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Driver`s reliability and its effect on road traffic safety

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Abstract

A driver of a vehicle is a main part of "driver – automobile – road – environment" (DARE) system, sustainable functioning of which determines the effectivity and safety of the road traffic. The driver as an operatof of DARE system gets most of the information from the road, scilicet from moving and stationery objects on it, traffic signs, traffic lights, condition of the surface and traffic environment. Analysis of the majority of road accidents demonstrates that the weakest part of human-machine DARE system limiting its efficency and reliability is a human. To provide necessary reliability and safety the driver of any vehicle has to be cautious. It is maintained by the appropriate psychophysiological condition which is in turn affected by many factors. In the article the analysis of research works considering the effect of different factors on the vehicle driver's reliability is presented. The means and methods of research conducting are described. The recomendations on constructing the stand for research of the effect of driver's psychophysiological condition on road traffic safety are given.

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Keywords: Driver reliability; Road traffic

1. Introduction

Automobile transport is an integral and essential component of the transport and communication complex of the Republic of Kazakhstan. It is characterized by:

- The greatest distribution and availability

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- High maneuverability and speed of delivery of passengers and cargo
- It is characterized by the possibility of carrying out «door-to-door» transportation without any additional intermediate cargo operations
- No alternative provision of services at short distances (intercity and suburban transportation, transportation in rural areas)
- High degree of adaptation to various technological processes, both in production and in the service sector;
- relatively low capital intensity [1]

In view of these circumstances, road transport is considered as an integral component of all modern transport technologies and is in a state of continuous development (traffic intensity, speed, and payload increase). Along with the indisputable advantages of automobilization, there is a tendency to an increase in human and material losses due to accidents involving vehicles. The car is a potential source of increased danger to people, which has increased dramatically in recent years as a result of an increase in engine power and speed.

2. Effect of the driver on road safety

The driver of a motor vehicle is the main component of the system "driver - car - road - environment" (DCRE), the stable functioning of which is determined by the efficiency and safety of road traffic. The driver can be considered as the operator of a complex dynamic system DCRE [2].

The driver as an operator of the DCRE system receives most of the information from the road - moving and stationary objects on the road, road signs, traffic lights, road surface conditions and traffic environment.

In the DCRE system, there is a continuous exchange of information: from the car and the road to the driver comes informative, and from the driver to the car - command. After performing the control actions, the driver receives information on the results of these actions through the feedback channels and, in accordance with the changed situation, performs the following necessary control actions. In this way, the DCRE system is a regulation system in which the position of the car relative to the road is the driving variable, the driver the regulator, and the car an adjustable object. All parts of this system are interconnected, interdependent and determine the reliability of each other.

The reliability of the driver as an operator of the DCRE system depends on his ability to perceive and process the incoming information. Information is received and transmitted through the sense organs: sight, hearing, joint and muscular, vestibular and tactile senses, smell, and also the visceral analyzer, from which the cerebral cortex receives information from the internal organs [3].

The analysis of the majority of road accidents (RTA) shows that the weak link of the man-machine system DCRE limiting its efficiency and reliability is the man himself. The fault of the drivers is from 65 to 85% of the accident [4].

One of the causes of accidents among drivers, along with low discipline, is poor preparation and quality of training. In this regard, the driver of motor vehicles, to the level of his professional preparedness are increasingly strict requirements [5].

The driver, driving the car, is in constant tension. In motion, he continuously perceives and interprets the rapidly changing traffic situation, position, speed and condition of his car, instantly makes decisions and implements them. Such an active and continuous course of mental phenomena in a rapidly changing environment and danger increases the tension of the nervous system and leads to fatigue, and sometimes to driver overwork [6].

The poor health of the driver, the disease leads to a decrease in its efficiency and a corresponding increase in the likelihood of accidents. Deficiencies in the mind of drivers are the cause of an accident.

Therefore, studies of the influence of the psycho physiological state of the driver on road safety are of paramount importance. Along with the indisputable advantages of automobilization, there is a tendency to an increase in human and material losses due to accidents involving vehicles. The car is a potential source of increased danger to people, which has increased dramatically in recent years as a result of increased engine power and speed. In this regard, increasing requirements for driver reliability.

Difficult situations on the road, in which erroneous actions are likely, arise for any driver relatively often, and therefore, according to statistics, about once a month he gets into a conflict situation and, on average, once in 6 years he can become a participant in an accident [7, 8]. Road accidents bring enormous damage to society, their number is growing from year to year and is already reaching catastrophic values. According to the UN Statistics Agency, approximately 40,000 people per year are killed on the roads, and the economic damage caused by these accidents amounts to approximately 200 billion Euros per year. To this must be added the damage caused by accidents without casualties, which occur much more frequently [9]. This is what concerns the primary losses. In addition to these, there are still secondary losses, including the costs of necessary medical care, social costs, loss of working potential, loss of transportation, etc. The overall level of losses is difficult to determine [10, 11].

To ensure the reliability and safety of work, the driver of any vehicle must be the most vigilant. This is ensured by its corresponding psycho-physiological state, which is influenced by many factors.

Studies of the influence of the psycho physiological state of the driver on road safety are of paramount importance and its relevance is indisputable. When conducting such studies, it is necessary to analyze the brain activity of the driver [12].

3. Analysis and research methods of human brain activity

Different methods and tools are used to analyze human brain activity. One of such methods for many years has been the identification, measurement and analysis of electromagnetic impulses arising in the brain. Thanks to this method, such areas as electroencephalography (EEG) and magneto encephalography (MEG) have emerged. Over time, these approaches to the study of brain activity evolved into important and widely used scientific disciplines. Among their main advantages are the speed of obtaining relevant brain signals and the accuracy of their measurement.

On the other hand, the use of both of these approaches is fraught with many problems, especially if the measurements are not carried out under laboratory conditions. As for the application of these approaches in the field of transport, in particular in the cabin of a moving vehicle, it is not possible.

Therefore, the search continues for other methods that could be applied in similar conditions.

The measurement of electromagnetic brain signals and their subsequent analysis is widely used in medicine and other fields. This method has many advantages, especially it is worth emphasizing the ease with which signals can be read from a person's head, while the person does not feel anything, and a large amount of information comes to the location of scientists. Since the recorded signals are mostly quasiperiodic and quasistationary, known Fourier methods cannot be used to analyze them, which can be attributed to the disadvantages of this approach.

The problem of establishing contact, described above, does not manifest itself in the case of MEG, which is the measurement of the magnetic component of electromagnetic waves that are produced by the human brain. However, the fact that today parasitic magnetic fields are present practically everywhere, forces us to carry out these measurements with extreme caution, under an anti-magnetic shield. Such shields not only occupy a lot of space and are very heavy, they are also very expensive. Thus, a similar experiment cannot be implemented in the cabin of a moving car. For this reason, this method can also be used exclusively under laboratory conditions.

Taking into account all the advantages and disadvantages of the above methods, it is proposed to develop a combined electromechanical analysis of brain activity (CEMABA). In this method, you can combine the advantages of electromagnetic and mechanical methods, while minimizing their disadvantages [14].

Currently, the most common simulator for carrying out such research is the simulator of the German company VRteinment [13]. All its main elements imitate European middle-class cars.

It is a steering wheel with two pedals and a gear shift lever. The signal from the control mechanisms arrives at the computer where the processing is performed. The operator wears 3D LCD glasses, on the screen of which the previously known landscape is displayed. The disadvantage of this simulator is that you cannot create and change the landscape. In addition, the stand does not allow to simulate the work of units and units of the vehicle. Also, the described stand cannot respond to the sudden demands of the experiment.

In this regard, there is a need to create a simulator that allows you to simulate the units and the car as a whole and on the basis of this to investigate the state of the driver.

The staff of the Czech Technical University has developed a stand that meets the above requirements. It is closest to reality in terms of driver ergonomics, since a real car is used.

The subject sits in a real cockpit, and virtual landscapes are projected on the wall of the screen in front of the hood of the car. Created support for creating landscapes using real data. The results of measurements using such a device are more reliable. They do not have an error caused by the difference between the simulator and the real car.

4. Results and discussion

The structure of our simulator is divided into four modules. The first module is the device simulator itself. It consists of software and hardware. The simulator software consists of a virtual reality engine (3D-graphics and spatial sound) and a physics engine. The actual behavior of the simulated machine is a prerequisite for good experimental results. For this reason, it is necessary to pay much attention to the realistic behavior of the car.

The second module of the simulator is a cabin, which consists of parts of a real machine and computers connected to the network. The next module is a database of test tracks and cars. To obtain objective results, it is necessary to have a certain complexity of the track. The last module presents tools for creating assets that make up the tracks. Basically, it is modeling of 3D-objects and tools for automating such a process and databases of simulated objects. Each object in virtual reality is accompanied by a texture. The texture of such a picture, which simplifies the creation of a 3D object. Textures can be of different types.

A helmet with sensors that allow you to completely simulate signals in 3D format is put on the head of the test operator. A sensor connected to the head scans the operator’s head. This data is primarily used to assess the movement of the projected image, and this data can be stored in a database for further analysis of the driver's brain activity [15].

Thus, based on the analysis of the existing structures of automotive trainers for the training of drivers of motor vehicles, an interactive car simulator has been developed that provides comprehensive training for future drivers on safe driving behavior. In addition, it can be used in research activities.

5. Conclusion

At present, the growth of the car park of the Republic of Kazakhstan and the constant increase in traffic intensity have highlighted the problem of road safety as the most important state task. Therefore, the problem under consideration is relevant not only in Kazakhstan, but throughout the world. In this regard, work in this direction is necessary to force.

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