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Tendency of Creation of "driverless" Vehicles Abroad

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This paper describes the tendency of creation of driverless vehicles in Russia and in the world. Analyzed international experience developing driverless vehicles. Showing the prerequisites for the development of similar vehicles in Russia. The experience of the FSUE "NAMI" in the field of driverless transport.

Key words: Driverless vehicle, Control system, Vision system, radar, Lidar.

Active development of driverless vehicles (DLV) leading foreign automakers began with the 1980s for cars, trucks, agricultural machinery and vehicles for military purposes, "in-plant" transport, ensuring the maintenance of all transport operations in modern logistics centers and storage areas. Driverless vehicles, practically all the leading automakers of the world, especially in the United States, Germany, Japan, Italy, China, Britain, France, Korea (automakers General Motors, Ford, Mersedes Benz, Volkswagen, Audi, BMW, Volvo and etc.). Considerable amount of work carried out in a closed category by defense orders and for this reason the results of almost not published in the press. Sophisticated high-end technical solutions, software, sensors, control systems of DLV in many countries classified as dual-use goods[1-6].

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The main part

In the design of driverless robotic car has achieved the greatest success the company Google (USA) - Figure 1. Google cars have been around 1.13 million. km, most of which occur in driving through the streets of California.

Google vision system of vehicles is able to recognize roadworks crossings, intersections and complex series of interactions with cyclists, including the recognition of signals from cyclists. It includes video cameras, radar 4 (front, rear, left, right), a laser range finder (Velodyne HDL-64E Lidar), a GPS navigation system with detailed road maps and angular position sensor to determine the exact location of a vehicle.

Fig. 1. "UAV" Google on public roads

Google-vehicle movement is tracked on the road map, which makes the motion control system. Google cars in test mode drove along the roads of California over 1 million 100 thousand km. Most of the path is passed in fully automatic mode, in which Google employees were in the car as a passenger. Currently, the fleet of Google has more than 30 models of driverless vehicles Toyota Prius, Audi TT, and others.

Are know a great amount projects on development of driverless vehicles, among which are the following:

Driverless vehicle called - Adaptive und Kooperative Technologien fur den Intelligenten Verkehr (briefly AKTIV), is being developed by a 28 well known European companies. These included BMW, Siemens, VW, Bosch, Vodafone and 23 more companies.

The main priority for the creators of AKTIV was the following objectives: to improve active safety of vehicle, transport communication and organization of traffic management, prevention and control of traffic jams. Another aim is to AKTIV tracking system safety drive on the roads, allowing “hedge” the driver in difficult situations. At this stage AKTIV able to control the smoothness of the acceleration and deceleration, synchronizing the process, even for a whole group of cars. In addition, the control system AKTIV includes emergency braking system with emergency situations. When testing a driverless car on the racetrack AKTIV a top speed of 180 km / h.

Another project on the development of driverless vehicle also conducted in Germany to establish a car-robot called Leonie. Its management system is able to control the vehicle’s position in the overall traffic flow through a large number of sensors, range finders and thermal imagers. Car-like robot can go in the deserts, and on a busy highway, and overcoming great distances and tunnels.

German designers are working on the creation of yet another driverless vehicle robot called - Made in Germany (MIG). MIG project is implemented only in Germany. In its creation are involved many scientists from several leading universities. At this stage, the car is able to control the MIG surroundings within a radius of 70 meters and has the experience to overcome the intersections and pedestrian crossings. As the “senses” are used all the same sensors and rangefinders.

The conference HAVEit German Volkswagen Group held a demonstration technology Temporary Auto Pilot (temporary autopilot, PDF) on the basis of car Volkswagen Passat. By analogy with the aircraft, the driver of the vehicle may include automatic control of the car on the road sections unloaded. Volkswagen Temporary Autopilot works when driving on highways at speeds up to 120 km / h. The main advantage of its management that it is almost ready for deployment on production cars.

Autopilot Volkswagen car is able to stick his lane and maintain a stable distance in front of the traveling vehicle and to slow down if necessary. The system is also able to recognize the signs and change the speed accordingly. Volkswagen autopilot can drive in traffic, repeating the same type of cycle start-stop, keeping their distance and lane. Vehicle maneDLVers are currently limited and he can’t drive a route, without the help of the driver, as do cars Google.

The main objective of the company General Motors (USA) in the development of a vehicle with a fully or partially automated control is the improved security. In the coming years, the use of autonomous vehicle control systems combined with innovative safety systems can completely eliminate the accident by interfering with the control even when the driver is still unaware of the dangerous situation. The work of these automatic driving systems in the future to completely replace drivers.

Examples of driverless vehicles developed by automakers are shown in Fig. 2-7.

Fig. 2. Vehicle Stanley

Fig. 3. Vehicle Sandstorm

Fig. 4. Vehicle Highlander

Fig. 5. Vehicle KAT-5

Fig. 6. DLV, developed by companies BMW, Siemens, VW, Bosch, Vodafone

Fig. 7. DLV Leonie, developed by engineers group in Germany

Principles of development “driverless” trucks are almost the same as that against DLV passenger vehicles (Fig.8).

Traffic control system of a vehicle Terramax builds three-dimensional images of the landscape with the three pairs of video cameras. Two closest cameras are used at low speeds and are capable of detecting obstacles at distances up to 15 m. At high speed robot selects a pair with the greatest diversity of cameras to scan a distance of

20 m to 50 m. Third pair scans the intermediate distance between these distances. When an obstacle is detected with a decrease in the rate of the motion control system of the car is made Terramax switching pairs camcorders far distance on average pair of chambers, and then short-range detection and correction of the vehicle when it detects all obstacles in the field of vision.

Fig. 8. Vehicle Terratax (|USA)

With regard to freight transport company Gotting KG (Germany) on the prototypes demonstrated its own technology for automated control of motorcade consisting of several dump trucks.

Front of the machine column runs a professional driver, and electronic devices monitor the actions of the driver and pass them on the radio in the form of commands to other controllers installed in the following for the first car vehicles. All vehicles are equipped with guided laser scanner for motion control the vehicle in front. Such a solution is promising for the transport of agricultural goods, mining in the mining industry, road construction, for Arctic transport and facilities of the Ministry of Defence of the transport of goods on hazardous areas.

Company Volvo Truck Corporation, through its subsidiary Volvo Technology Corporation. Volvo specialists believe that the application of "driverless" trucks in the convoy reached:

1) improvement of road safety as minimizing the negative impact of the human factor, which is the reason for the statistics, almost 80% of road accidents;
2) save about 20% of the fuel;
3) drivers are as testers in leding trucks, work in more comfortable conditions;
4) unloading of roads, as the intervals between trains will congeal.

"Driverless" in-plant transportation in developed countries are mass-produced. In Europe and the United States, it provides an effective transport services more than 1,000 logistics centers and warehouses, which employs about 30,000 driverless vehicles. Abroad actively working on the development and implementation of "driverless" tractors for agricultural production. In particular, the Finnish company Valtra tractor submitted a concept RoboTrac, which is controlled by means of GPS-navigation and the Internet. The vehicle is designed to work on the grape fields, coffee farms and orchards. It is capable of self-cultivate the land, work the soil, plant seeds, etc. (Fig. 9).

Fig. 9. Tractor RoboTrac

Fig. 10. Tractor Leica Geosystems

Swiss company Leica Geosystems, has signed a long-term contract with a Chinese manufacturer of machinery YTO to supply their equipment to control driverless tractors (Fig. 10).

The use of "driverless" tractor allows to automate many types of operations, improve quality and productivity, including the conduct of the work at night, to reduce operating costs in an uncertain natural conditions of agriculture.

Foreign automakers are developing DLV next destination:

1) Foreign automakers are also developing DLV of following appointment;
2) equipment for emergency situations (fire trucks, off-road vehicles, ambulances, special machinery, etc.);
3) dual-purpose vehicles;
4) for the protection of areas on the perimeter (mobile plant protection, surveillance and video recording);
5) for sports events at golf courts, parks, etc.

Analysis of successful projects in the United States, Italy, Germany and other countries of the "driverless" vehicles allows to identify a common software architecture of driverless vehicles, which consists of the following operations:

1) Preparation and processing of data from sensors.
2) Integration and coordination of the data.
3) Processing of images.
4) Determination of obstacles, road conditions and vehicle in the direction of their movement.
5) Characterization of the road surface.
6) Construction of a digital map.
7) Positioning of the car and determination of the current state of the system.
8) Making a decision.
9) Management of executive devices.
10) Logging of the data for further analysis.

In the most complex systems, such as traffic control systems Google, Volkswagen, Cadillac and agency DARPA, the software is divided into two levels - the lower level is responsible for interaction with sensors and actuators, and the upper level is directly responsible for the implementation of the algorithm of motion control car.

To test the car system motion control simulation of the behavior of algorithms is carried out. The optimal environment for the tests in this control system - Matlab / Simulink, which allows the use of rapid prototyping technology RAD. In this environment, you may receive a top-level C code.

Environment for the development of software (SW) of the lower level of the various developers selected depending on the microprocessor. Language development for low-level software - C / C ++, C #. Just to improve performance in critical areas for this company Google and Volkswagen use the insert code in Assembler.

In general, most of the leading foreign car makers believe that by 2015-2018, they can complete their test of "driverless" vehicles, and from 2018-2025 will be released on the organization of DLV production for use on public roads.

At the stages of creating of "driverless" Car the Safety Administration of Traffic of United States (National Highway Traffic Safety Administration, NHTSA) is considering five levels of automation of the vehicle:

1. Non-automated cars (No-Automation, level 0): during the trip the driver carries out a full and sole control and management of the brakes, steering, throttle, transmission and clutch (if equipped).
2. Partial automation (Function-specific Automation, Level 1): an automated traffic control system performs one or more specific functions, such as implementing electronic stability control (ESC) and emergency brake.
3. Combined automation (Combined Function Automation, Level 2): an automated traffic control system performs at least two functions, for example, including the management of an adaptive cruise control system in combination with the system which warns the driver about leaving the lane.
4. Limited autonomous driving (Limited Self-Driving Automation, Level 3): automated traffic control system performs a full control over all critical safety functions under certain conditions in which the driver mostly carries only supervise the work of traffic management systems. At this level,

probably comfortable switching control car driver. Google cars are currently at level 3.

5. Full automation (Full Self-Driving Automation, Level 4): the automated traffic control system performs all the critical functions of driving and monitoring the traffic situation at all times during the trip.

Currently, NHTSA doesn't recommended to allow the work of "driverless" vehicles for purposes other than for their tests. In general, most of the leading foreign automakers plan to complete its 2015-2018 tests of "driverless" vehicles, and from 2018-2025 to organize mass production of DLV for use on public roads.

The Russian Federation also works on creation of "driverless" vehicles[7-10]. One of the leading developers is FSUE "NAMI", which already has experience in creating "driverless" vehicles for civilian use. Currently, a new project with the Ministry of Education and Science of the Russian Federation (the unique identifier for Applied Scientific Research (project) RFMEFI62514X0006) provides for the establishment of the experimental sample of vehicle's electric driverless cleaner. This project provides the work to improve traffic management systems and "vision" of the driverless vehicle, the development of new solutions for DLV "environmental security" by applying it in the drive (ie, exclusion from the construction of the internal combustion engine - one of the sources of pollution environment) and establishing a system of purification and distribution of the air in the car to ensure the environmental safety of passengers.

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