The introduction of unmanned automotive vehicles in Russia

N A Filippova, T E Melnikova and R V Litvinenko

Moscow automobile and road state technical University (MADI), 64 Leningradsky Ave., Moscow, 125319, Russia

E-mail: umen@bk.ru

Abstract. The article presents the modern concept of an unmanned vehicle according to the SAE classification. The features of use of unmanned transport, including its influence on traffic safety, efficiency of the organization of transportations and decrease in fuel consumption are considered. A brief overview of existing Russian developments in the field of unmanned road transport is given. The scheme of movement of an unmanned vehicle through the ice crossing using V2X technology is presented. The authors list the reasons of using unmanned vehicles on public roads.

1. Introduction

In today's world, unmanned technologies in transport are becoming increasingly common. Especially clearly their development is manifested in the automotive sector, where in recent years the spread of drones has increased significantly. Many large companies working in the field of road transport, such as BMW, Volkswagen and Tesla, are actively implementing automated control systems in their products. Unmanned technologies are one of the most markedly progressive areas of scientific and technological progress in road transport, and it is likely that over the next decade they will organically join in everyday life, so their consideration in this article is relevant.

2. The modern concept of an unmanned vehicle

An unmanned vehicle, in its simple definition, is a vehicle equipped with an automatic control system that can move without human intervention. However, at this stage of development of such cars there is the peak of popularity, and each company offers its own set of technical solutions, which leads to a difference in the degree of automation in cars of different manufacturers.

For the convenience of classification of the Community of automotive engineers (Society of Automotive Engineers, SAE) developed the standard for automated traffic control systems [1], which is widespread. The classification according to this standard is presented in table 1.

3. Features of the use of unmanned vehicles

The human factor in driving still plays a key role in creating emergencies. According to the annual statistics of the traffic police for 2018, a significant part of the accident was caused by the driver.[2]

On the contrary, an accident with participation of unmanned vehicles, which occurred due to the fault of the automated system, has not been recorded at this time. In Russia, there is no database on accidents with unmanned vehicles due to the lack of such vehicles on public roads. However, the experience of foreign companies shows that their unmanned vehicles get into an accident due to the fault of other road users.
### Table 1. Classification of unmanned vehicles according to the SAE standard

| No. | Name                      | Definition                                                                 | Degree of automation |
|-----|---------------------------|---------------------------------------------------------------------------|----------------------|
| 0   | manual vehicles           | The driver continuously drives the vehicle (vehicle), even if it is improved by warning and intervention systems | no                   |
|     | Driver assistance system  | The automatic assistant in a particular driving mode performs either steering or acceleration / deceleration using information about the driving environment, assuming that the driver will take over all other aspects of vehicle control | Partial automation   |
| 2   | Partial automation        | In a particular driving mode, one or more driver assistance systems perform both steering and acceleration / deceleration using information about the driving environment, assuming that the driver will take over all other aspects of vehicle control | Partial automation   |
| 3   | Conditional automation    | The system controls all aspects of driving provided that the driver confirms the system's request for intervention | Partial automation   |
| 4   | High automation           | The system controls all aspects of driving, even if the driver does not respond to the system's request for intervention | Partial automation   |
| 5   | Full automation           | The system controls all aspects of driving that the driver could take on, under any road conditions and environmental conditions | Full automation      |

When transporting goods in columns (platoons) there is a decrease in fuel consumption (figure 1). Scania tests have shown that driving trucks using “platoons” can reduce fuel consumption by up to 12 percent [3].

![Wireless communication between trucks](image)

**Figure 1. Movement of trucks “platoons”**

It is also important to take into account the time that the driver spends in the outfit when transporting goods. According to the mode of work and rest of drivers, the travel time should not exceed more than 8 hours, while the period of continuous driving is 4 hours. The use of unmanned trucks will increase the speed of delivery due to the continuous driving of the vehicle.

It should also be borne in mind that the automated system would be able to identify the optimal route of transportation faster than a person, as it is able to continuously process information from a large number of sources and take it into account in the coordination and management of traffic flows. Evaluation and application of optimal routes will improve traffic and reduce the load on public roads.

### 4. Development of unmanned vehicles in Russia

Russia is actively developing unmanned road transport, both in the passenger and cargo sectors, which are not only the choice of manufacturing companies, but also supported by the state. Thus, in 2016, the national research initiative "Avtonet" was established and the state plan for the development of the market of electric vehicles and unmanned vehicles until 2035 was approved.
The most notable successes of Russian drones in the passenger sector in passenger transport. Thus, the company "Yandex" presented its unmanned taxi back in 2018, and at the moment actively continues its test in various conditions. In the test area SKOLKOVO, an unmanned vehicle can be called through the application Yandex.Taxi [4].

In addition to Moscow, Yandex drones also travel to Tatarstan. Innopolis became the first city in Europe where you can use the drone for everyday trips. Despite the automated control of the vehicle, there is a test engineer in the cabin, ready to take control of the vehicle if necessary.

In addition to a taxi in Russia has experience of transporting passengers in driverless buses. In 2018, the manufacturer of trucks "KAMAZ" demonstrated in Kazan, the prototype of an unmanned bus a "SHUTTLE". For unmanned bus has built a separate closed track, with a length of 650 meters. Unfortunately, at the moment these vehicles are not widely used, but the development in this direction continues [5].

Not without attention and freight transport. An unmanned truck was presented at the St. Petersburg international economic forum (SPIEF). The KAMAZ company plans to start using the first unmanned truck for intra-plant transportation in 2019. The Ministry of transport also noted that the use of unmanned trucks, for example, on the route from St. Petersburg to Moscow, will reduce the cost of transportation by 60%. It is assumed that initially unmanned vehicles will be launched on dedicated lanes, and then gradually transferred to such a mode all the way [6].

5. Prospects for the use of unmanned vehicles in the Far North

In addition to the common types of vehicles and developers are engaged in the creation of atypical – for example, all-terrain vehicles. This direction is important for Russia, which has a large area with low traffic. The far North of the Russian Federation and equivalent areas occupy about 70% of territory of Russia the Importance of the North for economy is primarily determined by the raw potential [7].

Unmanned Rover Snowbus introduced the company Volgabus in June 2019. The all-terrain vehicle is designed for use in all conditions thanks to the large wheels and the 8x8 formula (figure 2).

![Snowbus unmanned all-terrain vehicle](image)

Figure 2. Snowbus unmanned all-terrain vehicle

It is reported that the "polar bus" can go on snow, ice, ice, creating low pressure on the surface. Also, the all-terrain vehicle can swim on the water, overcome vertical obstacles up to 1.6 meters high and crevices up to 2 meters wide. The all-terrain vehicle is designed to carry passengers, but the
presence of this development suggests that companies are interested in creating such vehicles, which in the future will be able to provide year-round transport links in the Northern regions [8].

The Northern regions of the Russian Federation are characterized by off-road, a large number of obstacles in the summer are very frequent cases of heaving roads, the formation of cracks, potholes, bumps and as a result – increased wear of the roadway.

Where the density of the road network is less than 0.3 km per 1 km² of the territory, the main accident rate increases sharply – the number of people killed per 10 thousand vehicles [9].

Ice crossings are one of the most dangerous types of seasonal roads, despite the serious measures to ensure the safety of people and goods during their operation, many cars fall under the ice every year. Proof of the seriousness of the security situation on the ice crossings can also be considered presented by the Road research Institute GOST project for ice crossings and winter roads [10].

Human security is one of the priorities in the development of unmanned vehicles. The use of this technology would reduce the level of danger on the roads of the Far North, for example, with the introduction of V2X systems.

The "car-anything" (V2X) concept uses the latest generation of information and communication technologies to implement the omnidirectional vehicle connection in the following configurations: "car-machine" (V2V), "car-infrastructure" (V2I), "car-pedestrian" (V2P) and "car-network" (V2N). This concept is schematically presented in figure 3.

![Figure 3. V2x technology](image)

This technology links various elements of transport, such as pedestrians, vehicles, roads and cloud environments, which can contribute to the creation of an intelligent transport system and contribute to the development of new modes of transport and new types of vehicles and transport services in the future. Improving road traffic efficiency following the introduction of such technology can not only save resources and reduce fuel consumption, which is extremely important in the Northern regions with their increased fuel consumption, but also to reduce the frequency of accidents and improve traffic management.

The principle of application of this technology is shown in the figure. A truck equipped with an autopilot is driven on safe sections of the road by the driver, but when driving through the ice crossing, the person leaves the cabin and then the car follows the dangerous part of the path on autopilot, focusing on the signal received from the network, another car or infrastructure element on the other side. After crossing the ice crossing, the driver takes over driving again (figure 4). The strokes indicate the section of the road on which the vehicle is controlled by the autopilot. In this case, the car as the data exchange with the infrastructure for the route, and betrays and receives information from other cars to calculate the safe distance between them when driving.

Despite the actively ongoing development of unmanned road transport and its advantages over equipment controlled by a human driver, in Russia there are a number of factors that prevent the rapid emergence of this technology on public roads. Among them there are significant initial investments caused by the high cost of development and components and imperfection of infrastructure, but the most important of them is the lack of documents regulating this type of transportation.
The main question facing legislators is who should be responsible in case of an accident. At the current stage of the introduction of drones in the car is a driver who is able to take control if necessary, which allows you to register his responsibility in the legislation.

However, such changes will only delay the solution of this problem until the time when the machines reach the 5th level of SAE automation, in which the control of driving is completely carried out by the control system without human intervention. If we take into account the growth rate of development of unmanned technologies, we can confidently conclude that will happen in the next decade.

6. Conclusion
Unmanned technology is steadily gaining its niche in the field of road transport. Many companies offer their technical solutions for automation of car control, including in Russia. At the moment, the Russian Federation is developing both passenger and freight transport, but before the appearance of these cars on public roads, it is necessary to solve a number of problems, first of all, to create a legal framework for this type of transportation.

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