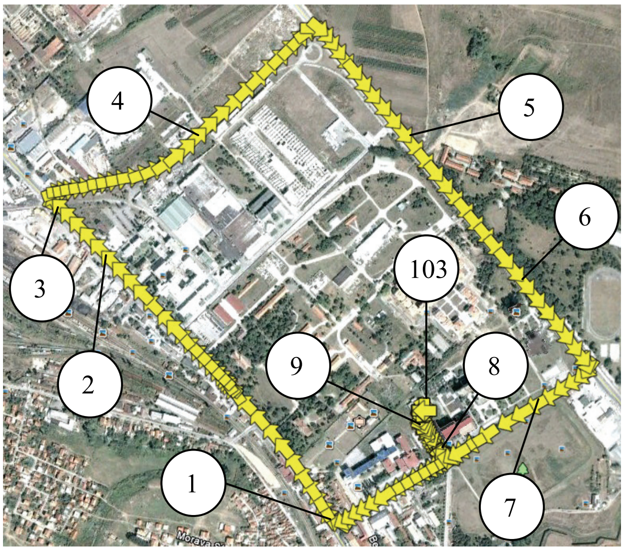


Fig. 9 The measuring route of the test car at the Google Earth

In Fig. 9, according to the recorded GPS data, the test car measuring route is drawn at the Google Earth with labeled events from Table 1. For drawing the measuring trajectory it is necessary to convert recorded data from Latitude and Longitude columns to a file with KML extension by using the site http://www.earthpoint.us/ExcelToKml.aspx. Opening that new file in the Google Earth gives the trajectory of the measured route.

5 Conclusions

An application of the second generation of a portable measurement and data acquisition system for analyzing dynamic characteristics of vehicles is presented in this paper. It is shown how that device can effectively be used for measuring, analyzing and interpreting vibratory accelerations associated by conducting the field measurement of ride vibrations at a passenger vehicle.

The new device has been developed as a further part of overall ride comfort projects researched at the Faculty of Mechanical Engineering in Niš, Serbia. The main improvement in relations to the first generation device is reflected in the use of more vehicles three axes accelerometer sensors for analyzing more points of interest simultaneously. Therefore, the new system consists of six sensor modules, as well as a GPS module and a communication module for synchronization between all modules and for connection with the measuring computer. Moreover, the analyzing software application installed at a measuring computer is extended to enable to take an inventory of ride environments in terms of statistical parameters such as power spectral density distributions and standard deviation values, because ride comfort studies indicate that they are important parameters in qualitatively defining ride vibrations.

The recorded data show that the vibrational environments measured for various types of test conditions tend to be random in nature and that they could be evaluated only with the use of computer processing. These field studies are performed in an attempt to understand the cause-and-effect relationship of the vibration environment for evaluating dynamic behavior of analyzed vehicles, their riding quality, running stability, correctness of vehicles construction and suspension, and also to estimate the condition of the road infrastructure on the bases of vibration measurements. Also, it is possible to bring these measured data into connection with exactly determined positions on a route.

The developed system is proved to be as an effective device for vibration measurements on a significant number of vehicles, including railway, passenger and commercial vehicles. However, this portable measurement and data acquisition device can also be used to research dynamic characteristics of other technical systems such as elevators, cranes, etc, as well as for wind turbines, what is especially important for the current project.

References

1. John, J., Cutherines, S., Scholl, H., *A Method for the Measurement and Analysis of Ride Vibrations of Transportation Systems*, National Aeronautics and Space Administration, Washington D. C., 1972.
2. Wambold, J. C., *Vehicle Ride Quality – Measurement and Analysis*, SAE 861113, Society of Automotive Engineers, Warrendale, PA, 1986.
3. Singh, J., Singh, P. S., Joneson, E., *Measurement and Analysis of U.S. Truck Vibration for Leaf Spring and Air Ride Suspensions and Development of Tests to Simulate these Conditions*, Packaging Technology and Science, Volume 19, Issue 6, 2006.
4. ISO 2631-4, Mechanical Vibration and Shock—*Evaluation of Human Exposure to Whole-Body Vibration*, Part 4: Guidelines for the Evaluation of the Effects of Vibration and Rotational Motion on

Passenger and Crew Comfort in Fixed Guideway Transport Systems, International Organization for Standardization, 2001.

5. Mee, B., Whitten, B., Neijikovsky, B., *Railway testing using a portable ride quality and vibration measurement system with GPS*, Proceedings SPIE – The International Society for Optical Engineering, Vol. 2458, 1995.
6. UIC Code 518, *Testing and approval of railway vehicles from the point of view of their dynamic behaviour - Safety - Track fatigue - Ride quality*, International Union of Railways, 2009.
7. Kim, G. Y., Won, K. B. H., Kim, W. S., Kim, k. C., Kim, W. T., *Correlation of Ride Comfort Evaluation Methods for Railway Vehicles*, Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit, Volume 217, Number 2, 2003.
8. Milošević, M., Stamenković, D., Pejčić, N., Radojičić, D., *A Portable Measuring System For The Measurement And Analysis Of Ride Vibrations Of Transportation Systems*, Proceedings of X Triennial International SAUM Conference on Systems, Automatic Control and Measurements, Niš, Serbia, 2010.
9. Milošević, M., Mladenović, S., Pejčić, D., *Istraživanje dinamičkih uslova rada železničkih vozila na prugama Železnica Srbije*, Zbornik radova XII Naučno-stručne konferencije o Železnici ŽELKON '08, Niš, 2008.
10. Stamenković, D., Milošević, A., Milošević, M., *Research of Connection of Rolling Stock Primary Rubber Suspension and Ride Quality*, Proceedings of the 53rd Internationales Wissenschaftliches Kolloquium, Ilmenau, Germany, 2008.
11. Milošević, M., Stamenković, D., Pejčić, N., Radojičić, D., Mladenović, S., *Measurement and Data Acquisition System for Analyzing Dynamic Characteristics of Railway Vehicles*, Proceedings of the XIII Scientific-Expert Conference on Railway ZELKON '10, Niš, Serbia, 2010.
12. Stamenković, D., Milošević, M., Jovanović, S., Banić, M., Jovanović, D., *Experimental Investigation of Railway Vehicles Dynamic Characteristics*, Proceedings of the International Conference Mechanical Engineering in XXI Century, Niš, Serbia, 2010.
13. Milošević, M., Stamenković, D., Stefanović, A., *A Portable System with GPS for Measuring Ride Quality and Vibrations at Vehicles*, Proceedings of the International Congress Motor Vehicles & Motors 2010, Kragujevac, Serbia, 2010.

NOVA GENERACIJA PRENOSIVOG SISTEMA ZA MERENJE I PRIKUPLJANJE PODATAKA ZA ANALIZU DINAMIČKIH KARAKTERISTIKA VOZILA

Miloš Milošević, Dušan Stamenković, Aleksandar Stefanović

Posle prve generacije, druga generacija prenosivog sistema za merenje i prikupljanje podataka za analizu dinamičkih karakteristika vozila je razvijena kao rezultat saradnje između Mašinskog fakulteta i firme EUROGENYX, Niš, Srbija. Kao i prethodni, i novi uređaj je korišćen kako bi se poboljšao kvalitet vožnje koji utiče na udobnost putnika, istraživali kvalitativni parametri saobraćajne infrastrukture, kao i za analizu okruženja proizvoda tokom njihovog transporta snimanjem vibracija u tri međusobno upravna pravca, brzine i geokodiranog položaja. Novi sistem se sastoji od šest senzorskih modula opremljenih troosnim akcelerometrima, modula za utvrđivanje globalne pozicije i komunikacionog modula za sinhronizaciju svih pomenutih modula i za povezivanje sa mernim računarom na kome se nalazi posebna programska aplikacije za prikupljanje i obradu mernih podataka. Razvijen sistem se pokazao kao veoma efikasan uređaj za istraživanje dinamičkih uslova eksploatacije železničkih vozila. Ovaj rad razmatra upotrebu nove generacije prenosivog sistema za merenje i prikupljanje podataka na primeru analize dinamičkih karakteristika putničkog vozila. Ovako realizovana oprema pruža mogućnost za korišćenje u bilo kom transportnom ili tehničkom sistemu za slična dinamička ispitivanja i za dalja istraživanja.

Ključne reči: *mirnoća hoda (kvalitet vožnje), vibracija, ubrzanje, merenje, vozilo*