

## AUTONOMOUS TRANSPORT OF THE FUTURE

**Yevdokymenkova K.A.**

*National Aviation University, Kyiv*

*Scientific adviser - Yanchuk M.B., doctor of Economics, professor*

**Keywords:** *autonomous car, unmanned vehicle, autonomy, development, driving.*

The idea of autonomous car control has existed for almost a century. However, only now advances in sensors, efficient drives, new materials, and increased computing power led to the realization of this idea.

Unmanned land transport is a reality of the coming years. Unmanned, autonomous, as well as highly automated – so-called vehicles that do not need a person as a driver. These are not only cars, but also trucks, trains, agricultural machinery and forklifts, which are controlled by an automated driving system that takes on decision-making, interaction with the environment and safety [1]. Full autonomy is what the development of unmanned vehicles strives for, but this requires 5 levels of automation:

Level 0: Complete lack of automation (driver controls the steering wheel and gas).

Level 1 "Driver Assistance": The car has advanced driver assistance systems that control steering or speed (for example, adaptive cruise control, which automatically accelerates and decelerates the car based on data from other vehicles on the road).

Level 2 "Partial automation": The autonomous system controls both steering and speed under certain conditions. But the driver must constantly monitor the situation and be ready to intervene at any time if the system is unable to respond properly.

Level 3 "Conditional automation": The system is capable of driving without human tracking and response, but can ask the driver to intervene. Then he should be able to constantly monitor the situation, despite the higher level of autonomy of the machine.

Level 4 "High automation": The system fully controls the traffic under certain conditions, but if all conditions are not met the vehicle stops moving (for example, may require manual control when leaving the road).

Level 5 "Full automation": The car moves without the participation of the driver in any conditions (i.e. anywhere and anytime) [2].

Thus, the stimulus for the development of unmanned vehicles in 2021 was a pandemic. Under the new conditions, the demand for delivery and transport without human contact has increased. The development of unmanned vehicles is the subject of work in most countries. The use of unmanned technologies will affect the work of postal and courier services, the delivery of food to urban areas. Falling delivery costs

will lead to wider changes in consumer and business behavior. For example, the retail sector is less likely to shop at local 24-hours shops, while the number of "dark kitchens" (restaurants without the physical presence of customers) will increase. The proliferation of autonomous vehicles can increase public confidence in the autonomy of all species. According to PwC (an international network of companies offering consulting and auditing services), the first autonomous cars will appear on public roads in 2021. Their autonomy will be incomplete, the driver in some cases will have to control the driving process. The projected volume of the global market for autonomous cars and trucks by 2021 is 6700 units. The use of fully autonomous vehicles by 2025 can reduce the number of accidents by 90% and partially vehicles – by 40%, saving 30000 lives per year. In 2030, vehicles will completely cease to be needed by man. According to PwC analysts, by 2040 a completely unmanned transport infrastructure will be created in large cities. At the same time, all cars will become electric cars, which will have a positive impact on the environment [3].

In order for a car to become unmanned, developers use different sets of components depending on the tasks and operating conditions. The technologies used to create an autonomous vehicle are aimed at solving 3 global problems: building a local map and identifying objects from the environment; global positioning on the world map; processing of information on the basis of which decisions on vehicle actions are made. Specialized artificial intelligence is the "pilot" of an unmanned vehicle. He drives the car and makes decisions along the way, receives and processes information from other systems. Stereo cameras receive and form 3D images using CMOS (complementary metal oxide semiconductor) and CCDs (charging device) technologies used to determine the range of objects. Cameras receive visual information such as road signs and traffic lights. Radars use radio waves to determine the range of the object, their speed and location. LIDAR (light detection and range) uses light as a pulsed laser. Lidar sensors send 50000-200000 pulses per second to cover the area and compile the signals returned to the three-dimensional cloud of points. Satellite navigation allows you to track the location of the car on a world map, build a route. Most autonomous car developers try to build their cars without regard to infrastructure development.

The drone in 2021 just needs a quality road, and most tasks the driving system will solve on the basis of data coming from lidars, radars and other sensors on board the car. The need for specialized infrastructure will increase as more and more unmanned vehicles become available on public roads.

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