DEVELOPMENT OF AN AUTOMATED ROAD CONTROL SYSTEM "ALA-ARCHA"

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DOI: 10.36724/2664-066X-2022-8-4-18-21

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statistics of accidents at work are presented, the high rates of which are due to large volumes of production and an outdated system for monitoring compliance with safety rules and the availability of personal protective equipment for employees.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

Every year around the world there is a tendency to increase the number of vehicles, respectively, density of the flow and its intensity, which, in turn, causes the need for traffic management [1-5]. One of the priority vectors of development in this direction is the development of automated traffic control systems. The main task of automated system is to increase the vehicle traffic regulation efficiency, reduce intersection delays of their traffic trajectories, as well as increase the level of comfort and safety of traffic participants [6-11].

One example of an automated control system is the use of a special cabin with a visit control point at the entrance to the parking area or airport area, where you can stay for a limited amount of time [12-15]. The sequence of entry and exit consists in the approach of the vehicle to the barrier, next to which there is a point for issuing "visitor cards". The driver, having received the card, takes it to his salon, waits for the opening of the barrier and drives into the territory. When leaving, the driver returns card back, barrier opens and vehicle leaves the territory [16-18]. These systems are manufactured by companies such as Mallenom systems (Automarshal barriers).

RESEARCH METHODS AND RESULTS

From the material presented above, we can conclude that one of the priority areas in the development of automated control systems is the development and improvement of software, namely the identification of a vehicle on the road and the highest quality data collection about it. Also, in addition to the technical aspect, it should not be overlooked that it is necessary to develop a reliable system, coupled with ease of maintenance and affordable cost of the finished complex, so the development of a traffic control system is one of the priority areas in the field of traffic management [19-21].

As part of the implementation of the project "Development of the automated road regulation system "Ala-Archa"", the goal was determined, which is to develop a control system, its logic and control algorithms, as well as the analysis and selection of equipment necessary for the implementation of a checkpoint that controls the entry of vehicles funds to the reserve "Ala-Archa", located on the territory of Kyrgyzstan, as well as departure from it.

In the course of the project, an analysis of modern systems for regulating the movement of vehicles at the entrance to a closed area, as well as leaving it, was carried out. A significant disadvantage of this system is the need for the driver to perform the following actions – stop in front of the barrier, open the window, reach for the button to receive the visitor's card, take the card into the salon, close the window, wait for the barrier to open, and only after all of the above actions the driver will be able to enter the territory. The driver will have to carry out a similar sequence of operations when leaving the territory [22-23].

Accordingly, the imperfection of the existing traffic regulation system is due to inappropriate software that does not provide autonomous operation of the checkpoint, as a result of which drivers must perform a certain sequence of actions in order to be able to enter and exit the territory, which, in turn, takes a large number of time, and, accordingly, entails the formation of a queue in front of the checkpoint. In addition, if the driver was in the closed area for more than the set time, he must go to the payment point in front of the barrier at the exit, pay the amount that is calculated depending on the time that the driver spent in the territory in excess of the established limit, and only after payment does he get the opportunity to leave.

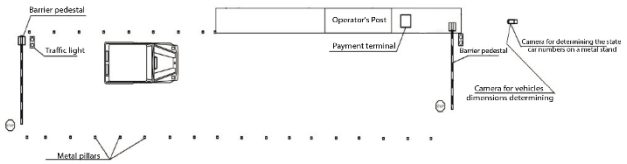

Figure 1. Car movement scheme at the entrance to park territory

After analyzing the existing traffic control system, a proposal was put forward to organize an automated collection of payment from vehicles based on determining the dimensions of vehicles at the entrance to the Ala-Archa Natural Park, as well as at the exit from it.

Figure 1 shows a diagram of the movement of a vehicle at the entrance to the park. The vehicle drives up to the first barrier, after which the system for determining the dimensions of the car is located, and, provided that there is no vehicle in the dimension determination zone, the first barrier lets the car into the dimension determination zone, and closes immediately after the passage. If there is another vehicle in dimension determination zone, the first barrier remains in closed position. Then the driver activates fare payment button, while determining car dimensions using CCTV cameras, which makes it possible to identify vehicle dimensions with an accuracy of several centimeters, in parallel, the car number is read and data about vehicle is sent to the system. After making the payment, a second barrier opens to enter the park. After payment this vehicle has access to enter the park within 24 hours.

Figure 2 shows a vehicle movement diagram (when leaving the park). The vehicle approaches the barrier at the territory exit, video surveillance system identifies vehicle presence, after identifying vehicle presence, open barrier, vehicle leaves the park. This system logic allows five times to reduce the time for car to leave the closed area.

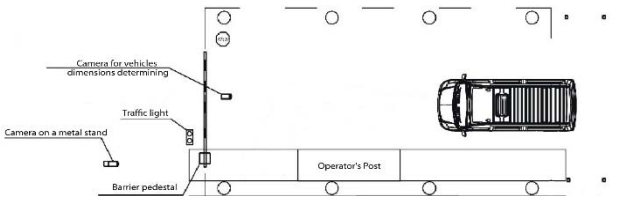

Figure 2. Car movement scheme (leaving the park)

To implement this logic, the following resources are required: Server, barrier, payment terminal, image recognition cameras.

The project is based on the Open CV computer vision library and implemented on the Python programming language platform. During the implementation of the project, the accuracy of recognition of dimensions and car numbers was increased to 92%, and during the optimization of the system in 2021, this figure was already brought up to 98%. Such high performance was achieved by training the neural network with more than 10 million frames of images of vehicle numbers.

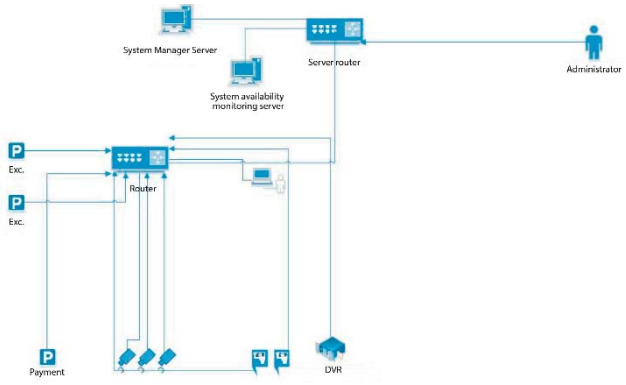

Figure 3. Scheme of interaction between the components of system logic for automated payment collection from vehicles based on determining the dimensions of vehicles at the entrance to natural park "Ala-Archa"

DEPARTURE LOGIC

1. At the entrance there are two barriers, for each passage – a vestibule.

2. The first barrier works automatically after magnetic loop is triggered, the second one opens only after payment, or checks list of free cars (white list) against billing, or the list of cars whose owners have paid fare or more than 24 hours have not passed since the payment.

3. Exposure at the first barrier – when the loop is approached, a signal is sent to open (it does not matter in what position the barrier boom is now - if it is open and the vehicle enters the loop, the barrier will close) after the boom has taken a vertical position (open) , which withstands a passage waiting pause of 120 seconds, if the car does not cross photo elements on the barrier, then auto-closing occurs, if it crosses photo cells, barrier closes immediately after crossing the photo cells.

4. Each entrance barrier has two magnetic loops (one in front of the barrier, second behind it).

5. When the car is on the second barrier (loop 2 of the second barrier), the car that drove up to the first barrier, barrier will not open, opening occurs only after passing through the second car barrier, which was in the magnetic loop 2, in this case, first barrier will open automatically.

6) After payment and opening of the second barrier, there is a waiting at the intersection of photocells for 120 seconds, after which, if no action occurs, the barrier will close automatically; if there is an intersection of photocells, barrier will close immediately after intersection.

7. In order to correctly determine the dimensions and make payment, there should be only one car in the vestibule.

8. If there are two vehicles in the vestibule, the dimensions and numbers of vehicles may be considered incorrectly.

9. The vehicle must move along the vestibule no more than 5 km / h for the correct reading of numbers. If the car number was not considered for any reason, it must be entered manually. In no case should the vehicle be allowed to drive back and forth along the vestibule, this can lead to damage to the fence, as well as barriers if the driver is inattentive.

ENTRY LOGIC

1. When the car approaches exit barrier and runs into the magnetic loop, there is an exposure for 10 seconds (for license plate recognition), and car is searched in the system to transfer it to passage history.

2. After which the exit barrier opens and waits for 40 seconds to pass through the photocells, if there is no passage, barrier closes automatically.

CONCLUSION

Comparing the proposed system for organizing entry and exit from the park with existing analogues, we can conclude that thanks to the improved logic of the system, drivers only need to activate pressing the ticket purchase button and pay for it, the system performs all other operations autonomously, significantly increasing the speed of vehicles passing by territory of the park and reducing the time for the vehicle to leave the closed area, as well as unloading the work of the cash desk operator and administrator. These advantages of the developed system are provided by the implemented logic based on the computer vision library "Open CV" and the programming language "Python", as well as a set of special equipment described in this article.

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