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DRIVER OR AUTOPILOT – WHO IS THE FUTURE

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Abstract. The human factor is the main element in the production of road events, not only in terms of percentage, but also in absolute importance, because, ultimately, road and technical issues are involved in road accidents only in strict accordance with the behavior and the direct action of the driver, who, within the road traffic system, is more variable and unpredictable than the vehicle, road and environmental factors. The driver is guilty of 70-90% of the total number of road accidents. More than a third of people killed and injured in road accidents worldwide are drivers. The article describes the role of the driver in the DVRE system, the risk factors and the causes contributing to the occurrence of road accidents. A brief analysis of road accident statistics due to drivers in the Republic of Moldova and around the world is performed. It also describes the evolution of the unmanned car and other innovative technologies and ideas for automating car driving.

Keywords: *driver, autopilot, road accidents, traffic accidents, traffic safety.*

Rezumat. Factorul uman constituie elementul principal în producerea evenimentelor rutiere, nu numai din punct de vedere procentual, dar şi ca importanţă absolută, pentru că, în ultima instanţă, aspectele rutiere ca şi cele tehnice sunt implicate în accidentul rutier numai în strictă concordanţă cu comportamentul și acțiunea nemijlocită a conducătorului de vehicul, care, din sistemul de trafic rutier este mai variabil şi imprevizibil, decât factorii vehicul, drum și mediu. Conducătorul auto este vinovat în 70 - 90% din numărul total de accidente rutiere. Peste o treime din cei decedați și traumatizați în accidentele rutiere în întreaga lume sunt conducători de vehicule. În articol este descris rolul conducătorului auto în sistemul CVDM, factorii de risc și cauzele contribuitoare la producerea accidentelor rutiere. Este efectuată o analiză succintă a statisticii accidentelor rutiere din vina conducătorilor auto în Republica Moldova și în întreaga lume. De asemenea, este descrisă evoluția automobilului fără pilot și altor tehnologii și idei inovative privind automatizarea conducerii automobilului.

Cuvinte cheie: *conducător auto, autopilot, accidente rutiere, accidente de circulație, siguranța circulației.*

Road safety depends on the safe operation of all components of the „*Driver – Vehicle – Road – Environment*" system. The reliability of this complex system must be ensured by the technical perfection of the road and the reliability of the car, as well as by the safety of the driver's actions in different traffic situations. The main element of this system is the driver, whose reliability means the ability to choose correctly and in a timely manner the most optimal traffic regime and to assess the road situation.

According to the *Road Traffic Regulations*, the driver is the person who drives a vehicle on public roads, an organized group of people, accompanies isolated animals, burdens, riding or herds, herds etc., as well as the person who conducts training in driving [1, 2].

The driver is the factor that most influences the traffic conditions. In heavy traffic, the driver performs the function of a traffic controller, following the legal speed and correct distance from the vehicle in front, correctly assessing the distance and speed of overtaken vehicles and those coming from the opposite direction, as well as distances and intervals in relation to the overall dimensions of the driven vehicle.

In addition to knowing and respecting the rules of road traffic, the driver must have a good command of the driving technique, which requires a long practice, so that the driver is able to solve without difficulty the difficult situations of increasing crowded road traffic. Traffic safety depends directly on the driver's attention and vigilance, on his ability to anticipate all possible situations, which could lead to an unwanted road accident, as well as to sense measures to prevent it. The driver must also know how to act in situations when, for fortuitous reasons, the road accident could occur in order to minimize its consequences.

It turns out that the main role in road traffic is played by the human factor, first by the driver, beginner or experienced, amateur or professional, being important the way in which he participates, actively engaged in traffic, in the mechanical tumult of the street. Therefore, anticipating situations that may lead to accidents, avoiding the accident that is about to occur or engage in a traffic event, as well as choosing the best option for getting out of an accident that cannot be avoided with a minimum of consequences, represents the basic norms of traffic and preventive conduct.

Experience shows that drivers could avoid many road accidents if [3, 4]:

- would anticipate the actions taken in the next seconds by pedestrians engaged in crossing without insurance or those who suddenly appear from the sidewalks on the road;
- would take into account the behavior of children and the elderly near the road;
- would take into account the behavior of some drunk pedestrians stopped on the road or crossing it;
- would take into account the unexpected maneuvers of cyclists and other road users;
- would take into account the dangers that may occur when driving near parked cars;
- would drive at adequate speeds in all places with limited field of vision;
- would anticipate the dangers that may arise in the process of driving a car with an advanced degree of wear;
- would keep the tracking distance while walking in the column depending on the speed, the condition of the road surface, visibility etc.

Anticipation is thus of great importance in driving the car, the human factor having at its disposal this „*tool*” to help achieve a safe and smooth flow.

The rapid increase in the number of cars, which currently amounts to about 1,2 billion worldwide [5 - 7] and 1,2 million in the *Republic of Moldova* [8], requires a proportionate development of the driver training system, which takes place in various educational institutions, many of them without the necessary material and technical basis, as well as, highly qualified teaching staff. In this sense, in the process of road traffic takes place selfeducation, learning and retraining of an important part of drivers. Naturally, as the density and intensity of road traffic increase, this phenomenon complicates in particular the task of ensuring road safety.

Given the current traffic conditions, the driver must respond quickly and promptly to a wide range of external stimuli, assimilate and continuously process a large amount of information, which sometimes exceeds its physiological possibilities, and then make appropriate decisions. to perform command actuation movements.

In countries with heavy road traffic, it has been found, that the average frequency of various information, processes, situations and events to which a driver's attention is subjected has high values. Thus, he receives an average of 125 information and makes 12 - 15 decisions per kilometer traveled, at 3,2 *km* he makes a mistake and is put in a position to avoid a collision at 800 *km*. The statistics also show that a collision is possible at every 100000 *km*, an accident with injuries at every 700000 *km* and a fatal accident at every 25 million kilometers. A survey of 100 drivers in *Hanover* showed that in urban traffic conditions, the driver receives an average of 62 pieces of information per minute (external stimuli) and has to make 35 - 40 decisions in this short period of time [3].

The ability of a person to carry out the professional activity of a driver is generally determined by the following qualities such as [9]:

- agility, endurance, physical development and good coordination of movements;
- ease in education and change of motor skills;
- high level of development of the functions of the sensory organs, especially of hearing, muscular sensation and sight;
- speed and accuracy of sensorimotor reactions;
- the accuracy and speed of determining the spatial relations and the speed of circulation;
- wide distribution, speed of switching and stability of attention;
- sufficiently good visual memory, as well as the high level of memory preparation;
- courage, determination and perseverance;
- inclination towards technical thinking, technology, interest in the professional activity of the leader;
- discipline, emotional stability and self-control;
- ingenuity and initiative;
- developed imagination, the ability to reflect and anticipate the actions of other traffic participants etc.

An analysis of accident statistics, including road accidents, in over 45 countries in the last 10 - 15 years shows that 75 - 80% of accidents in transport, production and daily life occur for three reasons: from the cause of „*unwillingness*", „*ignorance*" and „*incapacity*". The remaining 20 - 25% of accidents, including traffic accidents, occur due to adverse climatic and operating conditions, as well as reasons related to the technical condition of vehicles and mechanisms. The maximum number of accidents and casualties is due to car transport. It is the most dangerous type of transport – 12 times more dangerous than sea and river transport, 8 times more dangerous than rail transport and 4 times more dangerous than air transport [10].

According to estimates by the *World Health Organization* (*WHO*), approximately 1,4 million people die in traffic accidents each year, 30 to 50 million are injured with bodily injuries, of which about 17 million lose their ability to work or remain with disabilities. people [10 - 16]. More than a third of road accident victims worldwide are drivers (Figure 1). 29% of those who died in road accidents belong to drivers and passengers of cars, 28% to motorcyclists, 23% to pedestrians, and the remaining 20% – to other road users [12 - 16]. The situation varies significantly between regions of the world. In most low- and middle-income countries, the percentage of road accident victims, such as pedestrians, cyclists, drivers and passengers of two - and three-wheeled motor vehicles, is significantly higher than in high-income countries. For example, in the *WHO African Region*, 40% of all road accident deaths are due to pedestrians, and in the *WHO West Pacific Region* 36% are to motorcyclists, ie drivers and passengers of 2 - or 3-wheel motor vehicles (Figure 1). Drivers and passengers represent between 16% of those killed in road accidents in the *South-East Asia Region* to 48% in the *European Region*.

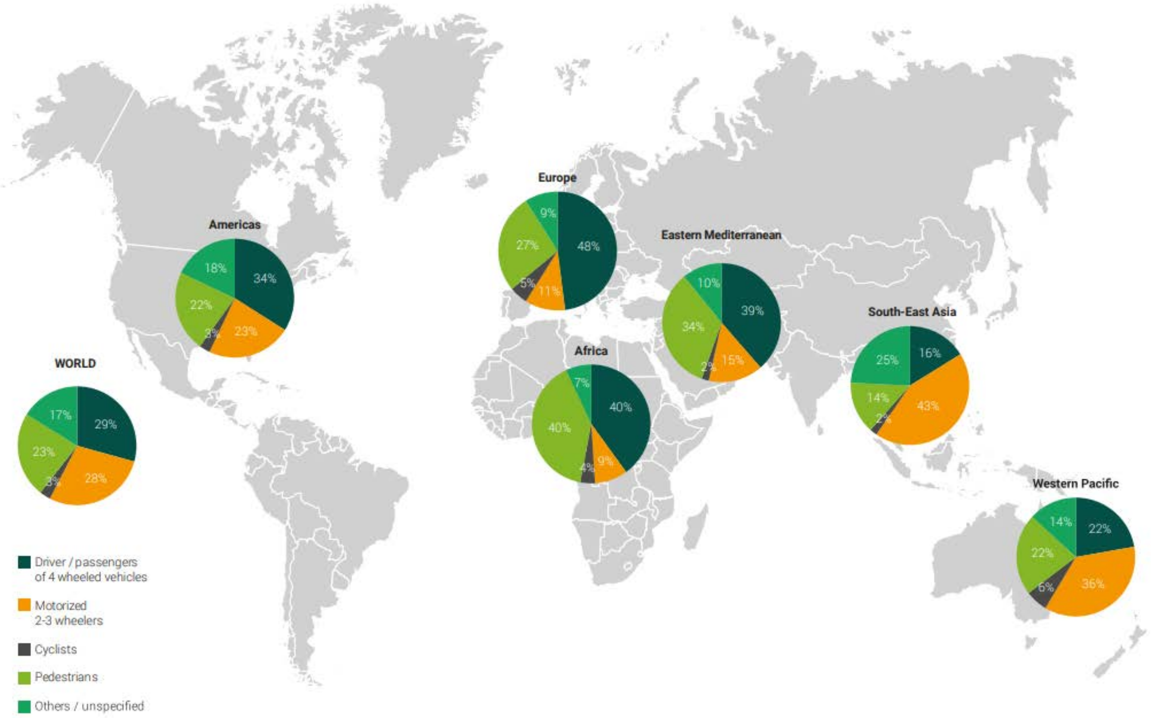

Figure 1. Distribution of deaths by categories of road users by *WHO* regions [10].

Worldwide 70 - 90% of the total number of road accidents occur due to drivers [3, 4, 10, 12 - 17]. From 35 to 40% of road accidents occur as a result of exceeding the vehicle speed above the set limit, 23-28% – due to carelessness of drivers and 15 - 20% – due to fatigue of drivers. From 45 to 50% of road accidents are committed by drivers, who have consumed alcohol and drugs [10].

Numerous special studies show that, depending on the degree of predisposition to danger, drivers can be divided into three categories: extremely reliable (safe) – 15-20%; potentially dangerous or prone to accidents – 7 - 12% and so-called indifferent drivers – 55-65%, which in some cases can lead safely, and in other circumstances can cause an accident [10]. However, such a classification does not allow the development of preventive measures at the individual level, as the driver's ability to ensure safe driving depends on individual characteristics, requiring a more detailed classification and analysis.

Based on complex studies [10], a parabolic dependence of road accidents has been established according to the age of drivers, according to which drivers are classified into: potentially dangerous – under the age of 25, dangerous – over 65, with medium danger – of at 25 to 30 years and from 55 to 65 years, less dangerous – from 30 to 35 years and from 45 to 55 years and relatively reliable (safe) – from 35 to 45 years. Also, as a result of the processing of statistical data, a curve was built, which shows the degree of danger of drivers depending on driving experience. According to these data, drivers can be divided into three categories depending on management experience: I – drivers with 10 - 25 years of work experience; II – with an experience of over 25 years; III – with less than 5 years experience. According to studies conducted in *England*, driving experience is more important than age. Drivers under the age of 30 with less than 4 years of work experience have 4 times more road accidents than drivers aged 60 - 65 with more than 14 years of experience.

The analysis of the road accident statistics during the years 2000 – 2019 in the *Republic of Moldova* (Table 1) indicates that on the territory of the country were registered 52383 (on average 2619 per year) serious road accidents, as a result of which 7702 died (385 per year) people, and another 63560 (3178 per year) were traumatized. The severity index of road accidents (the number of deaths per 100 victims) in the country as a whole in the reference period is 10,81 [2, 3, 6, 18 - 23].

According to statistics, most of the number of road accidents occurred through the fault of drivers: 44886 (on average 2244 per year, which is 85,69% of all road accidents in the country during the reference period).

Table 1

Frequency of road accidents (years 2000–2019)

Year	Road accident	Road accidents involving drivers	% of the total number of road accidents	Deceased	Traumatized	Coefficient of severity of road accident consequences
2000	2580	2128	82,48	406	3147	11,43
2001	2666	2219	83,23	410	3277	11,12
2002	2899	2327	80,27	412	3505	10,52
2003	2670	2166	81,12	424	3215	11,65
2004	2447	2170	88,68	405	2888	12,30
2005	2289	1975	86,28	391	2770	12,37
2006	2298	1989	86,55	382	2807	11,98
2007	2437	1976	81,08	464	2984	13,46
2008	2875	2215	77,04	508	3511	12,64
2009	2755	2324	84,36	487	3297	12,87
2010	2930	2604	88,87	452	3747	10,76
2011	2826	2480	87,76	443	3535	11,14
2012	2712	2435	89,79	441	3510	11,16
2013	2603	2281	87,63	295	3221	8,39
2014	2564	2209	86,15	324	3080	9,52
2015	2527	2278	90,15	297	3021	8,95
2016	2479	2267	91,45	311	2928	9,60
2017	2640	2322	87,95	302	2993	9,17
2018	2614	2265	86,65	274	3123	8,03
2019	2572	2256	87,71	274	3001	8,37
Total	**52383**	**44886**	**85,69**	**7702**	**63560**	**10,81**

Analyzing the violation of traffic rules committed by drivers, which lead to road accidents, it was found that the highest number of road accidents occurred because of the following causes:

- exceeding the set speed and speed unsuitable for road conditions [24];
- non-compliance with handling rules;
- not giving priority to pedestrians;
- driving the vehicle while intoxicated [19].

In the near future we could witness a real technological revolution, in which man-made cars will become part of history, and unmanned vehicles will come to replace them. *An unmanned vehicle* is called a robotic vehicle, capable of perceiving the environment and moving between the points of destination without the intervention of man (driver) [7, 25]. The fact that artificial intelligence will remove the man from driving is spoken about a lot and loudly. Currently, unmanned cars are recognized as the safest way to travel, and tomorrow may be the only choice for humanity. It could take 10-20 years for their dominance to become total.

The past of unmanned cars is no less interesting than their future. Today, the issue of the dominance of unmanned vehicles on the roads is no longer discussed – it has been solved long time ago. Now, some 40 - 50 years ago, there could be no question of passing control of the vehicle to a robot. These ideas seemed utopian to all, but the pioneers of the unmanned automotive industry.

It all started back in the 1930s, when *General Motors* engineers came up with two brilliant ideas from that period. The first idea was to drive the car with radio signals, and the second and more interesting was to build special tracks in the form of skateboard ramps [26]. Although the ideas were skeptical, they gave a strong impetus to the development of technology in the right direction.

The year 1961 went down in the history of unmanned vehicles, when *Stanford* student *James Adams* created and tested the first autonomous vehicle. It was directed by an ordinary signal through a cable. But already the second prototype was driven by radio signals.

This experiment did not go unnoticed and in the 70's of the last century, the famous scientist *J. McCarthy* introduced his corrections in the construction of the vehicle and modernized it with the help of a technological vision system. The vehicle could move independently and orient itself along the white line. The prototype was also equipped with a rangefinder, video cameras and 4 channels for data collection.

Following *McCarthy's* success, the engineers' efforts were directed towards creating a 100% autonomous vehicle with no remote control. Scientists in the *US* and *Japan* have had significant success, but real progress has been made by German researchers led by *Ernst Dieckmans*, where calculation mechanisms and a system for simulating eye movement have been applied for the first time. These innovations have led to the formation of a car preparation model, which independently assesses the situation and makes decisions.

Other notable moments in the history of the evolution of unmanned cars are listed below [26]:

- ✓ In 2004, the first car competition in history took place with the participation of *DARPA* robots, where unmanned cars appeared.
- ✓ In 2010, the world saw the first *Google* autopilot, developed based on the *Toyota* model. Equipped with radars, camcorders and the *Lidar* system, this *Google-mobile* could navigate in space, recognize road signs and interact with other road flow participants.
- ✓ In 2012, *Audi* tested its unmanned car. The autopilot car reached a speed of 193 *km/h*, perfectly entered corners and accelerated on the track.

- ✓ In 2013, *Nissan* and *Honda* demonstrated the efficiency of their patented autopilot systems. The companies plan to start mass production of robotic cars in 2020.
- ✓ In 2014, the Swedish company *Volvo* tested the first unmanned car with the unique *Drive Me* system.
- ✓ In 2015, the first unmanned mass production cars appeared – *Tesla Model S*, which travels on roads 100% independently. Together with *Google-mobile*, they are considered a standard of unmanned technology.
- ✓ 2016 - 2017 is the period in which all major car companies announced the development of their own prototyping and series production plans.

The construction of an unmanned vehicle includes the following main components [7, 25]:

- different sensors (optical, infrared, radar, ultrasound, laser);
- navigation, which combines *GPS* and electronic maps;
- the server with the installed program and power supplies;
- automated steering elements of the car (steering system, braking system, engine control system);
- automatic transmission;
- wireless network for communication between vehicles, access to program updates, electronic maps, road condition information, emergencies etc.

Many car manufacturers are currently working to create the unmanned car: *Audi*, *BMW*, *General Motors*, *Ford*, *Mercedes-Benz*, *Nissan*, *Tesla*, *Toyota*, *Volkswagen*, *Volvo*. *Apple*, *Autoliv*, *Bosch*, *Continental*, *Delphi*, *Google*, *Mobileye*, *Vislab* and others help them actively.

The potential advantages of unmanned cars are [7, 25, 27]:

- the reduction of the number of road accidents, caused by the driver's errors, and the practically total exclusion of the victims among the passengers, thus resulting in the decrease of the insurance, medicine, legal expenses etc.;
- reduction of freight and passenger transport costs, due to the economy of drivers' pay and rest, as well as the fuel economy;
- increasing the mobility of certain categories of the population (minors, young people, the elderly, people with disabilities, people with low incomes, without a driving license, etc.);
- raising the efficiency of traffic organization and therefore the ability to cross the road;
- reducing the need for personal cars and parking spaces;
- saving time spent driving, allows you to do more important things directly during the trip or rest;
- transport of goods in dangerous areas, during natural and technical disasters or military operations;
- in future, the reduction of the global ecological burden, both due to the quantitative optimization of the car fleet, and due to the wider use for their movement of alternative types of energy etc.

The disadvantages of autonomous vehicles, which prevent their rapid and widespread implementation, can be attributed [7, 25, 27]:

- software reliability, limited artificial intelligence capabilities and high system sensitivity to weather conditions (rain, snow, fog);
- liability for damages caused;
- loss of the ability to drive a car and the driver job. It is possible for lovers to drive the car to provide special roads, with additional safety measures, similar to the current ones, thus separating both the road network and the transport flows between them;

- loss of privacy;
- their use for criminal purposes;
- the ethical question faced by the car computer, in case of an inevitable collision, about the most acceptable number of victims, similar to the situation of choosing from two dangers the smallest.

In 2014, the professional association *SAE International* proposed a classification of unmanned vehicles according to the degree of automation. The classification includes six levels – from zero to complete automation 7, 25, 28].

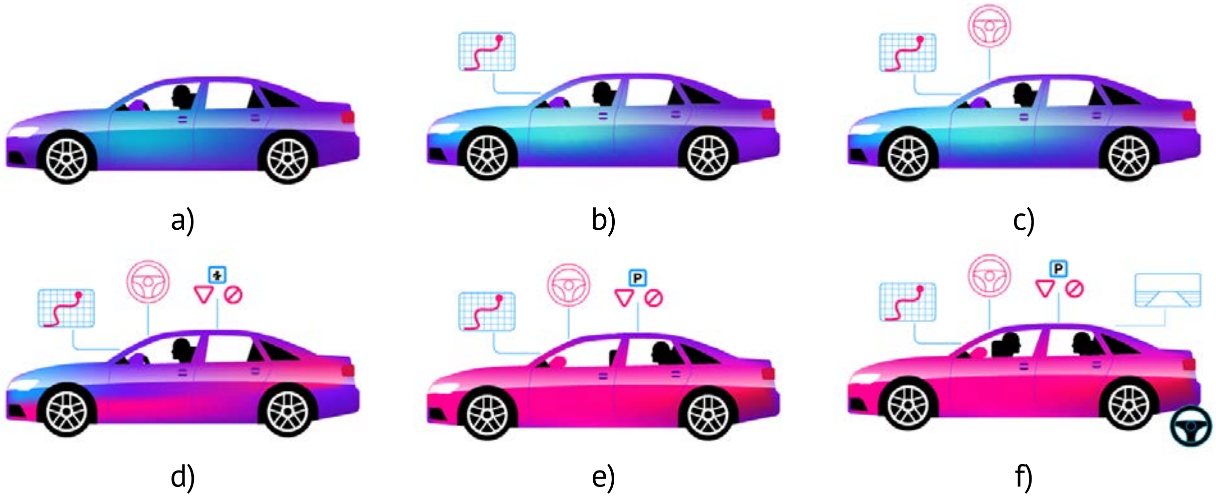

Figure 2. Automation levels of unmanned cars [26].

Zero level systems (Figure 2a), called *without automation*, do not perform driving functions, only warn the driver about the dangerous situation. Examples of systems with zero level of automation are:

- night vision system;
- band preselection assistance system;
- parking system.

In *level one* systems (Figure 2b), called *driver assistance*, some of the car's driving functions (steering system, acceleration and braking) are performed by the automation system. The driver permanently controls the traffic with the intention of taking complete control over the car. Examples of level one automation systems are:

- adaptive cruise control system (driver – steering system, automated system – speed);
- active lane departure assistance system (driver – speed, automated system – steering system);
- automatic parking system (driver – speed, automated system – steering system).

Level two automated systems (Figure 2c), called *partial automation*, are fully driven by the car. The hands can be taken from the steering wheel, the foot from the accelerator pedal. The driver follows the traffic with the intention of taking control. If the system does not handle the assigned functions, it can be disabled. Examples of level two automation systems are:

- *Tesla* autopilot;
- automatic traffic system in traffic jams (*Traffic Jam Assistant*);
- *Temporary Auto Pilot*.

Level three systems (Figure 2d), called *conventional automation*, allow the driver to completely distract from the movement of the car. During this time, the leader can read, write, watch a video. The driver intervenes in driving the car only at the request of the system. The following systems depend on level three automation systems:

- *Super Cruise* system;
- *SARTRE* system.

Level four systems (Figure 2e), called *high automation*, do not generally require the driver's attention. He can fall asleep, leave the driver's seat. When a dangerous situation arises, the system parks the car in a safe place and informs the driver about it. Systems, which can be attributed to level four automation are still few:

- the *Google* unmanned car;
- autonomous parking system.

In *level five* systems (Figure 2f), called *total automation*, human presence is generally not required. Therefore, the steering elements (steering wheel, pedals) can be removed from the passenger compartment of the car. The passenger activates (indicates the destination) and deactivates the system. There are currently no tier five automation systems.

The rapid development of electronic car systems makes the idea of the unmanned car a reality. Many car manufacturers and car component manufacturers are actively working to create the automatic driving system [29].

The problem is solved in two directions:

- complex automation of the car;
- automation of special vehicle traffic regimes (*parking, traffic in traffic jams, driving on the highway*).

A complex approach to creating an unmanned vehicle is taken by *Google*. Currently, the *Google* automatic control system is implemented on six experimental cars *Toyota Prius*, *Lexus RX 450h* and *Audi TT*, which have traveled in unmanned mode over 2,5 million kilometers. To perform the automatic control functions, the system includes the following input devices: lidar, radar, video camera, position appreciation sensor, inertial motion sensor, *GPS* receiver (Figure 3).

The *leader* scans the area around the car at a distance of more than 60 *m* and creates an exact three-dimensional image of his entourage. The leader has a rotating sensor on the roof of the car.

Radars help determine the exact position of distant objects. Four radars are installed on the car, three of which are located at the front and one radar at the rear. The *camcorder* sets traffic light signals and allows the control unit to recognize moving objects, including pedestrians and cyclists. The camcorder is located on the windshield behind the rearview mirror.

The *position sensor fixes* the movement of the car and helps determine the exact location on the map. The position sensor is mounted on the left rear wheel.

The *inertial motion sensor* measures the direction of acceleration or deceleration, the longitudinal and transverse inclination of the car body while driving. The directional stability system sensor is used.

The signals from the input devices are transmitted to the electronic control unit, where they are processed according to the established program and the control actions on the actuators are formed. The construction elements of the steering system, the braking system, the steering stability system, the engine control system are used as execution devices.

Unmanned cars do not fit simple maps and simple *GPS* accuracy (3 - 10 *m* error), the car must understand where it is with the accuracy of one centimeter. Despite the fact that the unmanned car has a lot of sensors, it must have accurate information about the environment (geometry of road markings, road boundaries, nearby traffic lights, etc.). All this information can be found in the so-called *HD*-maps. In order to keep cartography in its current state, special cartographic cars (special cars with cameras and lidars) have to travel the streets and „*digitize*" them. Thus, with the advent of the unmanned car race, the cartographic race between companies such as *Here*, *TomTom*, *DeepMap*, *lvl5*, *Carmera*, *Google* and others began [30].

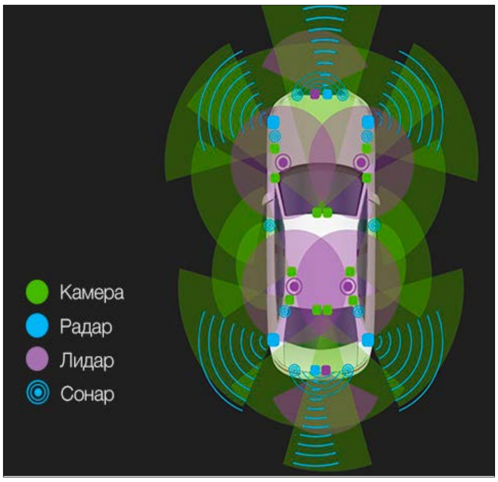

Figure 3. Car devices without a pilot.

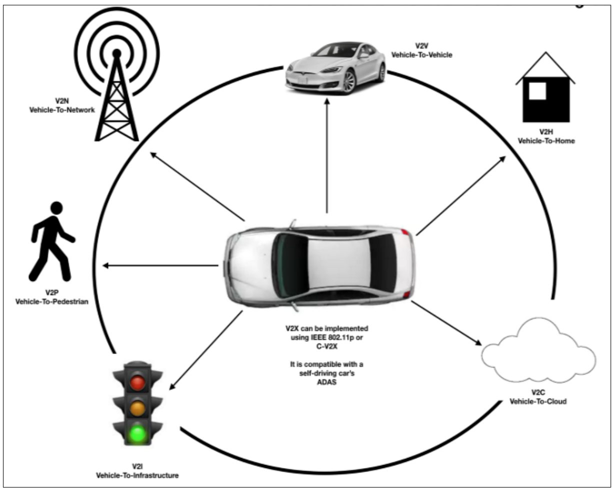

Figure 4. *Car-to-X* system [7, 30].

Unmanned cars require a new road infrastructure. And not only an infrastructure, but an intelligent infrastructure, in which cars could communicate not only with the infrastructure (indicators, traffic lights etc.), but also with other cars, pedestrians, etc. The communication system between cars has several names (Figure 4), in *Europe* it is *Car-to-Car* (*Car2Car*, *C2C*), in the *USA* – *Vehicle-to-Vehicle* (*V2V*). Car communication with infrastructure objects is called *Car-to-Infrastructure* (*C2I* or *V2I*), *Vehicle-to-Road* (*V2R*), and with pedestrians, *Car-to-Pedestrian* (*C2P* or *V2P*) – cars exchange information with pedestrians (for exemple, the car sees the pedestrian's smartphone and understands that there is a person there). The car also communicates with the buildings (houses), *Car-to-Home* (*C2H* or *V2H*), the connection network, *Car-to-Network* (*C2N* or *V2N*), and the information storage space, *Car-to-Cloud* (*C2C* or *V2C*). But all these names do not reveal the essence of the communication system, so more recently another name is circulating – *Car-to-X* (*C2X* or *V2X*). „*X*" means vehicles and infrastructure objects [7, 31].

The car communication system provides security in the following directions:

- assistance in crossing the intersection;
- left turn assistance;
- passing safely in opposite directions with the car in the opposite direction;
- warning when exiting the highway;
- detecting obstacles on the road;
- information about a traffic accident;
- emergency braking warning;
- rear collision warning (electronic brake lamp);
- warning about changing lanes;
- warning about adverse weather conditions;

- information about road signs;
- information about the approaching motorcyclist etc.

For example, a car travels on the highway, and the road sign 300 *m* ahead announces: „I'm a road sign and my name is..., I'm there...”. The unmanned car will be able to understand in advance what is to come and plan its actions according to this information.

Within the *HAVit* project (*Highly Automated Vehicles for Intelligent Transport*), in 2011 he presented the *Temporary Auto Pilot* semi-automatic system, *TAP* (*Temporary Autopilot*). The system allows the driver, under certain conditions, to hand over the control of the car under automatic control. In essence, the system is an intermediate step towards a robotic car [29].

The *TAP* system integrates into a common whole the already known elaborations of *Volkswagen*: the adaptive cruise control system, the lane traffic assistance system, the road sign recognition system. In its activity, the *temporary autopilot* system uses standard input devices of the listed active safety systems: lidar, radar, video camera, ultrasonic sensors. The system ensures the optimal degree of automation depending on the road situation and the driver's condition, thus contributing to accident-free driving. The system operates at speeds of up to 130 *km/h*. The *TAP* system is fully prepared for implementation on series cars.

Audi's Traffic Jam Assistant system is the first autopilot system for traffic congestion. The system automatically maintains the distance to the car in front, brakes, accelerates, turns, bypasses the obstacle and even gives way to emergency vehicles. Constructively, the traffic jam autopilot is based on adaptive cruise control and operates at speeds between 0 and 60 *km/h*. The system combines a number of input devices: two radars, a wide-angle video camera and eight ultrasonic sensors. Radar scans certain areas at a distance of 250 *m*. The video camera determines road markings and various obstacles. Ultrasonic sensors monitor the space in the front, rear and sides of the car. At any time, the driver can take control of the car.

Ford has prepared the automatic traffic system in traffic jams and has been using it in mass-produced cars since 2017. The *Traffic Jam Assist* system includes a radar and a camera, which monitors the movement of neighboring vehicles. The electronic control unit selects the desired speed and ensures the car's flow.

BMW is working on the *ConnectedDrive Connect* (*CDC*) system, designed for highway travel. The *CDC* system includes an ultrasound sensor, a video camera, a radar and a lidar, the signals from which are processed in an electronic control unit. As a result of the action on the execution mechanisms of the different systems of the car, the speed and the trajectory of circulation change. In addition, the system does not exceed the speed limit on the road sector, does not exceed on the right and returns the car to its lane after overtaking. In general, in the autopilot the algorithm of an ideal driver is realized. According to the company, the system is not yet ready for mass use.

Cadillac's Super Cruise automatic control system ensures the car's movement on the highway. It allows maneuvering, braking, driving on the belt without the participation of the driver. The system is based on a series of existing company solutions: adaptive cruise control system, automatic emergency braking systems, collision warning, lane departure assistance, lane preselection assistance, active light etc.

An interesting solution for automating car traffic is offered by *Volvo*. The *Safe Road Trains for the Environment* (*SARTRE*) system allows the movement of several cars on the road in an organized column. The cars move after the leading car, as a truck with a professional driver. The cars line up at a distance of 6 *m* from each other and completely repeat the movement of the leading truck, which allows the driver to rest, eat and talk on the phone. If desired, each car can leave the group at any time.

If road accidents involving people are a common phenomenon, then road accidents with unmanned vehicles become a real sensation. The press publishes hundreds of articles, paying attention to the smallest details, so that the news of a car accident with an unmanned vehicle cannot go unnoticed. At the same time, these smart vehicles are declared the safest: they have nothing to do with negligence and fatigue, poor visibility or irresponsibility, do not consume alcohol, drugs, do not talk on the phone, do not sleep etc. However, the development of artificial intelligence has not yet reached the point where errors are reduced to zero. Therefore, in road accident reports, the presence of unmanned vehicles is extremely rare. In average traffic conditions, traveling with an unmanned vehicle is almost 9 times safer than with human-driven cars [32]. Road accident statistics are also in favor of unmanned vehicles: other road users [33] cause 98% of accidents.

The only fatal road accident with an unmanned vehicle took place in 2016, in the American state of *Florida*. The *Tesla Model S* Robocar, driven by an autopilot, which bumped into a truck with a trailer at the intersection [33].

Conclusion. The 21st century has already become for the whole of humanity an era of innovative technologies, interesting ideas, automation of machines and the creation of „*intelligent*" robots. This is only a small part of what scientists and inventors can surprise us with. Some technologies have begun to modernize since the last century, referring to unmanned vehicles.

Innovation is a key vector of development; it is also a benefit, which makes life better, more comfortable, safer, cheaper, etc. It is understandable that today, with the old approaches, you do not get far. If we stop at this level, we have no chance of survival. The world is very conservative about innovation. If we get used to something, it is very difficult to move on to something new, even if it is better.

The profession of driver will disappear, like other obsolete professions, and this does not hurt anyone, in the end everyone could win. This is exactly what happens with constant technological progress – there are fears, is it a real benefit. Thousands of people die on the roads every day around the world because of the mistakes of others. If safety, comfort, economy and ecology are to be weighted, then it becomes obvious that the benefits for society as a whole are enormous.

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