ТРАНСПОРТНАЯ ИНФРАСТРУКТУРА, РАЗВИТИЕ СЕТИ ЗАРЯДНЫХ СТАНЦИЙ ДЛЯ ЭКОМОБИЛЕЙ. ИНФОРМАЦИОННО-КОММУНИКАЦИОННЫЕ ТЕХНОЛОГИИ НА ТРАНСПОРТЕ

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MOTOR TRANSPORT SAFETY IN TRAFFIC SAFETY SYSTEMS

O. Stepanov, assistant professor, cand. eng. sc., KhNAHU

Annotation. *This article considers various approaches to motor transport safety in traffic safety system. Much attention is paid to a complex method of increasing the efficiency of a system for keeping active safety. On the basis of authors research it is suggested to solve the problems of motor transport safety in traffic safety system through certain methodology of approach to the analysis and solution to the problem of motor transport safety management in a safety system of the Driver - Automobile - Road - Environment (DARE) complex.*

Key words*: motor transport safety, traffic safety, active safety.*

БЕЗОПАСНОСТЬ АВТОТРАНСПОРТА В СИСТЕМЕ БЕЗОПАСНОСТИ ДОРОЖНОГО ДВИЖЕНИЯ

А.В. Степанов, доцент, к.т.н., ХНАДУ

Аннотация. *В данной статье рассмотрены различные подходы к безопасности автотранспорта в системе безопасности дорожного движения. Значительное внимание уделяется комплексному подходу увеличения эффективности системы обеспечения активной безопасности. На основании проведенного исследования автором предлагается решать вопросы безопасности автотранспорта в системе безопасности дорожного движения через определенную методологию подхода к анализу и решению самой проблемы управления безопасностью автотранспорта в системе безопасности комплекса ВАДС.*

Ключевые слова: *безопасности автотранспорта, безопасность дорожного движения, активная безопасность.*

БЕЗПЕКА АВТОТРАНСПОРТУ В СИСТЕМІ БЕЗПЕКИ ДОРОЖНЬОГО РУХУ

А.В. Степанов, доцент, к.т.н., ХНАДУ

Анотація. *У даній статті розглянуті різні підходи до безпеки автотранспорту в системі безпеки дорожнього руху. Значна увага приділяється комплексному підходу збільшення ефективності системи забезпечення активної безпеки. На підставі проведеного дослідження автором пропонується вирішувати питання безпеки автотранспорту в системі безпеки дорожнього руху через певну методологію підходу до аналізу та вирішення самої проблеми управління безпекою автотранспорту в системі безпеки комплексу ВАДС.*

Ключові слова: *безпеки автотранспорту, безпеку дорожнього руху, активна безпека.*

Introduction

Motor-transport is one of the most important priority sectors of economic infrastructure because its functioning impacts directly on development of economy, social sector and security of a country. Being an extremely important component of infrastructure of Ukraine, motor transport provides both internal cross-sectoral connections, satisfies the needs of the population

in transportation, and it enables the delivery of passengers and export-import cargoes of various purpose in the interest of the development of international cultural and technical cooperation, and integration of Ukraine into the global economy. In this regard, motor transport safety is a serious social and economic problem. Knowledge and points of view on the motor transport safety system allow to make judgments about taking and understanding of arising problem, in other words there takes place a change of views on motor transport safety. Further development of motor transport system and keeping its stable functioning under conditions of road traffic safety is a strategic aim of the state. This problem should be fully solved, in regard to the resources of all the members of "Driver-Car-Road-Environment" system.

Analysis of major studies and publications

Scientific literature considers category of motor transport safety in road traffic safety (RTS) system in various aspects [2–8]. Thus, its definition has different meanings. Problems of studying motor transport safety and problems of finding ways to improve it have been raised in numerous works by Antonov D. A., Abramov A.B., Bazhinov O.V., Belenky Ju.B., Bendas I. M.,. Bigunov L. A., Bogomolov V. A, Borisenko G.V.,. Borisov L.L,. Varfolomeev V.M, Velikanov A. A.,. Volkov V. P,. Gecovich E. M, Govorushhenko M. Ja., Grinchenko O. S.,. Genbom B. B, Gessler N. A.,. Gredeskul A. B,. Djumin I. E,. Ilarionov V. A, Kosolapov G. M., Kravchenko O. P., Kuznecov E. S., Kugel R. V.,. Kuhtov V. G,. Lebedev A. T, Podrigalo M. A., Starosel's'kij A. A., Turenko A. M., Tkachov V. N., Fedosov A. S.,. Chudakov E. A and in works by many other scholars.

Within many years of formation of RTS it has been proven that it is dependent on various factors. To ease the analysis, all the factors affecting road traffic and its safety were classified into three interacting parts of the system: "Automobile - Driver - Road". Among these three elements of the system, a motor vehicle poses the greatest potential risks.

Formulation of the problem

To consider various approaches to motor transport safety in road traffic safety system.

Research Materials

Many researchers have proved that motor transport safety and the whole road traffic safety (RTS) are dependent on numerous factors [3–8]. For convenience of studying all these factors are classified into four interacting parts of a system: "Driver – Automobile – Road – Environment", and they are considered as the elements of the unified DARE system, that is a particular case of a "Driver - Car - Environment" system, which is common for contemporary science. Incompatibility of one of the elements of the "Driver – Automobile – Road" system to the other elements frequently causes road traffic accidents (RTA).

A lot of RTA occur because the requirements of traffic environment are high above the resources of human body or motor vehicle construction. The impact of extra stress brought by imperfections of automobile construction or by poor condition of a vehicle can deeply reduce the quality of driving, and in worst cases it can lead to an accident. On the contrary, a good construction of a motor-vehicle, which compensates psychical and physiological weaknesses of a man, may promote enhancement of road traffic safety (RTS). One of the ways to solve a problem of reducing the accident rate is to improve active safety of motor vehicles, of a combination of features that condition the ability of motor vehicles to prevent or decrease the probability of RTA occurrence.

In order to mention some modern trends and tendencies in field of improving motor transport safety let's turn to the history of origination of safety concept, and use the analysis of foreign authors, held by Ryabchinsky A. I., Rusakov V. Z., Karpov V. V. [6]. Consider two different approaches to the analysis of the problem of road traffic safekeeping, and, on their basis outline the main abilities in improving the safety system, which allow to considerably improve RTS.

Classical definition of RTS was suggested in 1966 (Wilfert) [6]. First it was suggested to divide vehicle safety into the active and passive ones. The innovation was to mark out four classes from active safety: safety of driving environment, perceptional safety and safe driving. In spite of unusual classification paragraphs in this scheme, some close interactions between the road, vehicle and driver are clearly recognized,

because even at that time there have emerged the necessity for a complex approach.

It should be mentioned that capability of motor-vehicles to reduce probability of RTA occurrence, i.e., the active safety of the DARE complex, is of priority importance when analyzing RTS nowadays. Foreign and domestic studies in field of increasing the efficiency of a system for keeping the active safety are currently on the rise, and a complex approach which is actively developed in countries with advanced automobile industry, sets new vectors for its further development.

According to experts estimates automobile active safety for the time being is just a limiting factor, but its not the main one in road traffic safekeeping. Such prioritization was a consequence of primary and sole driver's responsibility for safety of the driving process. Thus, still for a long time, scientists and automotive engineers will have only one challenge: to do their best to provide a driver with the maximum opportunities in their problem of safe driving.

In spite of rapid development of information and computer technology, the technology that could run the functions of driving a vehicle with much higher reliability than a man does is impossible in modern society. This is due to, primarily, a moral conflict over perspective to devolve responsibility for our lives and the lives of surrounding people to the artificial intelligence.

In aviation industry, this step has already been made and is quite successful, but this is due to the fact that this industry is served by highly professional and very few in number staff. But when talking about road traffic safety it must be taken into account that this process involves a lot of road traffic parties.

Since driving refers to oriented sensorimotor human activities, it is possible to divide it into three behavioral categories: behavior based on knowledge; behavior that is determined by certain rules; and behavior based on existing skills.

On the first level, the driver has to analyze different behavioral alternatives, choosing of them the one he finds appropriate. Mental processing of available experimental or theoretical knowledge takes the most time, and after that the chosen variant is transferred to actions through motor reactions.

The difference of the second level is that a driver has already a set of rules of conduct in a given traffic situation, since similar situation-associative conditions have already occurred quite often earlier.

Human behavior at the third level is characterized by reflex and response to certain stimuli actions. It is obvious that the third level is the most effective form of human behavior in limited time circumstances.

It is perfectly clear that the main trends of work on improving the traffic safety are: minimization of the situations which evoke the first behavioral level, optimization of the second level of driving task, and providing maximum efficiency and reliability of stabilizing influence of a driver at the third level. The solution to the first task among the mentioned ones lies in range of improvement of drivers' professional skills, as well as in development of various navigation systems that would help to choose the best traffic route.

Optimization of control level of a driving task has great importance for the overall traffic safety [2, 3, 6, 8]. At this level man is endowed with an extremely important ability to interpret the development of traffic situation, i.e., to choose the required parameters of movement in advance to compensate for the time of retardation that is usually inherent in the system described. The main directions of efforts are seen in development of driver information support systems, warning systems against various hazards, and also recommendations on appropriate actions in a given situation. The important purpose of development of this system is to avoid any failure within interaction between a driver and a motor-vehicle.

The quality of response of a vehicle to control action must be maintained at the required level, regardless of the intensity and speed of driver's actions so that the automatism of driver reactions to corresponding situations would stay within their physical limits and the driver would not have to switch over the level of behavior, based on knowledge. Here we approach to the problem of development of the systems that would allow to provide the highest level of indices of vehicle movement, that would improve substantially its active safety and, as a result, the overall level of road traffic safety.

Before getting deeper into the above mentioned systems lets consider one more approach to studying the problems of RTS. It is obvious that one of the most objective parameters for estimation of RTS is a relative index of quantity of road traffic accidents during some period of time [6]. If we consider a simplified approach to causal analysis of RTA occurrence - there exist the so-called “clusters of RTA” or critical points on the road network, where, according to statistics, the risk of occurrence of a road traffic accident is the highest, then the problem of reducing their number lies in the sphere of rational traffic management.

From the other point of view, there appear a lot of conflict situations while vehicle moves. The emergence of a conflict situation may be caused both by interference from inside of a vehicle (for example, dangerous control actions that are inadvertently made by a driver, or breakdowns in some systems of a motor-vehicle), and by interference from outside a vehicle (suddenly changing characteristics of a road or unexpected behavior of the other road traffic parties). At this point there happens a very negative process of change of drivers conduct from the third level to the first one.

It is possible to preclude appearance of this kind of situations only through introduction of fully automated solution for operation task by excluding a man from this process. This is unattainable at the present stage due to the reasons mentioned above. Considering the problems of improving the traffic safety from the point of this approach, we step up to the need for development of systems that would neutralize any excess control action, or even carry out a correction of insufficient control actions of a driver.

Automatic Blocking System (ABS) was the first in the history of development of these systems [4, 6]. It limited the braking force set by a drivers control action so that to realize the maximum traction under which braking is the most effective. In a similar manner, Automatic Slip Control system (ASC) limits an excessive input signal from a driver in the moment of pushing the accelerator.

In the system of active kinematics of rear suspension (on example of BMW) the mode of rear wheels control (ARK) is realized in such a way that it controls maintaining of lateral stability while a vehicle moves, even under extreme input control actions. It is achieved by redistribution of lateral forces acting on the front and rear axles.

The system of Dynamic Stability Control (DSC) is a complex solution for all exploitation modes and almost for all kinds of extreme maneuvers. It is worth to be mentioned that functioning of these systems doesnt come into direct conflict with the control role of a man as a subject of control which has been discussed above, since this systems actually lead to optimal parameters of control action, and this is just the thing the driver endevours to achieve.

For examples of practical solution lets consider the systems that optimize the parameters of manoeuvrability and stability of a vehicle, which are the important indices of vehicle active safety. One of vehicle manoeuvrability and stability indices while turning maneuvers is a control of turning and lateral displacement of a vehicle in relation to the plane of a road, which is carried out by vehicle drivers only through using control actions to the front wheels. Such type of control with a single level of freedom is often not enough to control lateral displacement, and for necessary orientation of the longitudinal axis of a vehicle on the road under conditions of a constantly changing traffic route. With that a driver actually has no ability to control a negative phenomenon of a body roll.

There are two main ways to help a driver with additional input control actions: to supplement a drivers input control action to control the trajectory of the movement of a vehicle; to prevent or suppress any undesirable uncontrolled movement of a vehicle, caused by a drivers action, or by some external forces.

Availability of adequate driving force is an important element in using active control technology. These forces, affecting the movement of a vehicle, can be received in various ways. So far most studies are based on the use and control of external forces affecting the tyres, and internal forces that arise in the suspension system of a vehicle. The forces acting within the contact of the tyre and the road can be used in various ways. Firstly, through lateral forces by introducing additional degree of freedom of control action to the wheels, and secondly, through the difference between the longitudinal forces at the left and the right side wheels of a vehicle.

Many scholars studied various methods of using

the controlled rear wheels, and also the possibility of additional steering control for separate wheels [1–6]. Taking into account that the concept of control over four wheels may effectively use the lateral forces on the wheels within the linear mode of the tyre work under conditions of normal driving modes, though it must be stated that the probability of saturation of the lateral forces in the tire contact is very high, and this limits the use of this method as applied to high lateral acceleration. Since that time the focus in this aspect has shifted towards the methods of direct control of moment of turning movement of a vehicle, according to which the tyres are used as drives of longitudinal forces. Arising moment is directed to application of braking or rotating movement to corresponding wheels.

As a rule, modern developments are based on the schemes that unite both concepts. However, not only integration of these methods is possible and rational, as it was proven, but also coordination of functioning of such modern systems as Active Front Steering (AFS) system and Active Roll Moment Control (ARMC) system with additional use of a Slipping Controller (SMC). These systems reflect a variety of means to help a driver both under normal driving conditions and in critical situations.

AFS system integrated with SMC may affect input control action from a driver by adding the adjusting controlling angle to keep angular steering speed of a vehicle under control during the whole driving process. The idea of using ARMC system lies in availability of a controller capable to set differential changes in distribution of a roll moment which regulates distribution of vertical load on the tyres of the front and rear axles.

This system can use, firstly, an active suspension for adaptive changing of roll stability of both axes in order to achieve desired lateral movement, and secondly, to control forces of active suspension to proportionally change the roll angle using additional springing actions, thirdly, to reduce the roll angle, realizing a closed control of lateral acceleration, or using simple PID-controllers. Collateral use of the given systems in a united strategy of centralized control allows to gain huge benefits, especially during driving in critical situations. Accuracy of AFS system is achieved due to use of SMC method, which, in its turn, is based on conformity of actual movement parameters of a vehicle to the etalon model of its conduct and its functioning is highly infallible.

A method of so-called “Automobile Parameter Identification” [5, 6] is worth to be mentioned. It uses a set of models, the level of precision and complexity of which is prescribed by the research objectives. There is held a series of minimum required road tests with registration of certain parameters. This registration is usually not a big deal. Physical and mathematical mechanism of the model, using the obtained parameters as input characteristics, executes a thorough analysis of the situation and predicts the indices we need for a full conclusion with high accuracy. In this manner maximum results of road tests are achieved with minimum expenses.

Conclusion

When considering problems of motor transport safety in road traffic safety system it’s necessary to determine methodology of approach to the analysis and solution to the problem of motor transport safety management in safety system of Man - Automobile - Road - Environment complex.

The approaches which have been considered are one more modern method of RTS analysis that leads us to necessity of creating some driver assistance systems which would supplement external input control actions according to a given driving situation. These systems substantially reduce the risk of RTA occurrence while not coming into ethnic conflict with social consciousness.

Further development of the problem of motor transport safety shows that the principles of regulation of RTS may be worked out on the basis of system approach, which includes: the analysis of RTA; the analysis of reliability of certain systems and elements of motor transport along with probability of breakdowns; analysis of domestic regulatory documents for conformity to UNECE Rules (to the requirements of International Transport Organization (ISO) that determines standards for motor-car construction). The analysis of this problem remains not complete enough and it needs further studying.

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Reviewer: E. Getsovich, professor, Ph.D., KhNAHU

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