5. Акуленко К.Ю.Конспект лекцій з навчальної дисципліни «Теорія прийняття рішень» для студентів спеціальності 122 «Комп'ютерні науки» денної форми навчання. Рівне:НУВГП, 2017. 51 с.

6. Смородинский С.С., Бтин Н.В. Системный анализ и исследование операций: лаб. практикум для студ. спец. «Автоматизированные системы обработки инфомации» дневн. и дистанц. форм обуч. Минск: БГУИР, 2009. 64 с.

7. Третьяк Л.Н. Обработка результатов наблюдений: Учебное пособие. – Оренбург: ГОУ ОГУ, 2004. 171 с.

8. Лебедик М.П. Технологія атестації цілісного розвитку особистості на основі оцінок соціальної зрілості учасників педагогічного процесу: монографія. Полтава: РВВ ПУСКУ, 2003. 305 с.

УДК 629.33 + 629.062

SIMULATION OF WORKING PROCESS OF THE ELECTRONIC BRAKE SYSTEM OF THE HEAVY VEHICLE

D. Leontiev[1], V. Klimenko[1], M. Mykhalevych[1], Y. Don[1], A. Frolov[2]

[1] Kharkiv National Automobile and Highway University, Ukraine

[2] Kharkiv scientific research institute examinations, Ukraine

There are many scientific publications devoted to research of the braking dynamics of multi-purpose vehicles equipped with pneumatic brake drive. These works show that the braking distance of vehicles of this class can be reduced to 20% due to reduction in the operating time of electro-pneumatic brake drives. At the same time, scientific and technical literature devoted to operation of automated braking control systems often focuses on the fact that such systems increase braking time of wheeled vehicles (WV). Therefore, there is an issue on selection of rational law of pressure change in electro-pneumatic devices of braking system used in heavy vehicles upon designing of automated braking systems.

Simulating study of electro-pneumatic drive system of heavy vehicles depends on mathematic model of its movement dynamics. Adopted mathematical model should implement various laws of pressure change in electro-pneumatic pressure modulators of brake drive of heavy vehicle.

Based on the approach to the dynamics of wheeled vehicle motion proposed in work [1] and the approach to the interaction of automobile wheels of wheeled vehicle based on creep theory [2, 3], for the different loading conditions of the vehicle, adopted a unique model for determining the deceleration of heavy vehicle.

Based on accepted mathematical model of motion dynamics of a heavy vehicle that considers the level of loading of a vehicle, it is easy to simulate the nature of the motion of such a vehicle, taking into account the slope of the road surface towards roadside, by determining of torsion angles of tires of heavy vehicle through the equation of motion dynamics of wheels. These angles depend on the nature of the pressure change in the brake cylinders of vehicle brake drive.

To solve the gas dynamics equations, we adopted the classical methods described in works [1, 4]. These methods represent pressure change during the working process of the brake drive as increase, holding and emptying phase of its throttling links, including cyclic mode.

Adopted mathematical model of the dynamics of pressure variation in electro-pneumatic brake drive can be easily executed by means of software complex MATLAB package SIMULINK. Output data for the simulation of the electro-pneumatic brake drive are taken in accordance with specifications of mobile laboratory [5] of A. B. Gredeskul Department of Vehicles where the individual pressure modulators were installed.

The results of the simulation of the pressure dynamics in one of the front and one of the rear of circuits of electro-pneumatic brake drive in ABS mode have showed that the decrease in the speed of wheeled vehicle results in decrease of intensity of emission of the working medium from the electro-pneumatic brake drive and frequency of its operation increases due to increase in the value of adhesion of tire with road surface that has direct effect on the deceleration of heavy vehicle (ja).

The analysis of the simulation of vehicle movement dynamics, considering processes that take place in brake drive suggest that the decrease of average pressure in circuits connected to the rear axles of heavy vehicle is conditioned by changes in the physical properties during adhesion of tires to road surface. The simulation of the vehicle movement dynamics also showed that the extension of the processes of filling the brake chambers during the operation of the electro-pneumatic brake drive reduces the load on the driver's vestibular apparatus and creates more comfortable conditions in case of emergency braking of the vehicle.

During the simulation study, it was also found that the braking performance of the wheeled vehicle depends on overlapping of operation phases of the automated brake control system located in the rear and front circuits of the vehicle braking system. During the simultaneous release of several circuits, the overall efficiency of vehicle's braking is reduced due to the simultaneous release of wheels brake.

The study of braking dynamics of vehicle in loaded condition showed that the decrease in the weight of the vehicle compared to maximum loading results in the increase of overall braking performance up to 20%. It should be noted the value of the average pressure in the brake drive decreases with the increase of deceleration. This is due to the physical processes that occur in the area where tire adheres to road surface, which are described in the scientific and technical literature [1 - 4, 6 - 9].

Experimental studies of wheel braking process under the influence of the electro-pneumatic brake drive during extension of brake chamber filling showed that such approach leads to a significant reduction in the load on the brake mechanism due to the decrease in the frequency of alternating loads upon application of braking force between tire and road surface.

In this case, larger pressure is observed in the brake chamber in comparison with that observed during braking under similar conditions without extension of filling of pneumatic brake chambers of the electro-pneumatic brake drive of heavy vehicle, depending on the value of tire slip relative to road surface due to the implementation of the braking force.

References

1. Turenko AN, Klimenko VI, Ryizhih LA, Bogomolov VA, Leontiev DN, Krasuk AN, Myhalevich NG (2015) Realizatsiya intellektualnyih funktsiy v elektronno-pnevmaticheskom tormoznom upravlenii transportnyih sredstv [The implementation of intellectual functions in the electron-pneumatic braking control of vehicles]. Kharkiv National Automobile and Highway University, Kharkiv

2. Levin MA, Fufaev NA (1989) Teoriya kacheniya deformirovannogo kolesa [The theory of rolling deformed wheels]. Nauka, Moscow

3. Leontiev D, Ryizhih L, Byikadorov A (2014) Opredelenie prodolnoy realizuemoy silyi stsepleniya avtomobilnogo kolesa s opornoy poverhnostyu po krutilnoy deformatsii shinyi i ee zhestkosti [Determination of the longitudinal realizable force of adhesion of an automobile wheel with a bearing surface by torsional deformation of the tire and its rigidity]. Avtomobilnaya promyishlennost 10:20-25

4. Leontiev D (2011) Systemnyi pidkhid do stvorennia avtomatyzovanoho halmivnoho keruvannia transportnykh zasobiv katehorii M3 ta N3 [System approach to the creation of automated brake control of vehicles of categories M3 and N3]. Dissertation, Kharkiv National Automobile and Highway University

5. OAO «Minskiy avtomobilnyiy zavod» (2012) Avtorbus MAZ-256. Rukovodstvo po ekspluatatsii 256-0000020 RE [The bus MAZ-256. Operating Instructions 256-0000020 OI.]. Minskiy avtomobilnyiy zavod, Minsk

6. Mark Denny (2005) The dynamics of antilock brake systems. European Journal of Physics 26(6):1007 - 1016
7. Ersal T, Fathy H, Stein J (2009) Structural simplification of modular bond-graph models based on junction inactivity, Simulation Modelling Practice and Theory 17:175 –196
8. Oniz Y, Kayacan E, Kaynak O (2009) A Dynamic Method to Forecast the Wheel Slip for Antilock Braking System and its Experimental Evaluation. IEEE transactions on systems, man, and cybernetics part B cybernetics 39(2):551–560
9. Taixiong Zheng (2011) Research on road identification method in Anti-lock Braking System. Procedia Engineering Engineering 15:194 – 198

DEVELOPMENT OF THE INTELLIGENT INSTRUMENT SYSTEM FOR MONITORING THE PARAMETERS OF THE STRESS - STRAIN STATE OF COMPLEX STRUCTURES

Lyudmyla Kuzmych, Dmytro Ornatskyi, Volodymyr Kvasnikov
National Aviation University, Kiev, Ukraine;

The most common current instruments of measuring the parameters of the stress-strain state of complex structures are strain gauges. Typically, the strain gages are connected to the process of measuring by the bridge scheme, which eliminates systematic measurement errors and compensates for temperature deformations. Advantages and disadvantages of their application for this purpose are well known [1-5].

The method of data transmission from primary sensors to secondary devices using analog interfaces with wired telecommunication lines in remote measuring systems is currently very popular, despite the large number of advanced and more advanced wired and wireless digital interfaces. This is confirmed by the fact that researchers and chip manufacturers continue to offer new integrated solutions for analog transmission of information [1, 2, 3, 6, 8].

Such decisions are explained by several reasons. In systems of industrial automation there is a large number of developed and manufactured many years ago devices that use analog data transmission channels. These may be gauges, actuators, registration devices, etc. Replacement of this equipment is slow and requires very large investments. In addition, the transfer of any production entirely to digital networks means a one-time replacement of virtually all equipment and information cable networks. Such a large-scale reconstruction requires not only enormous costs, but also stopping the production process, which in many cases is unacceptable. Therefore, when creating or upgrading automatic control systems, it is necessary to use analog