# Prevention of Critical Situations in the Traffic Flow by Using Devices of Technical Control

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September 5, 2022

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***Abstract*— The article considers the issue of improving intelligent transport systems in terms of identifying faulty cars moving in the traffic flow to prevent accidents in a timely manner. The purpose of such control is recording the facts of dangerous deviations of vehicle characteristics in real time, without investigating the reasons of such deviations. The article considers variants of remote registration of vehicle malfunctions based on the known signs of such breakdowns. It also contains possible methods of such diagnostics. Also, a way of systematically assessing the quality of the roadway using electronic means as well as vehicle's built-in devices is presented. The article presents the prospect of this approach.**

**Keywords— vehicle diagnosis, accident rate reduction, technical condition of roads, traffic monitoring, intelligent transport systems, automobile electronics**

## I. INTRODUCTION.

Ensuring safety on the roads is one of the first tasks of the road traffic organization. Vehicle malfunctions and poor road conditions become one of the causes of accidents on the roads, although far from the main one [1]. The number of accidents caused by malfunctions rises together with the number of vehicles on the road. And it's not even about the poor discipline of the drivers or those in charge. An extreme situation can develop quickly and be unnoticed even by an experienced driver. The important purpose of monitoring and diagnostics devices is to detect malfunctions in advance and help to eliminate them.

The process of technical monitoring consists of controlling the diagnostic parameters of vehicles during their operation and determining the condition of their units and assemblies by their values. Nowadays there are methods of detecting malfunctions of vehicles directly at the process of their work [2]. However, they do not solve the problem of remote detection of vehicles faults moving in the traffic flow.

The organizing and ensuring road safety problems have been transferred to intelligent transport systems with the developments in information technology [3]. However, it is necessary to develop appropriate diagnosis devices to control the technical condition of vehicles in the traffic flow in real time, and to search for methods of organization of non-contact control. The purpose of this article is to analyze methods of non-contact detection of faulty vehicles moving in the traffic flow, as well as assessing the quality of the roadway using built-in or special diagnostic tools.

## II. DETECTING SIGNS OF VEHICLE MALFUNCTION SAMPLE.

The list of malfunctions and conditions that prohibit the vehicle's exploitation was approved by the RF Government Decree "On Traffic Rules" (with the "Basic provisions for the admission of vehicle's exploitation and responsibilities of officials to ensure road safety"). They define requirements for the brake system, steering, exterior lights, windshield wipers and washers, wheels and tires, engine, and structural components of vehicles. The serviceability checking methods of the listed units and assemblies are regulated by GOST R 51709-2001 "Motor vehicles. Safety requirements for technical condition and inspection methods". Most of the listed malfunctions can only be detected by direct inspection of the vehicle using special diagnostic tools. However, some of them have characteristic features that may be noticeable to an outside observer.

Mechanical problems are often accompanied by knocking and specific noises, which can be registered by sensors of acoustic vibrations. This property occurs for a wide range of engine, chassis and other units or structural elements problems, i.e., not only those mentioned in the above list. However, real-time detection of other defects can also be important. First of all, if you identify breakdowns in the early stages, it is possible to fix them quickly and relatively cheaply. Secondly, it is important for road safety to exclude faulty vehicles from entering intercity and interregional roads and highways in order to subsequently avoid the need for technical assistance or evacuation of people when they are far away.

It is necessary to perform a more detailed analysis in order to determine the source of sound or vibration, and for that a method of examining the frequency spectrum of noises and vibrations, including a three-dimensional coordinate system, is proposed [4, 5]. This method does not yet give absolutely reliable results, because the defect is detected against the background of a working machine, which creates a significant level of oscillations and acoustic vibrations, and various problems with different localization will give a completely different spectral picture. The problem of identifying the vehicle arises in the process of detecting the malfunction of a vehicle moving in the traffic by using the spectrum of vibration it generates. This spectrum is different not only for trucks and cars, but also for the various models of cars, as well as for gasoline engines and diesels, and even for wheels with different treads. Nevertheless, the method can be promising, because in this practical application it is not required to diagnose the type of fault, but only to fix the very fact of its existence. Under the condition that the traffic flow is divided into special passing corridors and the average speed is reduced, the analysis of frequency-time diagrams can allow to identify periodically repeated knocks, characterizing the malfunction occurrence.

The implementation of this method can involve two approaches. In the first case, sound vibrations should be recorded by sensors that are external to the vehicle. They can be supplemented by means of identification (image recognition tools, weighing devices, etc.) [6]. In that case, it is not necessary to retrofit the vehicle. The recorded information is compared with the data from the stored databases for this type of vehicles. Information about the results can be immediately transmitted to the operator, or to an automated traffic control point for taking relevant measures. In the second approach, vibroacoustic sensors are installed inside the car, register vibrations for a long time, and according to the stored information can more accurately detect the occurrence of deviations for a particular car. Information about the vehicle's condition can be transmitted to special control points on request via wireless transmission means. However, in this approach, the results would also depend on the locations of the sensors and their number. It requires information resources for the gathering and processing the information.

A particular case of implementation could be the analysis of sound and vibrations recorded by smartphone sensors. The sensitivity of phone sensors, their computing power, the presence of built-in GPS-systems – all of these make it possible to implement such diagnostics of faults with the use of special applications. However, this will require a rigid fixation of the smartphone. This option can be positioned as a system of warning the driver about possible malfunctions. The main vulnerability of this approach is the existence of noises and sounds from other cars on the road. It means that objective diagnostics involving smartphones can work only when the engine is started and when the car is in the parking area or in the parking lot, which limits the functionality of such applications. On the other hand, noises and knocks during cold engine start can detect a number of engine malfunctions including problems with timing chain tensioner, timing clutch, alternator belt, cylinder piston group wear, etc. Therefore, the use of smartphone apps for car diagnostics remains a promising trend.

Other methods of fault detection, such as only image recognition, trajectory analysis, gas analysis, etc., are still insufficiently informative and objective, and yet quite costly.

## III. Wireless Vehicle Malfunction Detection System

Nowadays, most of the existing cars are equipped with electronic units providing their own internal diagnostics and registration system for errors that occur. They include the possibility of computer diagnostics through specialized diagnostic connectors. For example, OBD-II. In older vehicles, you can read the data and error codes through the cable. In more modern ones, communication with the on-board system is done wirelessly via Bluetooth or Wi-Fi. However, there are wireless adapters for OBD-II connectors that provide transmission with the same wireless standards.

You can use universal or special (for a particular make of car) applications for smartphones and computers to diagnose the car. There are also universal vehicle scanners that support most of the data transmission standards from the vehicle's diagnostic bus. All these devices provide readout of error codes as well as real-time measurement of vehicle parameters.

The listed equipment can also be used for rapid registration of the condition of the vehicle moving in the traffic flow. However, there is the problem of identification and authorized connection to the right car on the road. There are two solutions to this problem. The first one includes separation of the traffic flows and ensuring their passage through special checkpoints, as well as the transition to simpler radio frequency channels, using the principle of RFID (Radio Frequency Identification). The second method involves reading the vehicle's license plate number and establishing a data link from it. In this case, such a structure acquires an important additional feature: verification of correspondence between the read license plate and transmitted by the vehicle equipment on the exchange channel previously assigned registration code (e.g., VIN code). A mismatch of these parameters provides information for the technical supervision and registration service of the traffic police.

Modern equipment: RFID tags, RFID-readers and long-ranged antenna scan identify objects at a distance of up to 16 meters. The identification number and additional information is recorded in the memory of the RFID tag. For example, the key to the communication channel for data transmission. The RFID tag data can be transmitted to a computer. All further actions proceed according to the algorithms set in the information system. In our case, it may be the establishment of radio communication with the object using a unique key and reading data about errors and parameters from the electronic units of the car. This process can be completely automated and optimized in terms of time, taking into account the time of the vehicle passing the checkpoint.

RFID readers provide simultaneous interrogation of multiple RFID tags within the range of the reader's antenna, which can simplify the process of identifying a vehicle in the flow. In this case, the only limitation is the passage of the car for which you need to read the tag and a unique key, establish a connection over the radio channel, read the data, process it, pass the signal to the information system for further action.

The presented approach also has a significant drawback. Modern diagnostic equipment and vehicle scanners allow you to change the settings of blocks and systems of the car. This creates a potential threat: the possibility of interfering with the mode of operation of the car, and virtually, through information systems. However, the limited passage time of the car slightly negates this disadvantage, because it takes time and appropriate conditions to rebuild the systems.

## IV. EVALUATION OF ROADWAY QUALITY USING ELECTRONIC MEANS

Methods and techniques for assessing pavement quality have received a great deal of attention. However, in this field automatic ways of fixing pavement parameters are poorly represented. For example, there is GOST 32825-2014 "Methods for measuring the geometric dimensions of damage," but the produced equipment is poorly automated and mainly involves manual labor. In terms of the development of modern electronic means, many measurements may be performed with the use of existing and used in other areas solutions. For example, trajectory control, slope angles of road sections, potholes with reference to geographic coordinates can be measured with sensors installed in the smartphone. It only requires the development of appropriate software. Automation of measurements of other parameters is possible through the development of special equipment installed on purpose-made vehicles. Electronic, optical and ultrasonic sensors which are capable of solve these problems exist.

It is interesting to see a solution whereby the quality of the pavement of a section of highway, can be assessed by indirect, static data. The essence of the method is to read the data obtained when a vehicle passes through special checkpoints. It means that in such points in addition to diagnostics of the vehicle and its identification, the reading of the stored data about vibrations measured by sensors of the vehicle while passing on the given section of the highway, with reference to geographical coordinates is carried out. Analysis of these data and their statistical processing provides information about the average operating characteristics of the road section.

## V. CONCLUSION

Therefore, the potential for complementing existing intelligent transport systems with methods and means of detecting faulty cars in the traffic flow is considered. We discussed options for building such solutions, of which the system using RFID tags can be considered the most objective and complete. However, it should be noted that the use of such a system leads to the vulnerability of the vehicle through a possible change in the settings of its units and assemblies. The combination of the license plate recognition function of the Intelligent Transportation System and the use of a radio link to read the data removes this problem, and expands the functionality. What's more, the radio communication system can provide greater transmission range than the RFID-based option. However, this solution will require the development and tuning of a larger number of technical means of the vehicle.

The potential use of electronic means installed on vehicles moving in the traffic flow to assess the quality of road density on sufficiently long road segments is shown separately.


## ACKNOWLEDGMENT

Scientific research was carried out with the financial support of the Ministry of Education and Science of Russia Reg.number AAAA-A20-120102190039-6.


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