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Speed Control Measures in Minsk

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Abstract: The dynamic development of Minsk, especially in the last decade, causes a constant intensive increase in the number and variety of vehicles, as well as an increase in the requirements of enterprises and citizens for the quality of transport services. There is an obvious need for further development and integration of such systems in order to transform them into an integrated system, i.e. a modern intelligent transport system that provides not only traffic monitoring and centralized adjustment of traffic light objects, but also automated optimal traffic control and automatic control. The installation of automatic fixation cameras is one of the methods used to control compliance with the speed limit (instantaneous speed). The development of optimal solutions for application should be based on the study of the operating experience of already existing devices in conditions as close as possible to real ones (pilot zones of trial operation) and be carried out taking into account the specifics of the tactical, technical and economic characteristics of the means of detecting and photo-video recording of traffic violations that are currently available on the world market. For this, a pilot project should be developed aimed at experimental testing of technology and means of fixing speed violations. Tasks implemented in the course of the pilot project: verification of the technology of recognition of state registration plates of vehicles and compliance with the round-the-clock operating mode (without supervision) "RoadEye S01"; formation of a model of the evidence base for an administrative offense; checking for compliance of the devices used with the requirements of manufacturability, compatibility, reliability, etc .; formation of general requirements for the organization of control zones for the average speed of movement, taking into account the results (statistics) for the pilot zone on the section of Olshevskogo street.

Keywords: speed; control measures; pilot project.

1. Introduction

According to the UGAI GUVD of the Minsk City Executive Committee, the total number of vehicles as of 01/01/2020 was 895,240 units, and as of 01/01/2021, this figure reached 911,480 units. The city divisions and services are doing a lot to ensure the functioning of the UTS in these difficult conditions [1,2]. A number of modern technical solutions for traffic monitoring and control have been developed in Minsk, the basis of which is the ATCM and a video surveillance system. Currently, the need for further development and integration of these systems is obvious in order to transform

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them into an integrated system, that is, a modern intelligent transport system that provides not only traffic monitoring and centralized adjustment of traffic lights, but also automated optimal traffic control and automatic control. compliance with a large number of traffic rules [3,4]. The information basis of any such system is transport detectors, which supply the computing complex with data for the development of optimal modes of operation of traffic lights, as well as messages for dynamic displays and controlled road signs. In addition, we note that the accumulated data of vehicle detection are, in fact, the only source of reasonable planning of urban planning measures for the construction and reconstruction of highways [5,6]. The growth in the traffic intensity of vehicles leads to an inevitable increase in demand for parking space in the city, an increase in the number of forced maneuvers on the tracks and intersections, the massive use of a dedicated lane by individual vehicles for the movement of public route-passenger transport, and, consequently, to violations by drivers of various traffic rules ... The installation of automatic fixation cameras is one of the methods used to control compliance with the speed limit (instantaneous speed) not only in Minsk, but also in the Republic of Belarus [7,8]. There is a need for continuous improvement and automation of information collection and control processes in the field of road traffic. The development of optimal solutions for the application, obviously, should be based on the study of the operating experience of already existing devices in conditions as close as possible to real ones (pilot zones of trial operation) and should be carried out taking into account the specifics of the tactical, technical and economic characteristics of the means of detecting and photo-video recording of violations of the Traffic Rules currently available on the world market [1,5,9]. The development of a system of automatic photo and video recording of violations of the Road Traffic Rules contributes to the prevention of offenses in the field of road safety, significantly affects the discipline of drivers and makes a significant contribution to reducing the number of accidents, as well as the number of deaths and injured people. Various types of violations of the Traffic Regulations (driving on the lane of public transport, driving through a red traffic light, exceeding the speed - the average speed of traffic on the site, rules for stopping and parking vehicles) require an individual approach in applying the method and means of photographic and video recording. Photo and video recording in the automatic mode of violations of the Traffic Rules (except for recording the instantaneous speed of movement and the rules for stopping and parking) in the Republic of Belarus has not yet been performed. The creation and widespread use of information-measuring and control systems for traffic management is one of the main directions in solving economic, environmental and humanitarian problems that exist in cities and regions with heavy traffic flows. Optimization of traffic flows by controlling traffic throughout the road network will significantly increase the throughput of roads, improve the ecological state of cities, reduce the number of road accidents, congestion, and increase the service life of cars. To organize traffic control, it is necessary to assess the parameters of the traffic flow in the entire control area, to ensure the transfer of information to control centers and the formation of coordinated control commands. One of the main elements of the traffic control information and measurement system is a vehicle detector, which provides an estimate of the traffic flow parameters. The detectors are used as a means of monitoring and evaluating traffic flow parameters, providing the ability to adapt the control system.

As of the beginning of 2021, there are 824 traffic light objects in Minsk, of which 637 are in contact with the MCC of the ATCS. To date, as a result of many years of work by city organizations, in Minsk, transport detectors have been installed at 91 controlled intersections. Nevertheless, this amount is

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not enough for the information service of the city's road traffic network and the implementation of adaptive control algorithms at the tactical and strategic levels. One of the most promising directions in the development of vehicle detectors, which provides high technical and economic indicators, is the use of radar devices. Radar detectors are third generation detectors and have become available on the Belarusian market only recently. Previously, the high cost of this equipment, as well as the need to adapt software controls, settings and data transmission, limited the possibility of using these detectors to create traffic control systems in Minsk (they are not used to date)

2. General provisions and international experience of automatic speed control

The first radars capable of detecting a moving object and even determining its speed were invented by the Soviet scientist Pavel Oshchepkov, who in 1932 made a report in which he spoke about his discovery [10]. True, then he proposed using the effect of the reflection of radio waves to search for flying aircraft, which, in fact, was experimentally proved in January 1934. An article about the successful experience of detecting an airplane flying at an altitude of 150 meters immediately became a scientific sensation. The first radars to control the speed of vehicles began to be used in the USA, in the states of Michigan and Indiana, back in 1954. It was during these years that the total motorization of America fell. A huge army of new drivers, who had no family driving traditions, scampered along American roads at top speeds, causing many accidents. Prior to 1961, speed-control radars were cumbersome and often stationary. Only after the American company Radatron Tonawanda mastered the production of the first mini-radars, almost all traffic police began to use them. This radar operated at a frequency of 2.455 GHz, and the allowable distance, less than which the control was considered reliable, was considered two kilometers. How it works was published on the pages of the American publication Popular Electronics [5,7,12].

The first radars in the USSR appeared in 1972 in accordance with the Resolution of the Council of Ministers of the USSR of July 20, 1972 No. 539 "On additional measures to ensure road safety." Until the 80s of the last century, the traffic police used a mechanical radar with a light speed indicator "Headlight", which was triggered to overspeed with a light signal - that is, the light on the device simply came on, and the threshold was set by the inspectors themselves. Only with the advent of the Barrier radar did it become possible to record a specific vehicle speed [12]. Recently, in Europe, systems for controlling the average speed of a car on highways have been actively introduced. A conventional camera measures the instantaneous speed when a car passes in front of it - accordingly, drivers only need to slow down in front of the camera - to slow down to the permissible speed, and then you can drive as much as possible. There are also a number of devices that help detect such cameras: from radar detectors that respond to the radiation of a speed meter, to a banal database of cameras loaded into a navigator or smartphone.

Even if there are no devices that help to detect speed control systems, it is almost impossible not to notice the camera, so the movement is carried out in the stream: the stream starts to slow down, because someone has a radar detector, someone lives nearby and is aware of all control zones - the social side works perfectly. The system for measuring the average speed records the number of the car at the entrance to a certain section, and the second time - at the exit, based on the time it takes to pass the section, the average speed of the vehicle is calculated - a fine is imposed if the average speed exceeds the established limits. As a rule, the devices are installed at a distance of 0.2–10 km from each other (from the experience of using the Avtodoria complexes in Russia). This distance is

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strictly defined and invariable at each specific section of fixing the average speed. These photographs and data on the travel time between the two cameras are transferred to a single center, and with the help of a special program, the license plate number of the car is recognized and the time taken for it to cover the distance is calculated, this is how the Avtodoria complex operates, the work of which is necessarily tied to a single center [13,14,15].
When driving on Italian motorways with the old speed control method, the typical average ground speed (measured by the vehicle's computer) is around 110-115 km / h. It is quite obvious: you cannot go more than 130, but less you have to go quite often - then the queue gathers when overtaking a truck by a slow car or bus, dense traffic or a queue of people slowing down in front of the camera - in order to exponentially go less than the limit [11,12] (Figure 1).

Figure 1: Beginning of the average speed control section by the "Tutor" system on the motorway in Italy.

The Tutor Autostrade application has the best coverage in the country, the database is automatically updated via the Internet and contains, in addition to the Tutor system, the Vergilis system (several similar control systems are being deployed in Italy). The more flexible Tutor Tracker also takes into account the margin of error in speed measurement. According to Italian law, this is 4%, that is, up to 136 km / h a fine will not be issued to you, the amount of excess will be calculated from the same figure: "+10 km / h" (147 km / h) entails a minimum fine of 48 €, the next rate 79 €. The application also shows the recommended driving speed, taking into account your real average speed from the beginning of the section and the current limit - it makes calculations (Figure 2).

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Figure 2. Settings of speed thresholds in the "Tutor Tracker" application.

As a result, the average speed of a trip on highways with one of these applications brings the average ground speed to 125-130 km / h, and an increase in the average ground speed by 15-20 km / h will allow an additional fifty kilometers to be covered in three hours of travel, or an extra 15 a minute's respite at a roadside cafe. One way or another, this allows you to drive faster, more comfortable and safer, and also allows you to save fuel [14]. Average speed measurement systems operate in Austria, Spain, Italy, Great Britain, the Netherlands, Portugal, France, Finland, Switzerland and other countries. In Great Britain, this method of measuring speed has been in effect since 1999, in Austria and Switzerland for more than 10 years. Countries applying average speed controls indicate that on controlled sections of the road, this helps to significantly reduce the number of deaths, and depending on the country, by about 80%. Swiss traffic safety experts point out that average speed controls contributed to Switzerland's road safety rating in 2017 as the safest country in Europe [15].

3. Description of the pilot project and its area

The purpose of the pilot zone is to experimentally test the technology and means of detecting speed violations by calculating the average speed of movement on a section of the street. Tasks implemented during the pilot project: verification of the technology of recognition of state registration plates of vehicles and compliance with the round-the-clock operating mode (without supervision); formation of a model of the evidence base for an administrative offense; checking the compliance of the devices used with the requirements of manufacturability, compatibility, reliability, metrological and hardware-software; the formation of general requirements for the organization of control zones of the average speed of movement, taking into account the results (statistics) for the pilot zone.

The implementation of the pilot zone for the trial operation of technical solutions for fixing violations of the average speed of travel of vehicles on the UDS section was carried out in September - December 2020 within the framework of a cooperation agreement (partnership) between the Municipal Department of Internal Affairs of the Minsk City Executive Committee and the Safe Roads of Belarus CJSC. The pilot zone is organized on the section of Olshevskogo street from house No. 61 to house No. 59 (within the boundaries of Zhudro St. and D. Serdych St.). The investigated section of the street includes: regulated intersection with lane 6th Passage; regulated pedestrian crossing

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opposite the house number 61; unregulated intersection with the lane 8th Passage; exits from adjacent territories (4 pcs.); stopping points of route passenger transport (2 pcs.).
Currently, the main transport function of Olshevskogo Street, within the studied area, is the distribution of traffic flows from the 2nd city transport ring (Pushkin Avenue) towards the residential districts "Masyukovshchina - 1", "Rakovskoe shosse - 7" and "Rakovskoe highway - 3 "(up to P. Glebka street). The length of Olshevskogo street is 2.9 km, the length of the pilot zone is 339 meters, and the length of the street section controlled to measure the average speed is 300 meters. The main objects of attraction in the investigated area of Olshevskogo Street are (Figures 3 and 4): Minsk city polyclinic No. 12 (house No. 61 on Olshevskogo street); State Educational Institution "Secondary School No. 81 of Minsk" (house No. 70 on Olshevskogo St.); State Educational Institution "Secondary School No. 128 in Minsk" (house No. 59 on Olshevskogo St.); GUO "Nursery-garden No. 411 of Minsk" (house No. 74A on Olshevskogo street); stopping points of route passenger transport "Polyclinic No. 12" and "Danila Serdich"; Park of culture and recreation of regional significance.

Figure 3. Objects of attraction in the pilot zone. Figure 4. Scheme of traffic organization in the pilot zone.

Traffic in the section of the pilot zone along Olshevskogo street is organized in 2 lanes for traffic in both directions, the width of each of which is 5.25 meters (Figure 3.1.2 shows a traffic management scheme in the pilot zone). In accordance with clause 5.1.1 of TKP 45-3.03-227-2010, and the estimated speed of movement of vehicles for category Zh2 in free conditions is 60 km / h. The maximum permitted speed of traffic in the area of the pilot project on Olshevskogo Street is limited to 40 km / h from 7:00 to 20:00, at other times according to traffic rules - 60 km / h. The investigated section of Olshevskogo Street is made with a roadway covering made of asphalt concrete, road markings are made of road marking enamel, and road signs are installed of the 3rd standard size with a reflective surface of class 1B according to STB 1140. As can be seen from Figure 3.1, on the odd side of the pilot zone, high-rise residential buildings prevail, and on the odd side - private estates, which influenced the formed zones for stopping and parking vehicles on the roadway by citizens living or working in the indicated quarter - opposite house No. Olshevskogo street (State Educational Institution "Secondary School No. 128 of Minsk")

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4. Applied average speed control technology

During the implementation of the pilot zone for the pilot testing of technology and means of fixing speed violations by calculating the average speed of movement on the section of Olshevskogo street, the software and hardware complex "RoadEye S01" (hereinafter - KPA), produced by SZAO "Safe Roads of Belarus" in the Republic of Belarus, was used (TU BY 191694101.001-2019). The area of application of the "RoadEye S01" complex is the formation of photographic materials with recognized state registration plates of vehicles on the controlled section of the road with the display of the current time and location of the checkpoint (Figure 5).

Structurally, the KPA consists of a computing unit and a video module. On the body of the computing unit there are sealed connectors for connecting power cables, data transmission (ethernet) and antennas (coaxial). The video module is made in an impact-resistant and dust-and-moisture-proof thermal casing with an adjusting bracket and contains: IP-camera of the Vivotec LPC type, with a resolution of 2 megapixels and higher, transmitting a video stream using the rtsp protocol; infrared illuminator with an adjustable illumination angle (10 ° ~ 30 °) and a wavelength of 850 nm, with an object illumination range of at least 50 m. KPA are designed to operate in a continuous mode, and are stationary placed on supports, racks and other elements of the arrangement of highways and streets (Figure 6).

Figure 5. Video module and computing unit of the "RoadEye S01" complex.

The computing unit is made in the form of a hinged electrical cabinet, protected from dust and moisture, in which the following equipment is located: an industrial device for information processing with a built-in GLONASS / GPS module and installed software, designed for receiving, processing and storing information, equipped with network interfaces for connecting an IP camera and data transmission equipment, as well as a GPS antenna. The device is equipped with a drive for recording and storing generated files, the memory capacity allows you to simultaneously store at least 20,000 files; wireless cellular router 3G with ethernet interfaces, designed to transfer information through networks of cellular operators; a 24V / 12V voltage converter with a nominal input voltage of 24V, an output voltage of 12 V, a maximum output current of at least 5A, designed to power an industrial information processing device and a wireless 30 router. The principle of operation of the KPA is based on receiving information about the video stream from the IP camera installed at the entrance and exit of the control zone, and receiving the time and coordinates values from the receiver of signals of the global satellite system built into the KPA (Figure 7).

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Figure 6. Placement of the video module on the street lighting support.

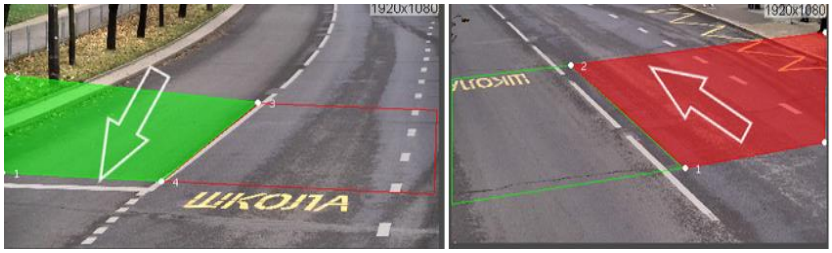

Figure 7. Location of control points in the pilot zone on Olshevskogo street.

After receiving data on the time and coordinates, a file is formed with the image of the state registration plates of vehicles and data on the current time and location of the checkpoint, which is determined at the time of recognition of the state registration plates of vehicles (model of the evidence base). Files are saved to the internal memory of the KPA in JPG format and can be transferred to the end user of information via wired (ethernet) or wireless (cellular) communication channels. KPA "RoadEye S01" (TU BY 191694101.001-2019), during the implementation of the pilot project was registered in the State Register of Measuring Instruments under the number RB 03 23 7790 20 and approved for use in the Republic of Belarus from October 29, 2020. (certificate of the State Committee for Standardization of the Republic of Belarus No. 13812). The main metrological and technical characteristics of the KPA "RoadEye S01", according to the description of the type of measuring instruments for the State Register of Measuring Instruments (approved by the RUE "Belarusian State Institute of Metrology") is controlled during annual tests and verifications. The completeness of the "RoadEye S01" complex (TU BY 191694101.001-2019) is as follows: Video module (IP-type video camera Vivotec LPC; waterproof casing; mounting bracket; IR illumination);. Computing unit (industrial device for information processing with built-in GPS module; GPS antenna; converter 24 / 12V; NumberOK software); Passport; Operation manual; Method of verification.

5. Analysis of the results of the implementation of the pilot zone

During the implementation of the pilot zone on the Oleshevskogo street section for the trial operation of the "RoadEye S01" complex to fix violations of the average travel speed, a model of the evidentiary base (with metrological characteristics) was formed to issue an order on the imposition

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of an administrative penalty in cases of administrative offenses for exceeding the driver of the vehicle, the set speed (Figures 8 and 9).
The photograph (file in JPG format) with the image of the state registration plates of vehicles indicates the metrological characteristics (about the current date, time and location coordinates), which are formed in the form of a stamp at the bottom of the frame and include (Figure 10): the first line is “Date: 04/15/2020, Time: 16:29:50, Lat: 53 ° 53.9150 N, Lon: 27 ° 34.4104 E, Status: OK, License plate: 1111AA7 "; the second line - "RoadEye S01, RE-2019-07-00018", where: "04/15/2020" - date; "16:29:50" - time; "53 ° 53.9150 N" and "27 ° 34.4104 E" - coordinates; "OK" - the status of connection to satellites (OK or FAIL); "1111AA7" - recognized state registration plate; "RoadEye S01" - KPA type; "RE-2019-07-00018" is the serial number of the KPA.

Figure 8. Model of the evidence base during daylight hours.

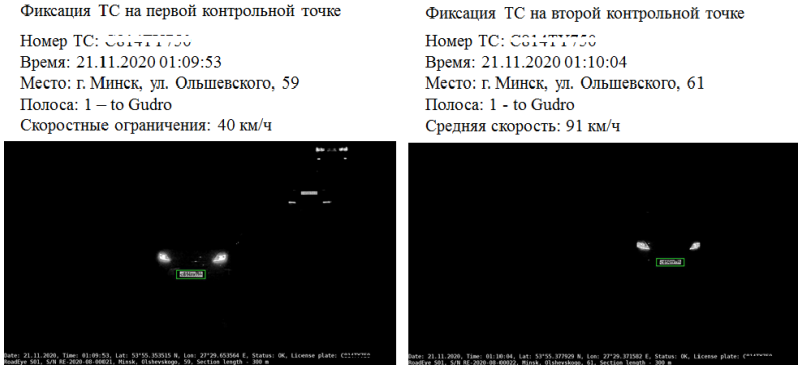

Figure 9. Model of the evidence base in the dark.

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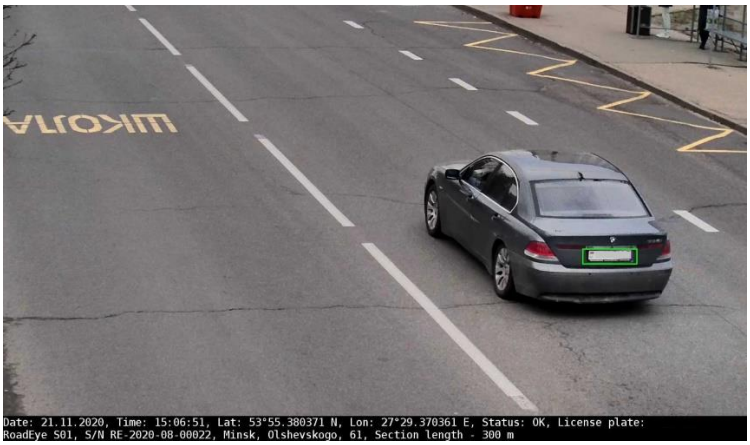

Figure 10. Photo with metrological characteristics.

On the organized pilot zone for controlling the average speed of vehicles for the period of its operation (September-December 2020), statistical results were obtained on exceeding the set speed and the total number of passes.

Table 1 shows data for October and November (where weekends are highlighted in red). On average, 8.17% of offenders per day from the total number of travelers, while on weekends the number of offenders increases in relation to weekdays (from 6.7% to 11.4% in October and from 7.5% to 11 , 0% in November), with an overall decrease in the number of travelers on weekends in October by 47.5% and in November by 42.0%. The maximum average travel speed on weekends (on Saturday 11/21/2020 at 15:06) was 93 km / h, and on weekdays (on Monday 11/23/2020 at 13:46) - 85 km / h. Table 3.3.2 presents general data on the number of passes and excess of the set speed for November and December, taking into account the errors of the metrological characteristics of the KPA "RoadEye S01", according to the description of the type of measuring instruments for the State Register of measuring instruments, the limits of the permissible absolute error of the time scale in sync mode is ± 3 seconds.

As we can see from Table 2, the number of violators, taking into account the metrological requirements, sharply decreases (32.7 times - the total number in November, 36.2 times - in December). This is due to the fact that the error of ± 3 seconds (the total error for recording violations at the entrance and exit is 6 seconds) from the National Timeline is too large in relation to the control zone of the average speed of movement for the pilot project on Olshevskogo Street (300 meters). Even if the average speed is slightly exceeded by 11 km / h (in the zone where the permitted maximum speed is 40 km / h), the travel time of this section will be 21.2 seconds, and taking into account the error, the excess by 11 km / h will be recorded only when travel in 15.2 seconds, while if the error is brought to ± 1 second, the same fact in 15.2 seconds (travel without taking into account the error in 17.2 seconds) - it would already belong to the category of 61 km / h.

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Table 1: Overspeed data for October and November

date	Number Violations	Passages	% of violation	date	Number Violations	Passages	% of violation
	October 2020				November 2020		
01.10.2020	544	8 059	6,75%	01.11.2020	182	4 256	4,28%
02.10.2020	429	6 670	6,43%	02.11.2020	415	4 470	9,28%
03.10.2020	465	5 324	8,73%	03.11.2020	567	4 052	13,99%
04.10.2020	349	4 982	7,01%	04.11.2020	445	6 945	6,41%
05.10.2020	427	5 079	8,41%	05.11.2020	658	8 030	8,19%
06.10.2020	454	7 228	6,28%	06.11.2020	445	8 946	4,97%
07.10.2020	504	7 503	6,72%	07.11.2020	907	5 602	16,19%
08.10.2020	581	7 650	7,59%	08.11.2020	825	4 685	17,61%
09.10.2020	594	8 153	7,29%	09.11.2020	622	7 632	8,15%
10.10.2020	772	5 040	15,32%	10.11.2020	667	8 096	8,24%
11.10.2020	432	5 442	7,94%	11.11.2020	694	8 035	8,64%
12.10.2020	509	7 343	6,93%	12.11.2020	545	7 577	7,19%
13.10.2020	508	7 445	6,82%	13.11.2020	600	7 445	8,06%
14.10.2020	424	6 847	6,19%	14.11.2020	859	6 847	12,55%
15.10.2020	522	7 057	7,40%	15.11.2020	893	7 007	12,74%
16.10.2020	494	7 395	6,68%	16.11.2020	477	7 418	6,43%
17.10.2020	748	4 984	15,01%	17.11.2020	392	4 984	7,87%
18.10.2020	710	4 737	14,99%	18.11.2020	543	3 767	14,41%
19.10.2020	513	7 627	6,73%	19.11.2020	619	7 627	8,12%
20.10.2020	570	8 081	7,05%	20.11.2020	525	8 081	6,50%
21.10.2020	573	8 030	7,14%	21.11.2020	908	8 030	11,31%
22.10.2020	531	8 169	6,50%	22.11.2020	531	8 169	6,50%
23.10.2020	593	8 322	7,13%	23.11.2020	475	8 253	5,76%
24.10.2020	760	5 522	13,76%	24.11.2020	498	8 229	6,05%
25.10.2020	447	5 286	8,46%	25.11.2020	336	4 573	7,35%
26.10.2020	512	7 564	6,77%	26.11.2020	571	7 472	7,64%
27.10.2020	408	8 051	5,07%	27.11.2020	568	8 613	6,59%
28.10.2020	479	8 011	5,98%	28.11.2020	929	6 031	15,40%
29.10.2020	223	3 452	6,46%	29.11.2020	459	8 154	5,63%
30.10.2020	383	7 125	5,38%	30.11.2020	541	8 313	6,51%
31.10.2020	974	8 275	11,77%	-	-	-	-
total:	**16 432**	**210 453**	**7,81%**	**total:**	**17 696**	**207 339**	**8,53%**

It is obvious that with an increase in the threshold for exceeding the speed limit or the permitted maximum speed of movement in conditions of an error in fixing the time of violation of ± 3 seconds, as well as the length of the control zone of 300 meters, the probability of fixing the fact of violation tends to a minimum value. After analyzing the data shown in Table 2, one can see a significant decrease in the number of violations in December in relation to November and October (by 23.9%

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and by 18.1%, respectively) with a slight change in the traffic load. This change can be attributed to the fact that December 9, 2020. the fact of a pilot zone for experimental testing of technology and means of fixing speed violations by calculating the average speed of movement on the Olshevsky street section was widely covered in the media (minsknews.by, onliner.by, av.by, abw.by, etc.), which indicates a more effective provision of road safety when monitoring compliance with offenses without broad information and publicity, including without warning road signs. It should be noted that during the deployment of the pilot zone using the "RoadEye S01" KPA, a small amount of installation work is required, and taking into account the power supply of the computing unit and the video module from a traffic light facility or mobile power supplies, the complex can be used as a temporary measure in certain areas with seasonal a factor in increasing accidents, increasing the risk of an accident or traffic load.

Table 2: Data on exceeding the set speed, taking into account the error

Data		October 2020		November 2020	
		Per month	Average per day	Per month	Average per day
Total	Number of passages	190 008	6 129	206 402	6 880
	Number of violations, excluding errors	18 036	582	13 466	449
	% of traffic violations, excluding errors	**9,49%**	**9,49%**	**6,52%**	**6,52%**
	The number of violations, taking into account errors of 6 sec.	551	18	367	12
	% of violations from passage, taking into account errors of 6 sec.	**0,29%**	**0,29%**	**0,18%**	**0,18%**
On a weekday	Number of passages	147 806	4 768	169 080	5 636
	Number of violations, excluding errors	11 309	365	8 875	296
	% of traffic violations, excluding errors	**7,65%**	**7,65%**	**5,25%**	**5,25%**
	The number of violations, taking into account errors of 6 sec.	286	9	211	7
	% of violations from passage, taking into account errors of 6 sec.	**0,19%**	**0,19%**	**0,12%**	**0,12%**
On a weekday (7:00 - 20:00)	Number of passages	128 374	4 141	146 540	4 885
	Number of violations, excluding errors	7 261	234	5 328	178
	% of traffic violations, excluding errors	**5,66%**	**5,66%**	**3,64%**	**3,64%**

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Data		October 2020 Per month	October 2020 Average per day	November 2020 Per month	November 2020 Average per day
	The number of violations, taking into account errors of 6 sec.	111	4	94	3
	% of violations from passage, taking into account errors of 6 sec.	**0,09%**	**0,09%**	**0,06%**	**0,06%**
Total >61 km/h	Number of violations, excluding errors	2 824	91	1 977	66
	% of traffic violations, excluding errors	**1,49%**	**1,49%**	**0,96%**	**0,96%**
	number of violations, taking into account errors of 6 sec.	3	0,10	8	0,27
	% of violations from passage, taking into account errors of 6 sec.	**0,0016%**	**0,0016%**	**0,0039%**	**0,0039%**

6. Discussion

Control of the average speed of passage of a section of the street for the most effective security should be carried out without warning road signs 1.36 "Traffic control" or with the use of a new type of information and direction signs 5.44 "Beginning of the average speed control zone" and 5.45 "End of the average speed control zone speed "shown in Figures 11 and 12 (the road sign of the beginning of the control zone in Figure 12 can be used in conjunction with the road sign 3.24.1" Maximum speed limit ").

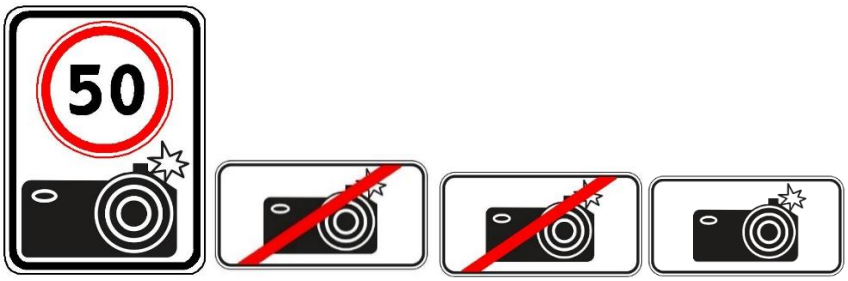

Figure 11. Suggested informational signs. **Figure 12. Suggested informational signs.**

Based on the results of the study of the current legislation, proposals were developed for making changes to more effectively ensure road safety: to introduce into the Code of Offenses and the Procedural Code of Execution the general rule on the possibility of fixing by special technical means any administrative offenses against traffic safety and operation of transport, and to exclude parts 5-8 of Article 18.13 of the Code of Offenses and parts 6-7 of Article 18.22 of the Administrative Code; to reflect the issue of fixation by special technical means of any administrative offenses against traffic safety and operation of transport in the Law of the Republic of Belarus dated January 5, 2008 No.

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313-3 "On road traffic" and the resolution of the Ministry of Internal Affairs of the Republic of Belarus dated June 01, 2012 No. 155 "On approval of the Instruction on the organization of the activities of units of the road patrol service of the State Automobile Inspectorate of the Ministry of Internal Affairs of the Republic of Belarus "; - provide for the possibility of establishing the fact of speeding on the basis of the average speed of the vehicle in a certain area. In this case, provide by a note that the average speed is determined by dividing the distance traveled by a vehicle by the time spent by this vehicle to overcome this section.

7. Conclusions

Conclusions based on the results of the pilot zone: for a better application of the "RoadEye S01" on small city streets (with a minimum length of spans), it is necessary to make improvements in the synchronization of fixing the time of entry / exit in relation to the National Time Scale, to an error value of ± 1 second; it is recommended to control speed modes by measuring the average speed of a vehicle's passage of a section of a street (highway) on control zones with a length of about 1500 meters, which is most effective for exercising control on republican highways and main streets of cities; the presence of curves in the plan and profile of the street section where the average travel speed is measured, as well as measures to calm traffic, traffic light regulation and unregulated intersections (junctions of secondary streets, driveways of the adjacent territory, parking lots, etc.); the quality of detecting the fact of violation of speed limits is not affected, only the number of detected offenses; complex "RoadEye S01" can be used as a mobile (for example, during the season of the year); the data obtained based on the results of the pilot zone functioning, the generated model of the evidence base and the certificate of the State Committee for Standardization of the Republic of Belarus No. 13812 on registration of the measuring instrument indicate the readiness to use the "RoadEye S01" complex on road in the Republic of Belarus; developed practical recommendations and proposals for the application of the "RoadEye S01"; carried out a qualitative analysis of the application of the technology for controlling the speed modes by recording the fact of exceeding the average speed of passage of a section of the street; a model of the evidence base was developed to record the fact that the average speed of passage of a section of the street was exceeded and proposals were made for equipping the place of implementation of such control; a pilot zone was equipped and a practical study of compliance with the technical conditions and quality characteristics of the radar detector was carried out; carried out a practical study of the effectiveness of the use of radar technology for adaptive traffic light regulation.

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