Substitute the above characteristics are found in the final solution (34) to find the general solution of the equation.

$$y = C_1 e^{k_1 x} + C_2 e^{k_2 x} + \frac{m_x a}{k_x} \qquad (34)$$

Thus obtained in an analytical form solution of the differential equation describing the model is integrated accelerometer.

Conclusion

The developed model is implemented in the educational system simulation of MEMS sensors, which includes a monitor system, a database, subsystem modeling, visualization subsystem and subsystem analysis of simulation results. Comparison of simulation results with experimental data confirm the feasibility of its use for structural design of integrated accelerometers.

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EFFECT OF IMPACT VELOCITY IN THE ROADBLOCK ON THE SPATIAL ARRANGEMENT OF ACCELERATION OF THE VEHICLE BODY

ВПЛИВ ШВИДКОСТІ УДАРУ В КОНТРОЛЬНО-ПРОПУСКНОМУ ПУНКТІ НА ПРОСТОРОВОМУ РОЗТАШУВАННІ ПРИСКОРЕННЯ КУЗОВА ТРАНСПОРТНОГО ЗАСОБУ

The article presents the results of experimental studies of the process of intense acceleration, passing through the barrier and the vehicle brakes adapted for the transport of persons using two speed ranges passing through the barrier. Tests were conducted on dry roads made of cobblestones. Performed experimental studies, which aim was to determine the acceleration in each axis while passing through the obstacle.

Key words: barrier, impulse of force, tire, suspension, acceleration.

Подано результати експериментальних досліджень процесу інтенсивного прискорення, що проходять через бар'єр і транспортний засіб, гальма пристосовані для перевезення осіб з використанням двох діапазонів швидкостей, проходячи через бар'єр. Випробування проводилися на сухих дорогах з бруківки. Виконані експериментальні дослідження, мета яких – визначити прискорення в кожній осі при проходженні через перешкоди.

Ключові слова: бар'єр, імпульс сили, шини, підвіска, прискорення.

Introduction

Land transport of goods and services is a strategic sector of the economy. Transport routes often cross, which leads to the need to ensure the safety of different vehicles. This is the example. Intersections of road transport and rail. The present infrastructure crossings and track tram, which may constitute "significant inequality" in relation to the road surface [1, 3-5]. In addition there are road within islets bumps [2, 6], and curbs. As a result of operating conditions can also occur ruts, jumps, craters and cracks. These elements cause when they were overcome sagging tires and suspension, as well as providing acceleration for car bodies in a tri-axial load condition.

Regardless of the surface area of the road may also occur also random. In the case of collisions on them, their size and speed of the vehicle and its load determine the value of acceleration pulses transmitted between the surface and the body of the vehicle. The article presents the results of experimental acceleration body at the time of contact with the obstacle vehicle type "bus".

Characteristics of the vehicle and environmental conditions

The vehicle used for experimental studies was a car Volkswagen Crafter in a version adapted for the carriage of nine persons. It had a drive unit with a supercharged diesel engine with a capacity of 2500 cm3. The vehicle was equipped with a automatic transmission gearbox. The car was produced in 2007.

Fig. 1. View research vehicle Volkswagen Crafter

Tires fitted to a vehicle test these tires Good Year's version of Marathon Cargo size 235/65 R16C. They are designed to carry higher loads as compared to tires for passenger vehicles. Tires are mounted on rims steel.

During the tests, additional environmental characteristics were measured before and after the study the kinematics of the vehicle. The results of the environmental testing are shown in Table 1.

Table 1

Performance measurement environmental conditions before and after road tests

	before attempts road	after attempts road
The ambient temperature	+25,6 oC	+27,5 oC
Wetness	25,0 %	26,3 %
Atmospheric pressure	1011,2hPa	1011,2hPa
Dew point temperature	+5,3 oC	+5,4 oC
The temperature of the road surface	+32 oC	+30,4 oC

Research methodology

The aim of the study was to measure the acceleration pulse transmitted to the bodywork of the vehicle while negotiating an obstacle. Test runs were performed from a standing start to re-arrest. Test vehicle was accelerated to a given speed, overcame roadblock in uniform motion, and then intensively inhibited to stop.

Equipment used for recording and archiving for this type of sensor Analog Devices ADIS 16385th non-invasive measurement system mounted by suction cups to the side window of the vehicle (Fig. 2). In addition, the tire deflection recorded during overcoming obstacles. Used measuring apparatus is characterized by a measurement uncertainty of 2 %.

Fig. 2. View vehicle with the test apparatus ADIS and video recording system

Obstacle used during the study was done in order to simulate the invasion of the low curb. Back obstruction and its dimensions are shown in Figure 3.

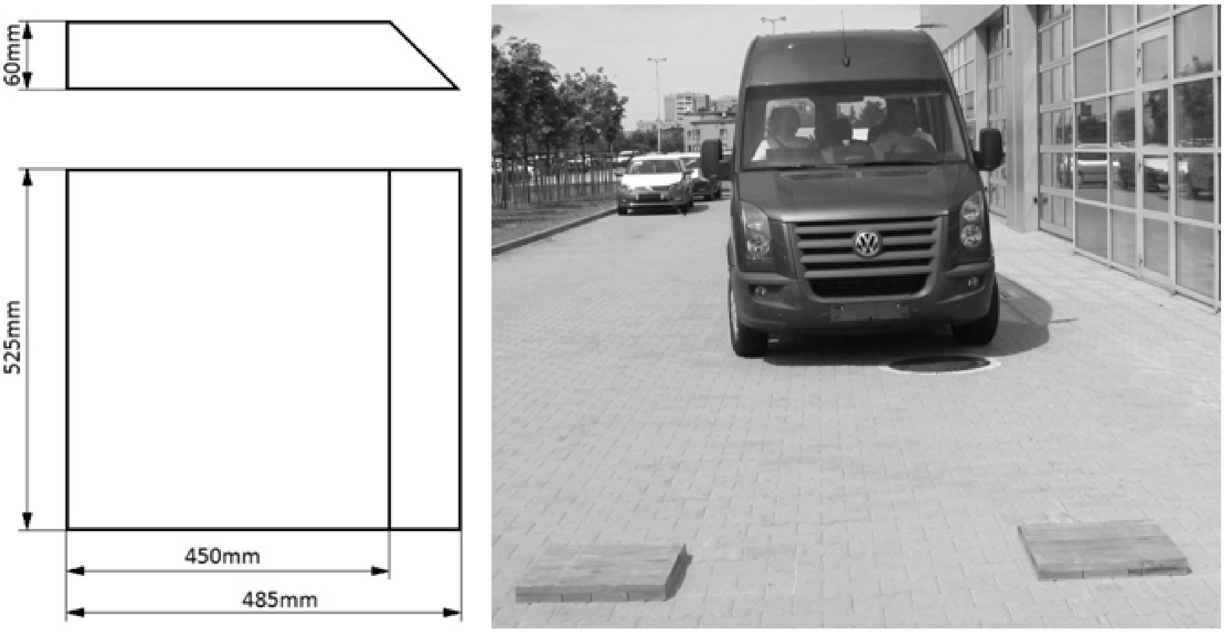

Fig. 3. Dimension used the obstacle (left), view the set of obstacles passage (right)

Results of measurements

Screening tests were performed for two-speed invasion of an obstacle. For each speed has made ten trips. The vehicle was the driver and the person operating the measuring equipment. The obtained values of the acceleration and full secondary delay (MFDD) for the individual test measurements are shown in Table 2 and 3, and examples of the results are shown graphically in Figure 4.

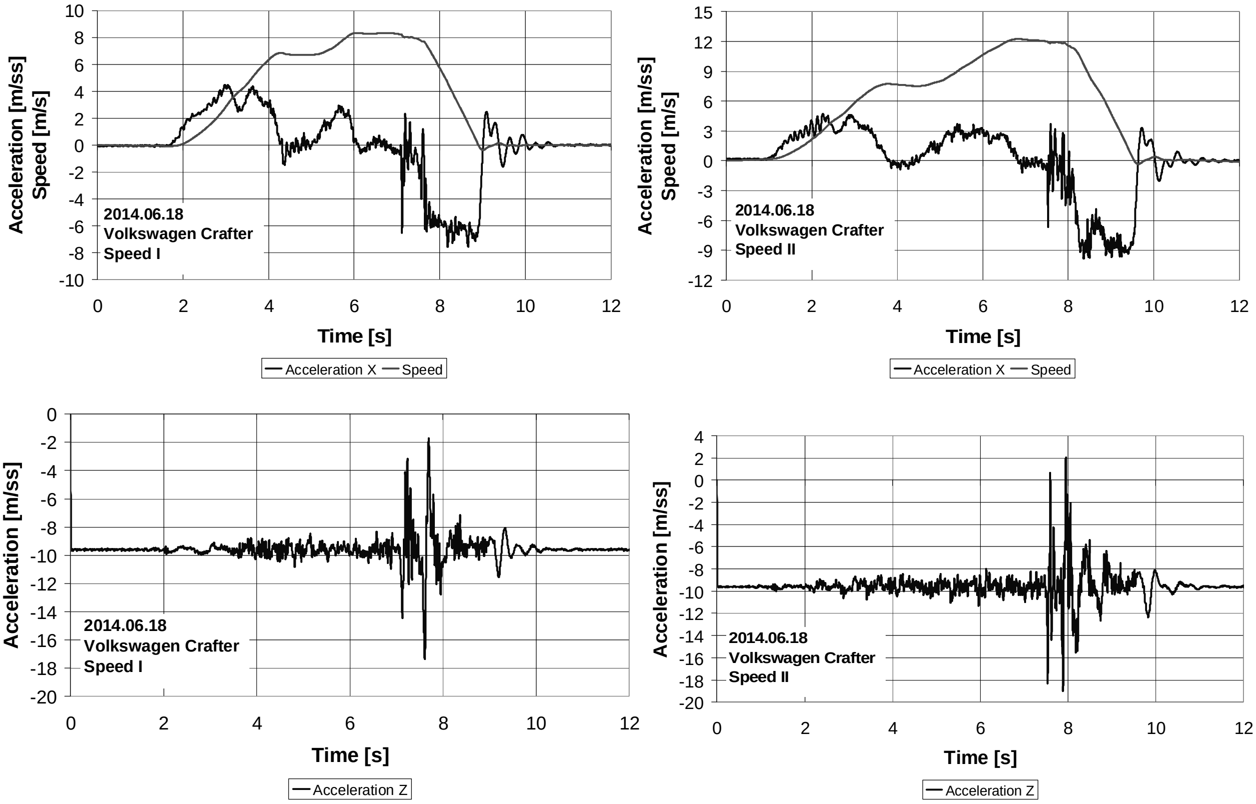

Fig. 4. Sample acceleration and velocity waveforms for two-speed invasion of an obstacle

Table 2

Parameters of a vehicle during test with speed I

Traveled road [m]	Time trial [s]	Time braking [s]	Road braking [m]	Speed braking [km/h]	MFDD [m/s2]	I Gear [m/s2]	II Gear [m/s2]
File corrupt							
36,5	9,273	2,840	3,55	20,250	6,018	2,293	
37,0	9,030	2,853	3,934	22,702	6,558	3,152	2,175
37,5	9,189	3,165	4,373	24,995	6,844	3,156	1,845
37,8	9,116	3,239	4,893	27,720	6,219	3,164	2,356
37,1	9,733	3,653	3,914	24,404	6,764	3,18	2,115
36,5	9,128	3,105	3,556	23,789	6,11	3,167	2,003
36,75	9,438	2,913	3,701	22,813	7,761	3,064	2,203
36,75	8,858	2,978	3,57	23,976	7,543	3,267	1,773
35,5	9,105	2,649	2,534	19,372	7,235	3,093	1,522
Average					6,784	3,059	1,999
Standard Deviation					0,627	0,293	0,271

Analysis of results

The collected video enabled performance analysis of time-lapse tires and suspension deflection at the time of the invasion of an obstacle. The results of analysis are shown graphically in Fig. 5 and 6.

Based on the characteristics of the longitudinal acceleration of the vehicle was determined momentary acceleration, transferred to the bodywork, tires generated by contact with an obstacle. Were taken into account acceleration pulses occurring along the X axis and the vehicle. This was due to the obstacles set perpendicular to the direction of movement of the car. The instantaneous acceleration values are shown in Table 4.

Table 3

Parameters of a vehicle during test with speed II

Traveled road [m]	Time trial [s]	Time braking [s]	Road braking [m]	Speed braking [km/h]	MFDD [m/s2]	I Gear [m/s2]	II Gear [m/s2]
57,9	10,522	3,538	7,85	45,205	7,842	3,315	2,46
55,7	9,919	2,907	6,573	42,836	7,879	3,304	2,458
56,6	9,987	3,030	7,459	42,635	7,337	3,394	2,417
55,9	10,550	3,523	6,495	42,023	7,688	3,352	2,330
57,9	10,615	3,555	7,273	41,486	7,750	3,269	2,388
57,7	10,534	3,419	6,886	41,926	8,089	3,313	2,346
57,2	10,599	3,776	9,584	43,585	8,056	3,413	2,382
57,9	10,659	3,411	6,304	42,394	8,171	3,274	2,384
57,9	10,49	3,337	7,128	42,091	8,007	3,22	2,328
57,9	10,439	3,31	7,328	41,612	7,992	3,313	2,355
				Average	7,881	3,317	2,385
Standard Deviation					0,245	0,058	0,048

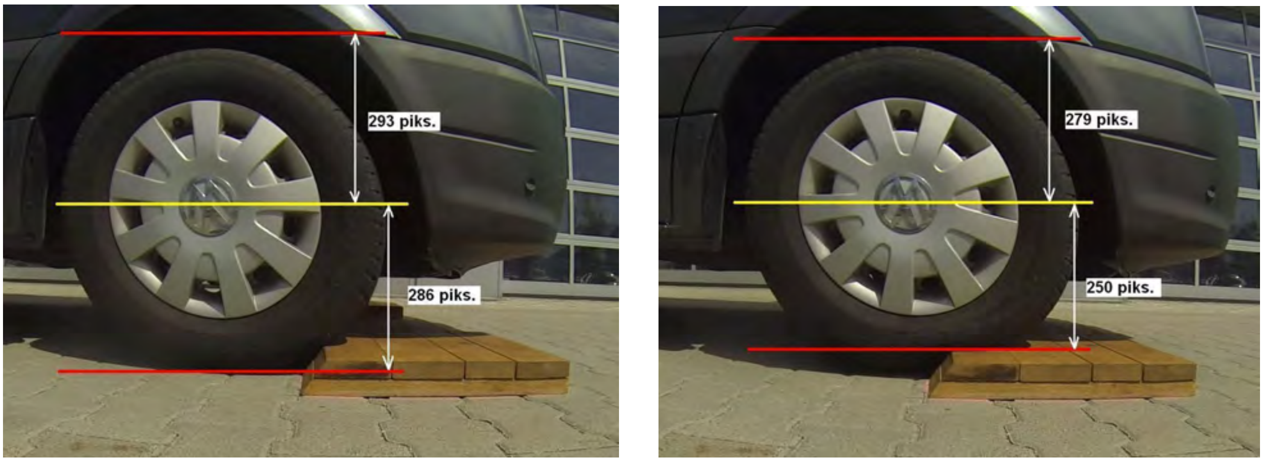

Fig. 5. View the Volkswagen Crafter while overcoming obstacles to Speed I

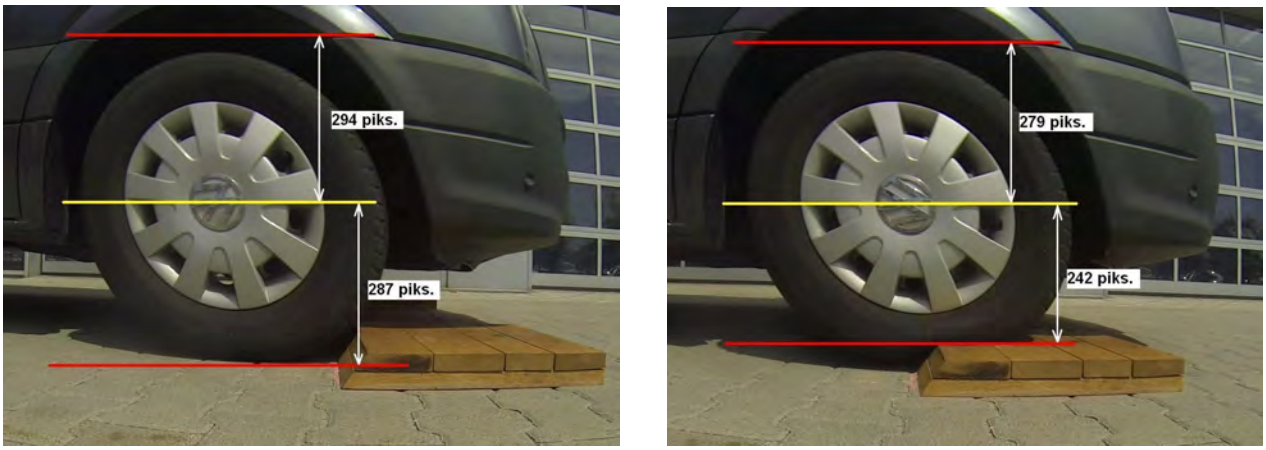

Fig. 6. View the Volkswagen Crafter while overcoming obstacles to Speed II

For both speed roadblock invasion of the instantaneous values of the acceleration occurring in the X-axis are almost identical. Similarly, the suspension travel speed for both is the same. Unlike the situation associated with the deflection of the tire and the acceleration in the Z-axis deflection difference tires for speed I and II speed is noticeable and is 9 pixels, while the value of the acceleration pulse Z rose from $a_{speedI} = 14{,}529\left[{m}/{s^2}\right]$ to $a_{speedII} = 17{,}994\left[{m}/{s^2}\right]$.

Table 4

Temporary value of speed and acceleration at the time of contact tires an obstacle

Speed I			Speed II		
Speed raid on roadblock [km/h]	The value of the acceleration pulse [m/s2]		Speed raid on roadblock [km/h]	The value of the acceleration pulse [m/s2]	
	X	Z		X	Z
			43,592	5,168	–17,280
22,450	6,548	–14,021	43,355	6,582	–16,790
24,505	6,566	–14,465	43,135	6,414	–18,225
26,622	6,590	–15,063	42,606	6,708	–18,492
29,282	6,512	–14,472	42,692	6,579	–18,364
25,920	6,491	–14,668	43,240	6,540	–18,416
25,524	6,590	–14,656	43,358	6,636	–17,874
24,448	6,721	–14,389	43,816	6,794	–18,261
25,560	6,265	–14,941	43,333	6,867	–17,982
21,438	6,054	–14,090	42,934	6,682	–18,254
Average	6,482	-14,529	Average	6,497	-17,994
Standard Deviation	0,201	0,348	Standard Deviation	0,484	0,551

Summary

On the basis of deflection of the tire and the instantaneous acceleration values of the X axis can be concluded that the tire mainly dissipates roadblock impact energy through its deformation, which significantly affect the transmission of forces from the surface to the body of the car. Tire deflection values are higher for higher speed raid on roadblock , this resulted in an increase in acceleration in the Z axis, and thereby increase the feeling of hitting roadblock .

The conducted experimental studies an introduction to the diagnosis based on the deflection of the suspension and tire deflection in terms of the size of the obstacles and the speed of the invasion. It is necessary to conduct further field tests using different vehicles and different sizes of obstacles.

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OPTIMIZATION OF MICROELECTRIC ACTUATOR DESIGN USING GOLDEN SECTION SEARCH TO GET THE DEFINED OUTPUT CHARACTERISTICS

ОПТИМІЗАЦІЯ КОНСТРУКЦІЇ МІКРОАКТУАТОРА З ВИКОРИСТАННЯ МЕТОДУ ЗОЛОТОГО ПЕРЕРІЗУ ДЛЯ ОТРИМАННЯ ЗАДАНИХ ВИХІДНИХ ХАРАКТЕРИСТИК

The article presents an example of the usage of golden section search to select the comb length of MEMS el electro-actuator to get the desired displacement at a given voltage heating. The proposed solutions are implemented as software code in the ANSYS system.

Key words: electro-actuator, computer-aided design, MEMS, finite element method, golden section search.

Подано приклад застосування методу золотого перерізу для добору довжини гребеня МЕМС-електроактюатора з метою отримання бажаного переміщення (displacement) при заданій напрузі нагріву. Запропоновані рішення реалізовані у вигляді програмного коду для системи ANSYS.

Ключові слова: електроактюатор, САПР, МЕМС, метод скінченних елементів, метод золотого перерізу.

Introduction

Recently thermo-electric micro actuators [1, 2], producing linear motion upon temperature change caused by Joule heating, have attracted a lot of attention [3-6]. These devices can have dimensions measured in micrometers and are produced mostly of polysilicon (theoretically can be made of any conductive material).

Electric actuators are mainly used to position micro-mirrors or move micro devices. To increase the effective force, multiple actuators can be combined together.

The main objective of the analysis is to calculate the actuator spike deflection that depends on the voltage applied to the contact areas.

When designing electric actuators, engineers are facing the task to create a structure that would ensure the necessary deflection for a given voltage. A lot of time is spent to optimize the design in order to obtain optimal output characteristics. There are many ways to optimize the design. One of these methods is the use of genetic algorithms, an example of which is presented in [7]. However, most optimization techniques cannot be applied to tackle the issues that can only be solved by finite element method. The analysis has been conducted to choose the optimization techniques to be used in ANSYS system. The obtained decisions show that to calculate the length of the micro actuator comb that would allow obtaining the desired bias voltage for a given heat, it is best to use the golden section search [8].We decided to