

PAPER • OPEN ACCESS

Drivers alert system in the conditions of information shortage

To cite this article: R S Glukhikh *et al* 2020 *J. Phys.: Conf. Ser.* **1515** 052009

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

Drivers alert system in the conditions of information shortage

R S Glukhikh, E V Grazhdantsev, V A Zeer, P A Rastovtsev and A I Elagin

Polytechnic School, Siberian Federal University, 79 Svobodny pr., Krasnoyarsk, 660041, Russia

Abstract. The article presents the results of an accident analysis in the Russian Federation. Trends in reducing the number of accidents have been identified, but over the past 5 years the severity of their consequences has remained at a high level, despite the development of vehicles active and passive safety systems. A new accident prevention system is proposed by informing drivers about the occurrence of an emergency in conditions of insufficient and limited visibility, based on measuring the parameters of the vehicle movement in real time using GLONASS / GPS technologies.

1. Introduction

The results of a statistical analysis of road traffic accidents in the Russian Federation (RF), Siberian Federal District (SFD) and Krasnoyarsk Krai (KK) over the past 5 years show a decreasing trend in accident rates in general, which is associated with the development of vehicles active and passive safety automatic tools, driver training systems, legislation and road infrastructure. At the same time, the share of vehicles collisions and the severity of their consequences in the form of the number of dead and injured per 1000 accidents remains at a high level due to the lack of physical ability to avoid collisions because of the vehicles high speeds at the moment of danger detection.

The aim of this work is to develop a drivers alert system while the vehicle is moving along public roads outside populated areas in the conditions of information shortage about the danger of collision with another vehicle that is moving in the same or opposite direction, approaching the intersection of roadways. The designed system is based on a complex of measuring the parameters modern tools of the vehicle movement using GLONASS / GPS technologies, the exchange of data between system objects (GSM, Internet) and the analytical calculation of the safe distance between road users taking into account the terrain map and traffic conditions.

2. Accident analysis

The authors of the article, on the basis of official accident data in the Russian Federation, analyzed the accidents in the RF, SFD and KK from 2014 to 2018 and 11 months of 2019 [1]. Over the past 5 years in the RF there has been a decrease in the number of accidents, deaths and injuries in them. The same trend is observed in the SFD and KK.

Annually, of the total number of accidents, the largest number (about 40%) are collisions.

The number of deaths as a result of collisions has also tended to decrease over the past 5 years, but their share in the total number is about 40% for the RF and the SFD. Moreover, in the KK, half of deaths in road accidents accounted for collisions. A similar picture is observed in the case of the wounded. The proportion of wounded in a collision is about 50% both for the RF as a whole, and for the SFD and KK, in particular.



Over the past 5 years, the number of dead and wounded remains the highest in the KK among the regions of the SFD and make up about 17% of the total number in the SFD.

The statistical information used on road accidents in the RF is based on absolute indicators that do not allow to fully assess the real level of road safety.

At the same time, in world practice, relative indicators are used to determine the state of safety, which make it possible to more objectively measure the accident rate for a country, region, city or road section. To assess the safety level, the following measuring indicators are proposed on the example of the KK: the number of dead and injured per 1000 accidents.

Considering these indicators, it is noted that the number of deaths and injuries per 1000 accidents remains at a very high level throughout the country, the SFD and the KK. The average number of deaths each year is more than 100 people per 1000 accidents, i.e. in every 10 accidents at least 1 person dies. And the number of injured per 1000 accidents exceeds 1000 people, i.e. in each accident at least 1 person suffers.

In the comparison to the number of dead and wounded per 1000 accidents in general and in collisions, then in the latter case, the indicators are significantly higher in the KK for both categories, and for the RF and SFD only for the wounded (figure 1).

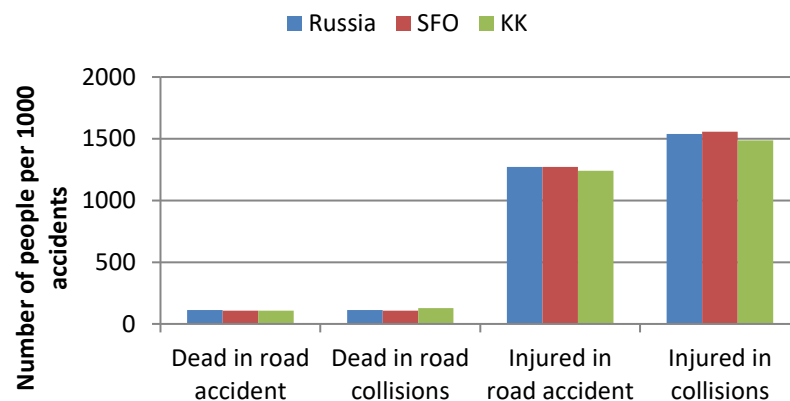


Figure 1. Comparison of relative accident rates.

The indicators proposed for measuring the level of road safety show that accident rate in the RF, SFD and the KK, despite the measures taken to ensure road safety, remains at a very high level. Moreover, the largest share of accidents is made up of vehicle collisions, which is additionally characterized by a high severity of consequences.

3. Classification of security systems

Road safety is ensured by affecting the main elements of the DCRE system (driver - car - road - environment). In this article, it is proposed to consider the active safety system of vehicles, taking into account all elements of the DCRE system [2]. Active safety systems are designed to warn drivers of dangerous situations, as well as to directly participate in driving when such situations arise due to vehicle system failures, adverse weather and unsatisfactory road conditions, erroneous driver actions.

Active safety systems can be classified according to the following criteria [3, 4, 5] (figure 2):

accident prevention method: informing (visual, sound, tactile), control;

source of initial information: video cameras, GLONASS / GPS sensors, ultrasonic sensors, electromagnetic odor sensors, laser sensors, infrared sensors, radars, lidars, sensors of the vehicle's internal systems;

source of potential danger: the car itself, other road users, road conditions, weather conditions, driver, traffic management equipment, obstacles);

implemented task: maintaining controllability, maintaining traction with the roadway, braking, informing.

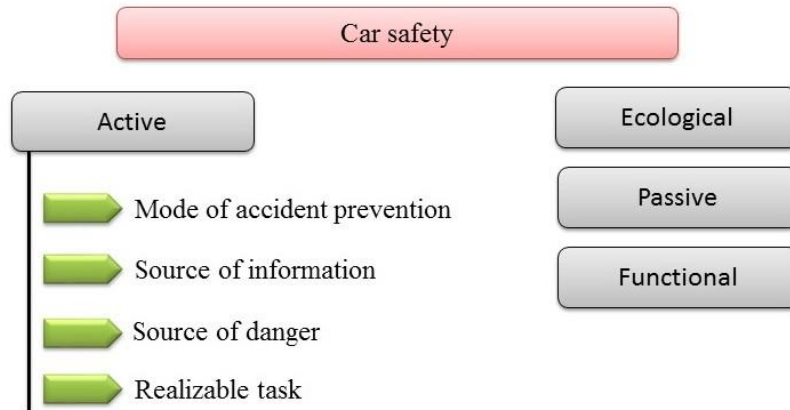


Figure 2. Classification of vehicle security systems.

According to the warning method, the most effective are active safety systems that are directly involved in the driving of vehicles, which helps to avoid incorrect driver decisions. But information systems, as a rule, record and identify a danger much earlier so that it can be eliminated by the driver on his own. In this regard, the presence of information (alert) systems is a prerequisite for the active safety of vehicles.

The intensive development of GLONASS / GPS technologies allows their efficient use in active safety systems, but their application is not widespread.

Based on the statistical analysis and the developed classification of active safety systems, it is of interest to study and design driver information systems using GLONASS / GPS technologies to prevent collisions by measuring the main parameters of the vehicle movement and determining their critical values [6].

4. Description of the designed system

The developed system is a multifunctional method for measuring and analyzing the movement parameters of vehicle in conditions of limited and insufficient visibility, with the ability to respond in the form of visual or audible alarms in the event of potentially dangerous situations.

An effective result of the system functioning is a guaranteed and timely notification of vehicles drivers about a possible collision in the conditions of visual information shortage (adverse weather conditions, difficult road geometry, steep ascents, descents, dangerous turns, etc.).

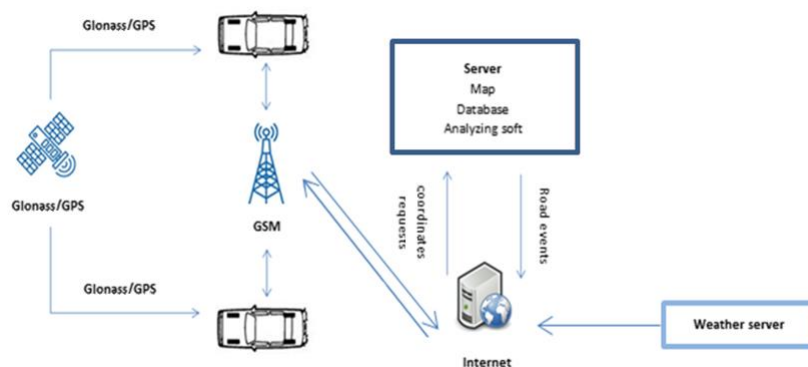


Figure 3. Schematic diagram of the vehicle driver warning system.

The developed system involves the use of satellite radio navigation systems GLONASS and GPS, with the ability to determine the location, direction of movement and high-speed mode of the vehicle. The system includes a GSM module that provides two-way transmission of information from a mobile or stationary device with Internet access, as well as a dedicated server, where the transmitted information from the vehicle is analyzed and evaluated to achieve critical indicators in which an accident can occur, and if necessary visual or sound information is provided (figure 3).

On the server for collecting and processing information through recorded key data about various parameters of the vehicle movement, such as coordinates of location, speed, direction of movement with reference to the available cartographic data, an algorithmic assessment of the probability of occurrence of the most common accidents, such as a collision with a passing vehicle, collision with oncoming vehicles and collision with vehicles leaving the secondary roads.

Algorithmic analysis involves working with several parameters that are taken into account in situational data processing, such as obtaining operational data on changes in weather conditions from meteorological sensors and open sources, followed by corrections for changing the state of the road surface, data from local sections with a difficult terrain, bearing a sharp change in heights and directions when using existing map services, such as Yandex and Google.

Based on the result of the algorithms work, the system decides to send notifications for a particular vehicle. Below are described the types of possible system notifications upon the occurrence of conditions of insufficient or limited visibility, as well as the conditions leading to emergencies.

4.1. Over speed

The system compares the maximum allowable speed of the vehicle in an emergency section with the speed of the vehicle participating in the exchange of information with the server. In case of exceeding the maximum permissible speed on the section of the route, the driver (s) will receive a notification about movement in the area of increased accident rate and a request to reduce speed (figure 4).



Figure 4. Example of speeding notification.

4.2. Unfavorable road conditions.

In conditions of insufficient visibility, the system notifies drivers of the need to reduce the speed to safe. In this case, a warning signal «Adverse weather conditions» is generated (figure 5).

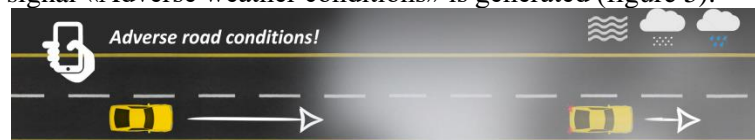


Figure 5. Example of adverse weather notification.

4.3. Risk of collision with a car.

The system determines the direction of movement and speed of the vehicle, including driving out of the lanes and, in the case of limited or insufficient visibility, based on the available algorithms for analyzing trajectories and calculating the minimum safe distance between cars, warns drivers who are nearing about a possible emergency situation (figure 6).

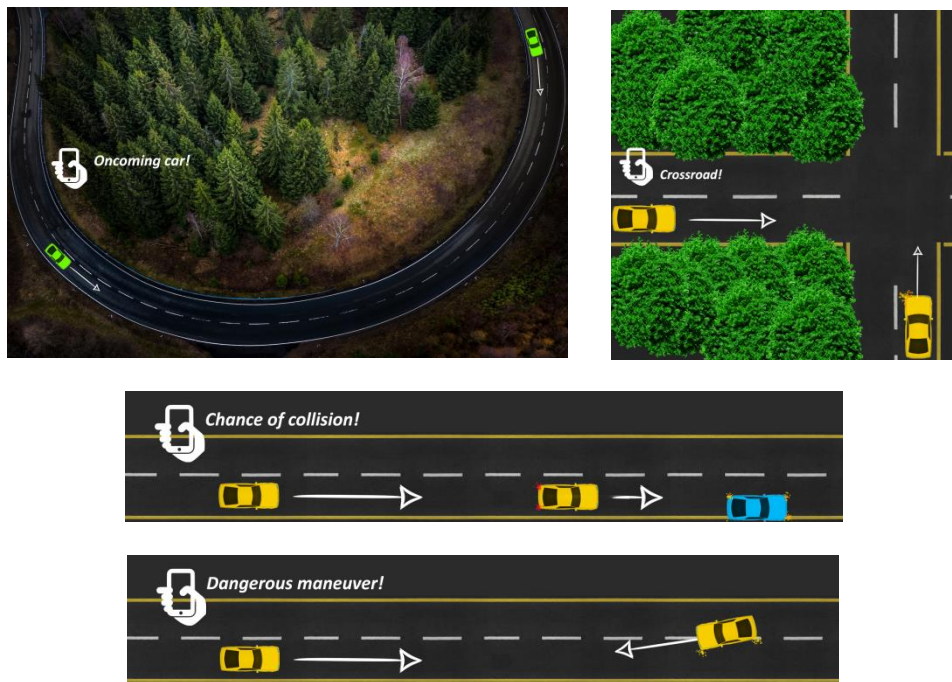


Figure 6. Notification examples of the collision danger.

5. System implementation diagram

The implementation of the developed system involves the use of the Client-Server architecture, in which server stores, processes the information and sends data. Request generation and receiving data is provided to the client side (figure 7).

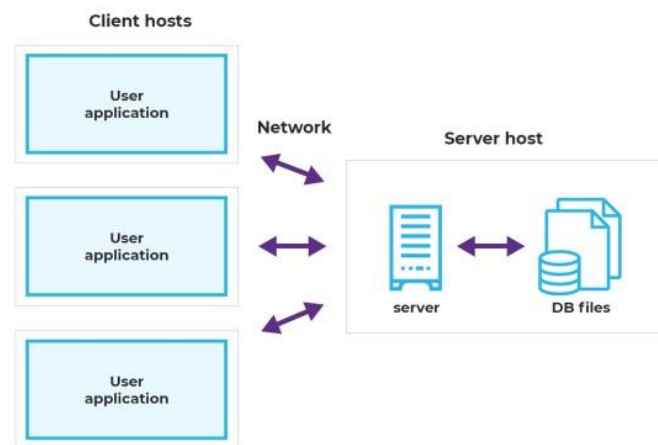


Figure 7. Scheme of the client-server system.

The client is a device that includes a control and data generation controller, a GLONASS / GPS module with an antenna, a GSM module with a SIM card, flash memory, a backup power supply, and a connection module for interface devices that carry out information output and control. This device includes client software with a user interface and a system of interaction with the server level of data processing.

One of the options for the «client» is a mobile phone. In the future, it is possible to use built-in on-board devices. The implementation of client software with a user interface and a system of interaction

with the server part, as well as other road users, is possible using the ANDROID operating system, which solves such problems as:

- multitasking and multifunctionality;
- high performance;
- end-user accessibility;
- ease of use and implementation of various functions;
- scalability and adaptability to growing requirements.

The server is a device that allows you to receive data from client programs and carry out operations for processing and preparing information for transmission to clients, and also contains various databases that store information necessary for the full functioning of the information. The mode of server part operation passes through data exchange via the Internet and the GSM channel.

In the proposed system on the server side, based on the available algorithms for analyzing trajectories and calculating the minimum safe distance between cars, situational information is generated that is provided to customers in the form of warning messages (figure 8).

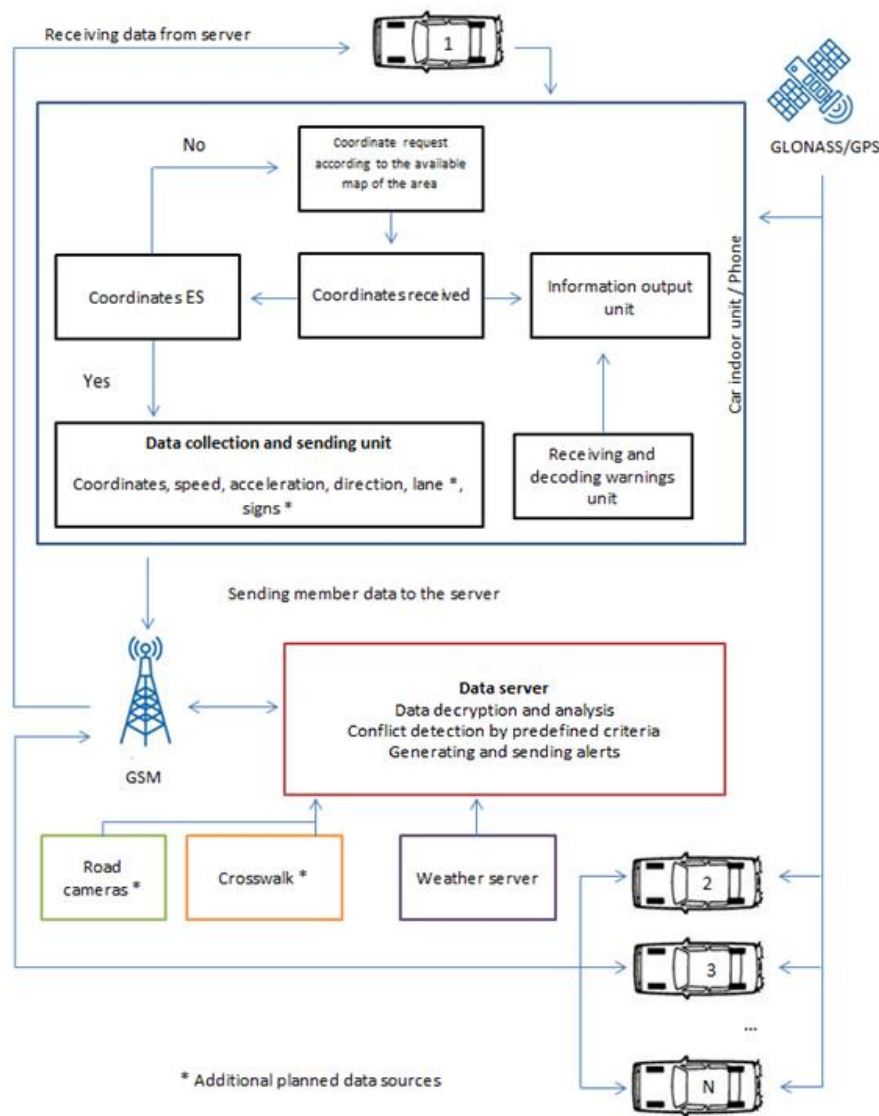


Figure 8. Functional diagram of the driver warning system.

For the developed system, it is necessary to determine the input and output parameters that determine the operation of the algorithms, as well as affecting the response of the system when certain events occur and determining the sending of warning messages described above.

The client part of the developed system always receives strictly defined initial data, including the identification number assigned by the system, vehicle coordinates, speed, direction vector (it is also possible to use such service data in the future as the state registration number of the car, current time and other necessary for its identification), adjusted depending on the necessary working conditions. The input parameters for the client equipment will be service and warning messages from the server part of the application.

For the server part of the application, in addition to the input parameters from the client part of the applications, it is necessary to implement such input parameters as data on changes in weather conditions to adjust algorithms for changing the state of the road surface.

The work on the algorithmic road situation analysis of the developed complex server part is planned to be performed according to the following scheme (figure 9).

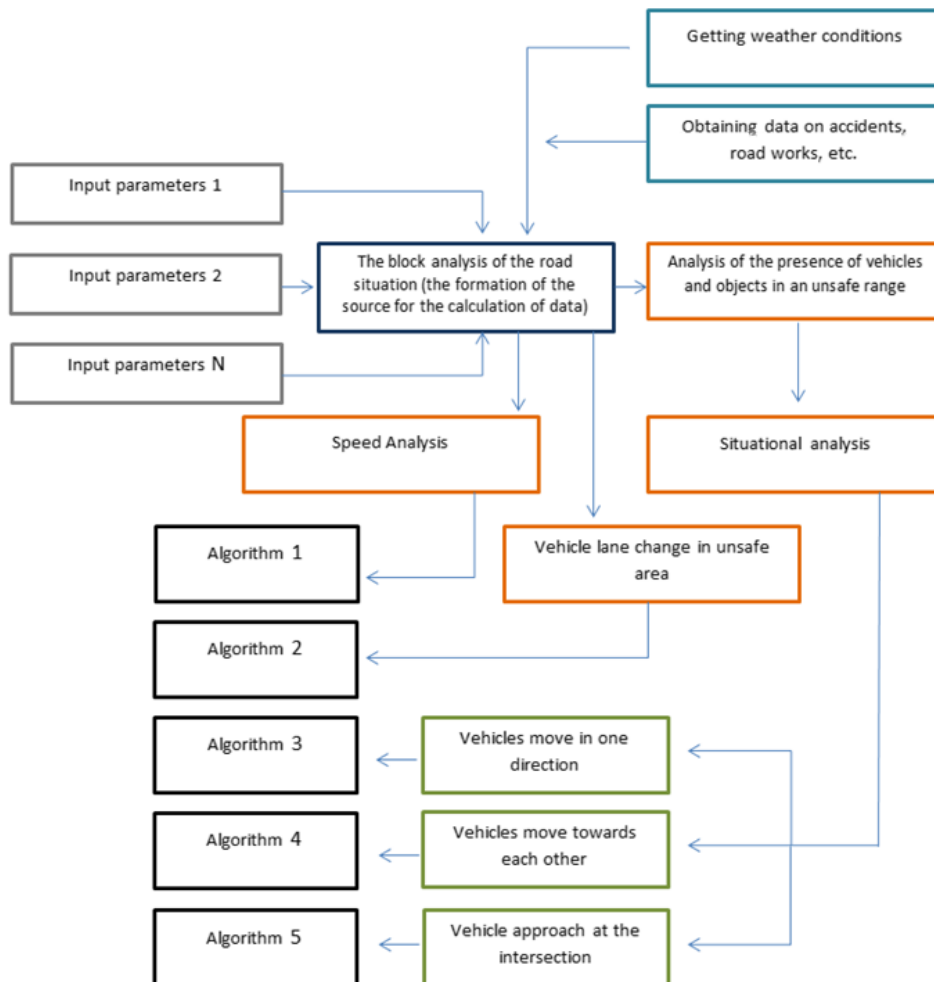


Figure 9. The scheme of the designed system algorithm.

6. Conclusion

The implementation of the developed system based on telematic data, the use of information transmission tools over GSM / Internet networks and the development of algorithms to prevent the occurrence of potentially dangerous situations, will provide drivers with an effective response tool in the form of visual or sound alarms.

Currently, it is planned to design the system through additional mobile devices, which does not cover all road users. At the same time, the development of special built-in stationary tools at the stage of automobile production will increase the number of vehicles involved in the system, which is promising, including for unmanned vehicles.

Further mathematical support of the designed system will allow to determine the exact parameters for the development of algorithms for analyzing traffic situations and their application.

References

- [1] Indicators of road safety The official website of the traffic police Retrieved from <http://stat.gibdd.ru/>
- [2] Mihalyova V N, Alekseeva O V, Gasilova O S and Sidorov B A 2011. Assessment of vehicle safety in the framework of the DCRE system. *News of the TSU (Technical Sciences)* **4** 220-7
- [3] Augustsson N and Wilhelmsson M 2010 *Verification of Collision Avoidance Functionality. A mileage multiplier approach to verify future Collision Avoidance Systems*. Technical report no EX034/2010 Retrieved from <https://odr.chalmers.se/bitstream/20.500.12380/148204/1/148204.pdf>
- [4] Sarajkin A I 2017 *Ensuring the safety of the vehicle in a situation of visual information shortage* (Orenburg)
- [5] National standard of the Russian Federation. *Intelligent transport system. Diagram of building the architecture of intelligent transport systems. Part 1. Service domains in the field of intelligent transport systems, service groups and services* (approved and put into effect by the order of Rosstandart from 31.08.2011 No. 251-st)
- [6] Wang W, Zhao D, Han W and Xi J 2018 A Learning-Based Approach for Lane Departure Warning Systems With a Personalized Driver Model *IEEE Transactions on Vehicular Technology* **67(10)** 9145-57