

# Prospects of scientific research in the field of active and passive safety of vehicles

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**Abstract.** Road traffic injuries cause colossal socio-economic damage to the society as a whole and irreplaceable losses for injured persons and their relatives. Huge amount of road and transport accidents are caused by human error. The paper studies statistics of road accident rate and influence of human factor on safety. In connection with revealed direct dependence of accident rate and the severity of its consequences on the driver errors, the evolutional path from vehicles without automation of any functions to entirely autonomous vehicles is considered in the paper. In continuation of the dynamic evolution of vehicles, the perspectives for the development of active and passive safety of vehicles are proposed. Reducing the need for full or partial control of a car by the driver provides ample opportunities for people with disabilities to use them, which is an additional incentive to the development of autonomous vehicles. Due to the existing difficulties caused by the unavailability of either road users or legislative or regulatory authorities for switching to autonomous vehicles, there may be scientific and related problems in their implementation in the Russian transport system.

## 1 Introduction

It is impossible to imagine the life of modern society without automotive technologies. Since the appearance of the first car was aimed at improving safety, technical and operational performance and comfort, it allows us to use now high-tech and reliable cars that can save lives of drivers and passengers in an emergency.

The constant development of motor vehicles and the increase in the level of motorization directly affects the safety of road traffic, namely the accident rate and related road traffic injuries. Statistics of road accidents remains quite high both in the world and in the Russian Federation.

One of the tools to increase the level of road safety and reduce socio-economic damage from road accidents in the RF should be the Federal target program «Improving road safety in 2013-2020». Its analogue (the Federal target program «Improving road safety in 2006-2012») was implemented in 2012, the success of its implementation can be judged by considering table 1 [4,5,6,8].

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**Table 1.** Results of the Federal target program «Improving road safety in 2006-2012».

		2006 year	2007 year	2008 year	2009 year	2010 year	2011 year	2012 year	In total	
The number of persons killed in an accident, people.	Forecast in the absence of FTP	35 800	36 500	37 200	37 900	38 600	39 300	40 000	265 300	
	The value of the index in accordance with the Federal	34 500	34 500	33 500	31 300	27 600	24 900	23 000	211 342	
	Actual value of the indicator	32 724	33 308	29 936	26 081	25 008	26 443	26 359	199 859	
	Deviation from the actual value of the planned	-1 776 (-5,1%)	-1 192 (-3,5%)	-3 564 (-10,6%)	-5 219 (-16,6%)	-2 592 (-9,4%)	+1 543 (+6,2%)	+3 359 (+14,6%)		-11 483 (-5,4%)
	Reduction of the actual indicator relative to the projected one, in the absence of FTP	-3 076 (-8,6%)	-3 192 (-8,7%)	-7 264 (-19,5%)	-11 819 (-31,2%)	-13 592 (-35,2%)	-12 857 (-32,7%)	-13 641 (-34,1%)		-65 441 (-24,7%)

As a result of the implementation of the Program, a decrease was achieved in comparison with 2004:

- transport risk by 44.8%;
- social risk by 22.7%;
- severity of the accident consequences by 24.0%;
- number of children killed in road accidents by 37.2%;
- reduction of the number of road accidents with victims by 10 thousand vehicles by 29.8%.

## 2 Existing solutions

The Federal target program "Improving road safety in 2013-2020" provides for the achievement of the goal (reducing the mortality rate due to road traffic accidents by 2020 by 8 thousand people (28.82 percent) compared to 2012 (as amended by the Decree of the RF Government dated 11.10.2016 №1031)) by implementing the following «packages»:

- 1) measures aimed at the development of the system of prevention of dangerous behavior of road users
- 2) activities aimed at ensuring the safe participation of children in road traffic
- 3) measures aimed at improving the technical condition of the vehicles in operation, their active and passive safety
- 4) activities aimed at the development of the system of traffic management of vehicles and pedestrians, improving the safety of road conditions
- 5) measures aimed at the development of the system of assistance to victims of road accidents
- 6) activities aimed at improving the legal, organizational and methodological support of activities in the field of road safety.

The results of the Federal target program "Improving road safety in 2013-2020" for 2018 are presented in table 2.

**Table 2.** Results of the Federal target program «Improving road safety in 2013-2020».

Year	2012	2013	2014	2015	2016	2017
Road traffic accident	203 597	204 068	199 720	184 000	173 694	169 432
Dead	27 991	27 025	26 963	23 114	20 308	19 088
Injured	258 618	258 437	251 785	231 197	221 140	215 374
The severity of the consequences	9,77	9,47	9,67	9,09	8,41	8,14

Detailed statistics of accidents in 2017: 169 432 accidents were recorded on the roads of Russia, which killed and injured 19 088 and 215 374 people, respectively. Of the total number of road accidents, 85% occurred due to the fault of drivers of vehicles and violations of traffic Rules, namely 143,458 accidents in which 15,691 people were killed and 191,648 people were injured. According to the General statistics of accidents, 85% of accidents were caused by drivers, and it is an unacceptable figure. This figure means a tragically large number of injured people on the roads of our country. It is necessary to decrease the number of accidents caused by drivers, constantly working on this problem, the solution of which lies in an integrated approach: the promotion of compliance with traffic rules, the development of intelligent transport systems, reducing the human factor, and reducing the possibility of driver error. The latter involves scientific research and, as a result, increasing the active and passive safety of vehicles. These works are represented by research and development studies implemented as a part of the program to improve road safety. One of the objects of research is the development of vehicle automation [4,7,9].

### 3 The evolution of automated cars

Today, people move on cars that are driven by them, but in the expected future, fully automated and self-driving vehicles passed through five levels of development (table.3) will be fully integrated into our life. There are already cars on the roads that can not only inform the driver, but also prevent unsafe changing of lanes or approaching an emergency dangerous barrier.

**Table 3.** Development of vehicle automation.

1	1950 – 2000	Safety/convenience	Three-point safety belt
			Airbag
			Anti-lock braking system (ABS)
			Cruise control
2	2000 – 2010	Advanced security features	Electronic stability control (dynamic stabilization system of car – ESC)
			Control of «dead» zones of the car
			Warning about the danger of collision with the vehicle in front
3	2010 – 2016	Advanced driver assistance features	Lane control system
			Rear view camera
			Automatic emergency braking
			Automatic emergency braking to prevent pedestrian collision
4	2016 – 2025	Partially automated security features	Reversing assistance system
			Adaptive cruise control
			Driver assistance assistant
5	2025+	Fully automated security features	Automatic Parking

Accordingly, the process of development of vehicles provides a path from complete lack of automation (it all depends on the attention, decisions, and actions of the driver) to full autonomy (automated vehicle operates completely independently, without the active participation of the driver) [1,2,3].



*Without automation*  
The driver performs all functions



*Help the driver*  
The car is under the driver's control, but some auxiliary systems may be present



*Partial automation*  
The car has a combination of automated functions such as acceleration and steering, but the driver remains involved in the driving process and is constantly obliged to monitor the situation on the road.



*Conditional automation*  
The driver is required to monitor the situation on the road and must be ready to take control of the vehicle at any time after notification.



*High level of automation*  
The car is able to perform all functions under certain conditions. The driver has the ability to control and drive the car.



*Full automation*  
The car is capable of performing all driving functions in all conditions. The driver has the ability to control and drive the car.

The safety benefits of automated vehicles are of paramount importance. Automated vehicles have the potential to eliminate human error, which is able to protect drivers and passengers, as well as cyclists and pedestrians. With a significantly high and tragic number of people killed and injured in road accidents related to the human factor, vehicle automation is a vital advantage of driver assistance technologies. Reducing the accident rate entails a positive socio-economic effect based on the reduction of downtime of the vehicle not directly involved in the accident, but caught in traffic congestion due to the presence of an accident on this section of the road. The socio-economic effect in this case is to reduce the spent fuel, reduce the number of cars caught in a traffic jam, reduce harmful gases to the environment, and increase productivity in the workplace of passengers and drivers of the vehicle.

## 4 Prospects and challenges

According to official statistics, there are 12,261 million people in Russia with the recorded I, II or III group of disability. Today, not all citizens of this category have the opportunity to move by car. The introduction of automated vehicles in the transport system of Russia would significantly increase the mobility of people with disabilities for health reasons and, possibly, would provide them with jobs and wages.

The use of fully automated vehicles on the roads has a number of difficulties associated not only with the difficulty of scientific research in this area [10,11,12].

Car manufacturers must comply with national and international standards for the safety of motor vehicles and confirm that the produced car is free from safety risks. Today, many companies are testing the latest automated vehicles to ensure that they operate normally, but much remains to be done to ensure their safe operation before they become available to a wide range of motorists.

Advanced vehicle safety technologies depend on the selection of electronics, sensors and processing power. The development and study of the potential of fully autonomous vehicles should be focused on cybersecurity in order to avoid outside interference in the control unit of an autonomous vehicle [13-16].

No less acute is the question of responsibility for the actions and consequences of the actions of an autonomous vehicle – who will be responsible in case of an emergency on the road – the owner, the developer-manufacturer, or the organization serving this vehicle?

Thus, scientists in the field of transport will have to carry out extensive research and design work to solve many related issues, but, as a result, it will allow automated vehicles to significantly improve the standard of living of people, their safety and alleviate significant social difficulties.

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