DRIVER VIGILANCE REMOTE MONITORING SYSTEM

V. V. DEMENTIENKO

Summary: *The major number of road accidents and emergencies is due to human factor. To reduce risks of negative development of human factor, an automated system of driver's vigilance remote monitoring will be quite feasible. This article presents general description of the issue, development and implementation of such system on the basis of one transportation company.*

Key words*: transport, road traffic accident (RTA), human factor, driver, vigilance, remote monitoring of driver's vigilance.*

INTRODUCTION

Despite revolutionary development of electronic systems of monitoring, increase of transportation safety by development of operating principles and devices of driver's functionality monitoring is an extremely urgent issue today. It is especially urgent in transport area, automotive in particular. It is known that 70-90% of emergencies at complex technical systems are due to wrong actions of the operators. Tens of thousands of people get perished at motor roads of Russia annually, and hundreds of thousands get injures. The available statistics of RTA shows that about 80% of these accidents are through drivers fault. 20% of RTAs with drastic consequences may be due to low vigilance of driver, namely, reduction of watchfulness, drowsiness and falling asleep at the wheel [1, 2].

REVIEW OF THE EXISTING METHODS AND DRIVER VIGILANCE MONITORING SYSTEMS

At present there are many proposals, completed scientific developments and even industrial products more or less solving the problem of driver vigilance control. These are based on analysis of one or several physiological and (or) behavior parameters [3, 4]. The Table 1 shows the data about the parameters of driver vigilance monitoring methods estimated by the sources in literature and tested during experiments at a car simulator and/or during simple monotonous actions (p – probability of dangerous fault (errors of the second type), 1/hour).

V. V. DEMENTIENKO, *professor, Ph.D. in technical science, CEO, JSC NEUROCOM, Moscow.*
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H. Gao, J. Guo, Y. Zhang andZ. Zha are with the School of Information Science and Technology, Southwest Jiaotong University, Chengdu 610031, China (e-mail: swjtu_gh@163.com). Corresponding author: Y. Zhang (ydzhang@home.swjtu.edu.cn).

Table 1. Methods determining indications of sleep and deep relaxation.

Vigilance estimate technology	*p*
Change of driving 'style'	0,3
Rational actions	0,3
Pulsus	0,3
Posture (muscles tone)	0,2
Glance direction	0,2
Head tilt (muscles tone)	0,1
Speech	0,1
Oculography	0,05
Blinking	0,02
Microsaccades (optional)	0,001
EDA (72 mln man-hours without accidents)	< 0,0001

Trends of research and developments

Experimental units were built for each of the methods to measure physiological and behavior parameters by physical methods. From the point of view of dangerous fault, the most reliable turned out to be driver's vigilance monitoring by registration of his/her electrodermal activity [5]. Electrodermal activity (EDA) is change of resistance between two electrodes (pulse front duration less than 5 s) applied on a human's skin in the area of fingers, palm or wrist. EDA characterizes psycho- and emotional state of human, level of vigilance in particular. During behavioral experiments using a special technique to create monotony it was established that decrement of specific EDA pulses occurs before operator's errors related to deep relaxation prior to falling asleep. The experiment provided qualitative results enabling to state (reliability 0,9999) that if a distance between the EDA pulses does not exceed 60 s, then a human is in the state of active vigilance [6]. It is this result that served as a basis for development of a system for continuous monitoring of psychological and physiological condition of driver *en route*. This system is VIGITON [7] (Fig. 1).

Fig 1. *VIGITON system of driver's vigilance monitoring*

The system includes a portable part made as a bracelet, a stationary unit and a commutation unit. The portable part is equipped with the electrodes enabling to continuously read the information about electrical resistance of a human’s skin. These data are transferred to the stationary unit where, using a unique software, specific EDA pulses are detected. The algorithm determining level of vigilance includes estimation of EDA intensity (the first channel of monitoring), time responses of human’s interaction with the device (response to inquiry to confirm vigilance) – the second channel – and estimation of rational actions during driving – the third channel. Also, the algorithm accounts for the speed of the vehicle. The information about rational actions of the driver such as pressing the brake pedal, using winking lights, hand-brake activation is read using the commutation unit. If the vigilance level is lower than critical value, executive traffic safety devices are activated: hazard lamps and motor-horn informing the road users about faulty condition of the vehicle. When the VIGITON system is connected to the navigation equipment on the vehicle, there is an option of real-time transmission of the information about the driver’s condition to a traffic superintendent.

Driver’s vigilance remote monitoring system

Let us consider the VIGITON system as a part of the driver’s operability remote monitoring complex. The latter consists of onboard and stationary parts (Fig. 2).

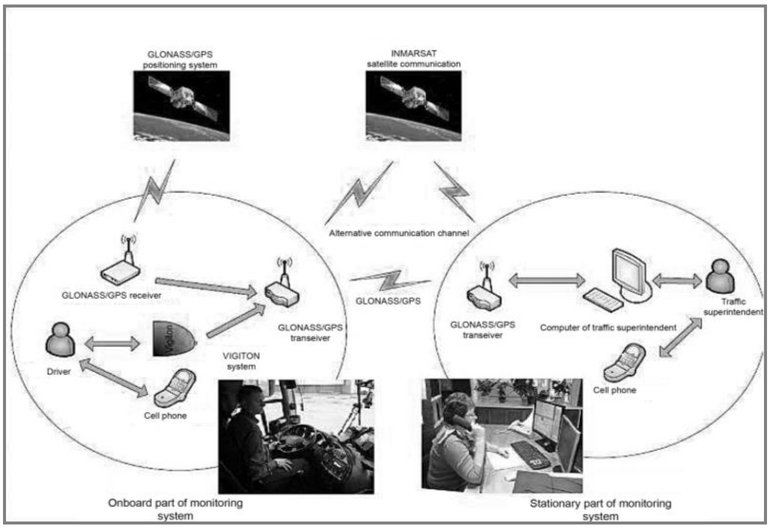

Fig 2. *Driver’s vigilance remote monitoring complex*

The onboard part includes the VIGITON system and the means to transmit the signal from a bus to a traffic control station. The stationary part includes the signal receiver and the place of traffic superintendent equipped with the NAVIGATION automated control system (ACS) – a set of computing technics and means of communication. Using the NAVIGATION ACS the traffic superintendent receives the current information about the state and progress of transportation and performs online management and control of the vehicles *en route*. The complex functions as follows: when the EDA intensity falls down to a specified value, analysis of the driver's condition starts using the second channel of monitoring: a request to confirm vigilance is issued by means of a light scale and then with acoustical signal of increasing volume. The driver is obliged to confirm his/her operability by pressing a button of the housing of the device. If no confirmation occurs during seven seconds, and there are no data confirming sufficient level of vigilance by the third channel of monitoring, the traffic superintendent receives a message that the driver on this vehicle fails to react to the system's requests. After such message is received, the traffic superintendent (TS) – according to his/her job description - requests the detailed information about the vehicle: coordinates, route, current speed. Then the TS makes a decision whether to send a text message to the driver or to phone him and check if help is needed. Integration of the NAVIGATION ACS with the VIGITON system has been implemented on the basis of one of the branches of MOSTRANSAVTO performing inter-city and long-distance transportations. The integration is performed based on the computing machinery and the means of communication of NAVIGATION ACS and entails the following accounting of the transportation works:

- automated control and analysis of vehicles release *en route*;

- compilation and correction of assignment for field daily operation;

- automated control and analysis of routed transportation of passengers;

- automated regulation of passenger transportation process on the controlled routes, if deviations from the scheduled indices of the transportations process are detected;

- online correction in the database of the replacement system of buses and drivers from one route to another; when the buses are released from the line, delays on the line, attraction of automotive transport during stays, delays, lunch time, during shifts and after shifts;

In case of RTAs and other emergencies the traffic superintendents shall take measures according to the special instruction for informational provision of actions to eliminate consequences of RTA.

Within the last option the driver shall use the VIGITON system under continuous control of the TS.

Complex approach to increase of traffic security

It is natural that the VIGITON system may be considered as an effective means to increase security of transportation only in case it is one of links of a complex approach for security of traffic, including both psycho-physical selection of the drivers, and advance trainings and pre-trip control, and real monitoring of the driver's vigilance *en route*. At present universal implementation of the complex approach in Russia is hampered due to lack of regulatory framework, whereas in many countries of Europe special requirements for professional drivers have been active for many years already.

Importance of introduction of such requirements has been confirmed by the RTA statistics. According to the UNECE data, our country occupies one of the last places among the developed countries by the level of transport risks (number of RTA victims per one vehicle) (Fig. 3).

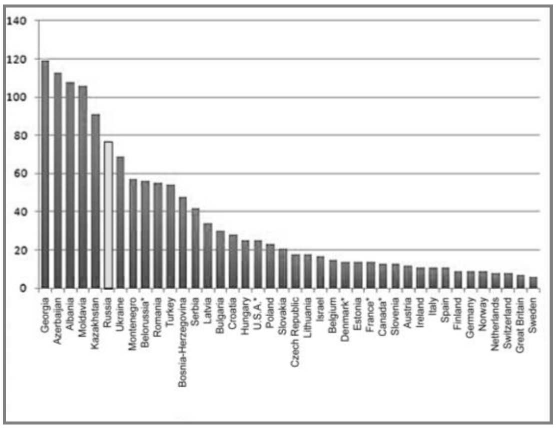

Fig 3. *Number of RTA victims per 100 thousand of cars in 2010*

CONCLUSION

Thus, inclusion of the driver remote vigilance control system into a set of other transportation security systems will enable to reduce number of RTA victims in Russia.

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