COMPUTER VISION

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ABSTRACT

This article explores the subject of computer vision systems – a technology that allows vehicles to identify, track, and also classify objects on the roadway. The objectives of the study are to consider the principle of operation of these automated systems, their advantages in comparison with modern road regulation, as well as the problems of implementation and development of these systems. The research was carried out on the basis of the analysis of information from open information resources. The statistics of accidents at work are presented, the high rates of which are due to large volumes of production and an outdated system for monitoring compliance with safety rules and the availability of personal protective equipment for employees. The scheme of interaction of the components of a computer vision system is considered, which will allow monitoring of events occurring in production during operation, monitoring the situation at the enterprise for the occurrence of a potentially dangerous situation for personnel and equipment, and, accordingly, this system will be able to prevent an emergency, as well as avoid personal injury by reacting even to minor deviations from operating parameters. The research was carried out on the basis of the study and analysis of materials published in open information sources.

KEYWORDS: *machine vision, traffic control system, computer vision, transport, neural networks, production, computer vision, safety compliance, monitoring, production process, safety.*

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INTRODUCTION

Modern digital technologies every year take an increasingly active part in our daily lives. One example of innovative technologies that have been actively developing over the past few years, are being introduced into various areas of our life and really help to improve its quality, is computer vision.

Computer vision is a technology that allows vehicles to identify, track and classify objects on the roadway. It is the automotive industry that is the "pioneer" in the field of application of computer vision systems and one of the main consumers of this technology.

According to analytical data from the VDMA (Verband Deutscher Maschinen und Anlagenbau, the German Mechanical Engineering Association), the automotive industry forms 23% of the machine vision market in Germany, as well as 21% in Europe. Machine vision is used to analyze the content of images and videos received from CCTV cameras and a set of special equipment installed directly on the car itself and on the roadway.

COMPUTER VISION ON AUTOPILOT (AUTO)

To carry out autonomous movement on the roadway, the car must be equipped with special equipment. For example, an unmanned vehicle should have about a dozen sensors, the read data from which will identify the position of the vehicle on the roadway.

One of the mandatory components for the implementation of machine vision is a video camera, which determines the headlights from other traffic participants on the roadway and the distance to obstacles, pedestrians and cyclists. Many modern cars are already equipped with intelligent systems that warn the driver about crossing road markings, and in some cases this system is able to align the vehicle's trajectory on its own.

Accordingly, the use of modern autopilot systems has faced the following problem – for its operation it is necessary to have high-quality road markings, and not in every region of our country the quality of road markings and roads, in principle, correspond to the stated criteria. There are several ways to solve the current situation.

The first is to equip the roads with special sensors and beacons, but this approach is difficult in terms of implementation and, above all, with the high cost of rebuilding the road lanes.

The second way is to develop an intelligent system that will allow vehicles to independently analyze the situation on the road lane and perform fully autonomous driving. Such a system uses CCTV cameras and special feature extraction techniques to identify lane boundaries.

Initially, from the image received from the camera, road lines located at a certain angle to the lens are determined. Then, extreme pixels are selected on this image to determine the width of the carriageway and the location of the vehicle in this lane.

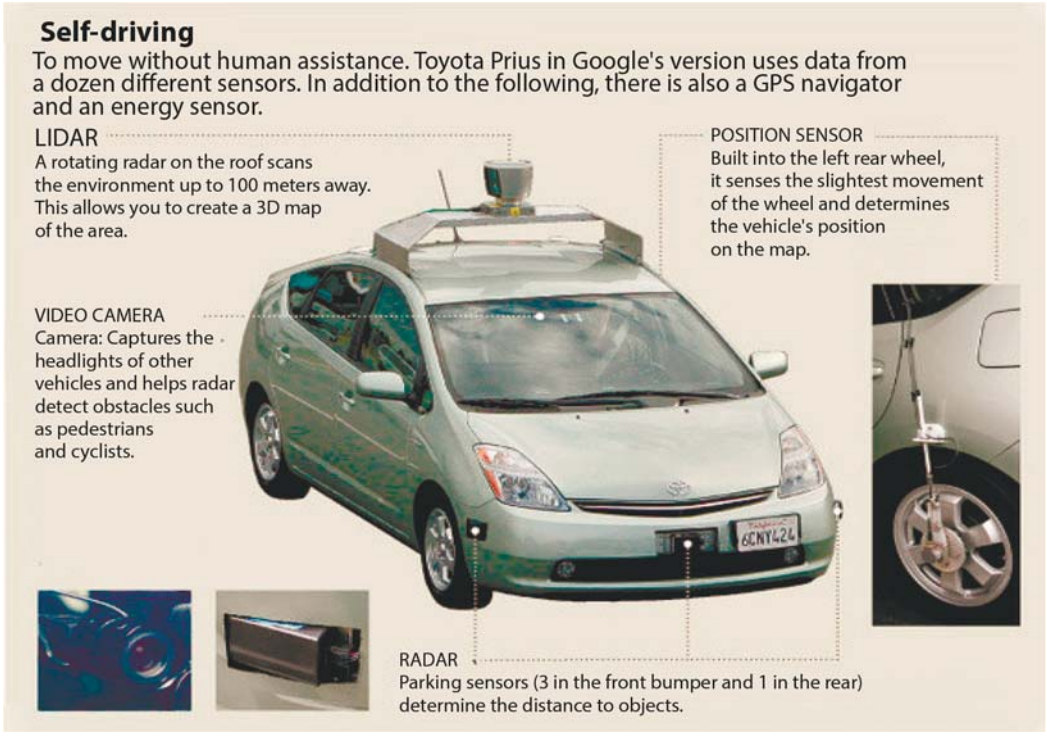

Figure 1. Technical equipment for autonomous piloting based on the Toyota Prius (Google version)

An example of the technical equipment of a car capable of fully autonomous piloting is shown in Figure 1.

Based on the foregoing, it can be concluded that the computer vision of a car identifies objects around the vehicle through the use of arrays of sensors and video cameras. Recognition of objects and determination of the distance to each of them is based on the principle of motion parallax.

The principle of parallax is that when moving along objects located in front of the observer, distant objects move a smaller distance compared to the distance that near objects move (Figure 2). The value of this displacement of objects is an indicator of the distance from the observer's point directly to the objects.

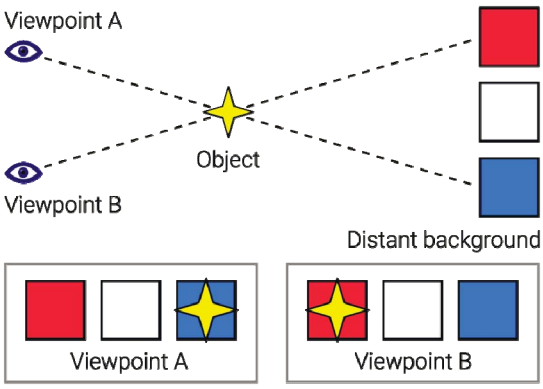

Figure 2. Principle of parallax. At the "viewpoint A" position, the observer sees that the "Object" star is in front of the blue square, when the observer is shifted to the "viewpoint B" position, the shift of the squares for the observer will be insignificant, while the closer "Object" star will move to the position in front of red square

Presence of autonomy of the car entails a large number of advantages in comparison with the existing driving system. Let us consider in more detail what exactly are the advantages of using the autopilot technology of a vehicle:

1) this technology will allow to carry out cargo transportation in the zone of military operations, natural, man-made disasters, while not risking human lives;

2) the absence of the need to hire drivers will significantly reduce the financial costs of paying salaries to employees;

3) more rational use of fuel;

4) during the movement, the driver can do work, rest, while not being distracted by driving;

5) people with disabilities will get the opportunity to travel in their own car;

6) the human factor is excluded, which, accordingly, will lead to the minimization of traffic accidents, and, as a result, the reduction of human casualties.

Obviously, the main vector of development in this area is the creation of an unmanned vehicle that will be able to work and carry out transportation in a completely autonomous mode.

At the moment, artificial vision in the field of vehicles is developing at an accelerated pace, the largest players in the automotive market, such as Tesla Motors, Toyota, Honda and others, are actively developing, as well as optimizing existing autopilot systems.

The introduction of machine vision systems will reduce accidents by at least 15.8 times, which is equivalent to two thousand lives. In addition, due to the timely notification of police officers and ambulances about serious accidents, the travel time for these employees is reduced by 10 times. Also, participants in an accident will not have to wait for police officers called to the scene of an accident, which in turn will avoid traffic jams on the roadway, and the time for analyzing the causes of the accident itself will be reduced from 4-8 hours to 30 minutes.

The potential for the development of machine vision is so great that, in addition to being introduced into the automotive industry, this system can be successfully used both in medicine and in optimizing work in factories and robotics, but on the way to the implementation of this idea, solve a large number of engineering problems.

COMPUTER VISION IN MANUFACTURE

The growth of mechanization in all economic sectors, from agriculture, the construction and energy industries, to trade and banking, has a decisive influence on the increasing role of industry in the modern world. For example, the role of industry in the agricultural sector is determined by ensuring the high quality and volume of produced feed, which can only be achieved with high-precision equipment.

The role of industry in the construction industry is determined by the volume of structures produced and the quality of building raw materials, which can be achieved, again, only with the help of high-precision equipment that allows high-quality assembly of structural elements, maintaining specified ratios and quality requirements for components preparation of building mixtures. In the energy sector, the main equipment is dynamic equipment such as compressors, gas turbines, pumps, which accordingly entails high requirements for monitoring operating parameters and safe operation of machines, which is ensured, again, by high-precision equipment.

The number of financial transactions, both in the field of trade and in banking, require enormous computing power, which is achieved through the use of computer systems and servers capable of processing and storing digital information. Summarizing the above, we can conclude that industry characterizes the main sphere of material production, in which a large share of GDP and national income is created.

Accordingly, with such an important role of industry in the modern world and the speed of its progress, more and more requirements are imposed on the volume of products, their quality and safety. Standard resources such as video surveillance systems, computer programs and human monitoring are no longer enough, and it is not

economically feasible for enterprises to hire additional personnel to monitor certain production parameters.

Therefore, at the moment, a system is being developed and optimized that will allow monitoring events occurring in production during the operation period, monitoring the situation at the enterprise for a potentially dangerous situation for personnel and equipment, and, accordingly, this system will be able to prevent an emergency situation, as well as avoid injury to personnel, reacting even with a slight deviation from the working parameters. This system is called a Computer vision system.

Computer Vision or CV is the automatic fixation and processing of both stationary and moving objects using computer systems and a set of special equipment. Computer vision is currently being actively implemented and improved in many industries where constant monitoring of a large amount of information is necessary to ensure high production quality and personnel safety (Figure 3).

Figure 3. The main areas of computer vision systems application

One of the most common functions of computer vision systems in production is the identification of the availability of personal protective equipment for employees carrying out their work activities in potentially hazardous areas. According to the operational data of the Ministry of Labor of the Russian Federation in 2019, there were 4078 cases with severe and fatal outcomes at production facilities as a result of non-compliance with safety equipment.

The introduction of computer vision systems will make it possible to constantly monitor compliance with security requirements, namely, to determine where a person has a head, arms and legs in an image obtained at any time and, most importantly, to identify comments for the presence means of protection.

This system analyzes whether gloves are worn, whether the employee uses a protective helmet and goggles, whether he has a portable gas analyzer with him, whether overalls are fastened, etc., warning the employee and his management about the violation. According to preliminary calculations, the introduction of computer vision systems in production will reduce the number of accidents by 30-35%.

For the enterprise, this system provides the following benefits:

– reduce the level of incidents at work associated with violation of safety requirements;

– to instantly identify the violation and immediately inform the employee and his management about this violation;

– cover a large area for monitoring with relatively small resources.

Computer vision can greatly simplify the work of labor protection specialists, namely, it allows them to focus directly on important points. For companies, the presence of this system allows you to reduce costs and increase the level of safety in production. A labor protection specialist cannot physically be at several production facilities or premises to verify compliance with the rules on safety and labor protection.

Of course, in the absence of machine vision systems at the enterprise, it leads to the fact that the specialist needs more time to detect violators, which, accordingly, leads to the emergence of a potentially dangerous situation for employees.

Also, the absence of this system in production suggests that specialists will spend their time constantly monitoring the situation in production, constantly watching videos received from CCTV cameras, but to view video from each installation, from each room, a large number of specialists, which is not profitable for enterprises from a financial point of view. Interaction scheme between the machine vision system components is shown in Figure 5.

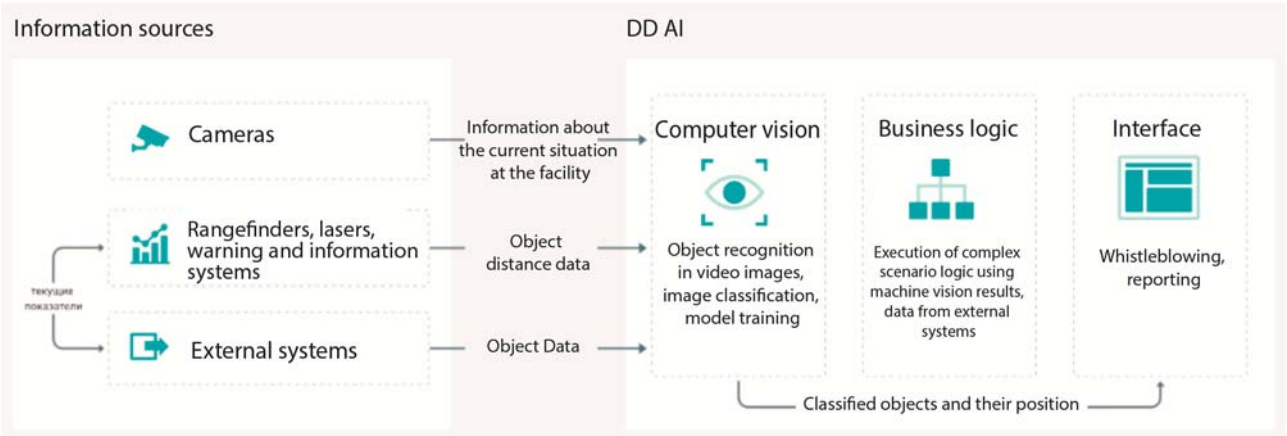

Figure 5. Interaction scheme between the computer vision system components

In addition to the field of industrial safety, computer vision is capable of monitoring and controlling production parameters, tracking their changes and regulating the flow of processes in production.

CONCLUSION

At the moment, development of artificial vision technologies is rapidly developing in many areas of human life - from optimizing the operation of mobile devices to ensuring trouble-free operation of industries, as well as breakthroughs in the field of medicine. The modern world poses many questions and challenges for scientists in terms of implementing projects based on the use of computer vision, which, of course, need to be addressed, given the potential of using this technology.

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