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Movement of an unmanned vehicle using the example of the "Dynamics M1" (educational set)

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Age group: high school students; students of students of secondary professional education

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General information about the business case

Movement of an unmanned vehicle using the example of the "Dynamics M1" (educational set)

- **What is a self-driving car?**

This is a car equipped with an automatic control system, capable of moving from point A to point B without human intervention.

- **How self-driving cars work?**

To arrive at a destination, an autonomous vehicle must know the route, understand the environment, follow traffic rules, and properly interact with pedestrians and other road users. To meet these requirements, the drone uses the following technologies:

1. Cameras: visually detect objects such as road markings and signs

2. Radar: detects obstacles and objects in front and behind and determines the distance to them

3. Lidar: similar to radar, but much sharper and detects objects around the vehicle (full 360 degree view)

4. AI: the brain of the car. Processes data from cameras and sensors, drives a car and makes decisions

Theoretical information

An organization called SAE International has done a good deed and has standardized 5 levels of autonomy that all market participants adhere to:

Level 0—No Automation: The driver has to control everything - steering wheel, brake and gas. An ordinary car.

Level 1—Driver Assistance: The car helps to brake or accelerate. Cruise control cars are about Level 1.

Level 2—Partial Automation: A car can control acceleration and deceleration at the same time, but the person must be aware of the situation and be ready to take control. The most striking example of Level 2 is Tesla.

Level 3—Conditional Automation: The car can completely control the movement, but at some point it may ask to take control. Rumor has it that the Audi A8 (2018) can do all of this, but there are no reviews yet.

Level 4—High Automation: Can do everything at Level 3, but can handle more difficult driving situations. In general, you can let go of the steering wheel and do nothing, but if the car cannot make a decision, it will notify you and smoothly park on the side of the road. Companies like Waymo or Aptiv are claiming the 4th Level.

Level 5—Full Automation: Full autonomy, no human involvement required. The car itself makes a decision in any situation, the steering wheel may be missing.

Application in other countries

General Motors

As one of the leading automakers, GM has spent a ton of money to remain the leader in self-driving cars. In 2016, he acquired the UAV startup Cruise Automation for over $ 1 billion. Cruise received a total of $ 2.25 billion from SoftBank and $ 1.1 billion from GM in 2018. To further dominate the autonomy market, GM also acquired a lidar maker. GM is testing its drones in San Francisco with plans to expand to New York.

Waymo (leader in manufacturability)

The oldest startup, founded back in 2009. At the moment, it is considered the most advanced self-driving car. Priced at $ 175 billion (!), Waymo has driven a total of 10 million miles in Chrysler, Honda and Jaguar vehicles. Waymo recently announced plans to buy another 62,000 Fiat Chrysler for a future self-driving paid taxi.

Tesla

Tesla has a very different perspective on the unmanned future. Elon Musk believes that the drone can only work on certain cameras (after all, a person drives a car with just a pair of eyes), without lidars. Despite the fact that Tesla cars have autopilot functions, they still trample the 3rd level of autonomy, and accidents due to autopilot are also enough.

Prospects, problems

Why has it taken so long to develop self-driving cars?

Waymo was founded in 2009 and only now they are more or less ready for commercial travel (and then in sunny California). That is, almost 10 years later. Why so long? While the race for unmanned technology has accelerated over the past 5 years, all companies face common challenges:

Lidar

Lidar is essentially a laser device that constantly turns and “shoots” a laser 360 degrees, determining the distance to every point that can be measured.

Unfortunately, lidars are expensive (from 500,000 rubles per 1 piece), and in an unmanned vehicle you need a lot of them (2–5 pieces).

There is still no way to get rid of it, because only the radar and the camera are not enough for clear navigation in the terrain. Various companies are working to reduce the cost of the lidar and release a new low-cost solid-state lidar (no rotating elements), but such products are still in development.

AI (artificial Intelligence)

AI is the heart of the car. AI detects objects from cameras, tries to recognize an object (for example, a dog, person, car, road sign, etc.), determine how pedestrians and other cars will behave. In order for such artificial intelligence to work, engineers “feed” it huge amounts of data so that special algorithms can learn from this data. The more quality input data, the better the algorithms will perform.

Even though algorithms have come a long way, they are still “stupid” for a two year old. A striking example is the incident with the Uber drone (due to which a person died), the algorithm could not recognize the person on the road (in other words, since the driver did not have time to notice him). But besides a person, you also need to "see" a large number of other objects - every car, road sign, traffic light, be able to determine traffic lanes and much more.

Prospects, problems

Weather

Let's be honest, almost no self-driving car can drive normally in snow or heavy rain. The exception is MIT University. They learned to navigate by the casts of the roadway under the car.

Cartography

Simple maps and simple GPS accuracy (3-10 meters error) are not suitable for unmanned vehicles; the car needs to understand where it is located with centimeter accuracy. Although the car has many sensors, it is necessary to have accurate information about the surrounding area (geometry of road markings, road boundaries, nearest road signs, etc.). All this information is in the so-called HD-maps - a digital model of the road.

For cartography to remain relevant, special cartographic machines (a special car with cameras and lidars) must drive through the streets and “digitize” them. So with the advent of self-driving car racing, a cartography race has begun among companies like Here, TomTom, DeepMap, lvl5, Carmera, Google and others. In the 21st century, data is the new gold

One of the Google Street View cars

Prospects, problems

Infrastructure

Self-driving cars require new road infrastructure. And not just infrastructure, but smart infrastructure in which cars could communicate not only with the infrastructure itself (signs, traffic lights, etc.), but also with other cars. Here are some basic terms:

V2V (vehicle-to-vehicle) — cars exchange information directly with each other

V2I (vehicle-to-infrastructure) — cars exchange information with road infrastructure

V2P (vehicle-to-pedestrian) — cars exchange information with pedestrians (for example, the car sees the pedestrian's smartphone and understands that there is a person here)

For example, a car is driving on a highway, and a road sign 300 m ahead says: "I am such and such a sign, I am there." An unmanned vehicle will be able to understand in advance what lies ahead and plan its actions in accordance with this information.

Scheme of data exchange through the Internet of Things between objects on the road for an unmanned vehicle

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Statement of the problem

Task

to create educational materials for schoolchildren and students on the study and development of the work of an unmanned vehicle based on the set of mobile robotics "Dynamics":

1. **Assemble and program 2 sets according to the instructions in the available design;**
2. **Create a scheme for supplementing the "Dynamics" structure with sensors that will bring it as close as possible to the driving conditions of an unmanned vehicle (according to the diagram on slide 8).**
3. **Algorithm for data transfer and data output using the Internet of Things between two sets of "Dynamics“**
4. **Visualization of the interface of the output data in an application for the Internet of Things (for example, Blynk)**

Performed using 1 or 2 sets of "Dynamics" produced by MGBot

Business case solution format

- Up to 10 PowerPoint presentation slides with infographics
- The total time for the presentation of the case should not exceed 10 minutes.
- Demonstration of the assembled "Dynamics" and the interface of the transmitted data from the car in the application for the Internet of Things on a phone or PC