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SYSTEM-INFORMATION COMPLEX OF MONITORING AND INTELLIGENT DISPATCHING OF CARS ON HIGHWAYS

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Abstract. The article describes the hardware-software system, designed to prevent system accidents on highways by early informing drivers who are at risk of a possible collision about the accident. The considered complex of monitoring and intellectual dispatching of vehicles allows to increase the time for making a decision about emergency braking and its implementation and, thus, to increase traffic safety on highways.

Keywords: system accidents, monitoring car traffic, intellectual dispatching of vehicles.

Introduction

Transport problem is the subject of a great interest around the world. There is a conflict of ideas, the clash of opposite views. Information and communication technologies are developing with trend forecasting and definition of resource potential. This allows drivers to increase their information resource in an emergency. The problem of automobile transport safety becomes one of the most complex and topical in situation of density increase and traffic speed on city streets, and especially on expressways. The complexity of its solution increases because of raised risks of objective (meteorological) property influence on traffic. It results in an unexpected deterioration of road conditions that leads to sudden changes of the pavement physical characteristics. The traction coefficient with the road surface decreases (rain, snow, ice), as well as the visibility reduces (rain, fog, smoke). These factors usually lead to occurrence and an accident progression of systemic type (abbr. AST), caused by the domino effect

This accident is characterized by at least two following features. The first, the source of the accident is a traffic jam on the roadway, which completely blocks the movement and excludes the possibility to bypass the obstacle. The second, the subsequent car drivers don`t have time to put the brakes on and become participants in an accident because they lack a safe stopping distance for a complete stop. The number of participants in an accident depends on the average velocity and the density of moving stream of cars. Also it depends on the value of a safe braking distance.

AST often continue to develop after the arrival of traffic police and taking measures to eliminate the consequences. As a rule, AST are characterized by a large amount of material damage, death and injuries of people. On the figure 1 is shown an example of AST. This accident occurred in December 2019, in the US state of Virginia, when 69 cars collided due to ice and fog, 51 people were injured [1].

Figure *1.* –Accident progression of systemic type [1]

The first, the most obvious solution is aligned with increasing of braking efficiency of a car in extreme conditions. Patent search returned several solutions. One of them consists in equipping cars with false bottom, which becomes a major brake platform with the help of hydraulic cylinders in the case of an emergency situation. Another solution is related to the possibility of equipping a vehicle braking parachutes. However, these and similar devices do not lead to a safe emergency stop, because it can produce even more chain of possible collisions caused different reactions of drivers, different

road conditions and other cases in situations of emergency braking. In general, method of solution which associated with the reduction of braking distance is erroneous way to solve the problem.

In our view, the problem solution of preventing AST consist in time increment to make a decision about the emergency brake and its actualization, in other words, it consist in early driver awareness about possible collision.

The purpose of this work is to develop a method for preventing system-type accidents on highways.

Research results

Methodology of problem solving and system design. The object of the research is an accident of systemic type (AST). The subject of the research are monitoring and technical means of tracking and driving cars in extreme conditions, that prevent accident progression of a systemic type (AST). These solutions may also be used for monitoring and intelligent dispathing by other moving objects, mainly ground vehicles. In addition, they can be used in the system of traffic management in a district, city, state or region.

Boundary conditions for solving the problem. Then to solve the problem, it is necessary to formulate a range of boundary data for solving the problem. First of all, we need to identify an accident of systemic type (to separate it from the ordinary number of collisions). The second, it should inform drivers about the beginning of the accident. Thereby the lack of time is overcame to complete a safe stop. The third, the decision is based on logistics principles - an early warning to control the flow of cars.

Finally, fourthly, the signal about the rise of the accident is transmitted not only to cars driving on the highway, but also to signal beacons arranged along the highway, as well as to emergency services. So, we formulate the original problem: it is necessary to determine the place of origin of system accident and to provide information about the dangers of car moving on the highway in the direction of a possible collision.

Block diagram of the complex. Detailed description of the preferred embodiment of the system complex. We propose a method and system for monitoring and intelligent dispatching of cars on motorways. [2]. Complex system of intelligent control of traffic will allow painlessly to increase the technical capabilities of the modernization process of existing systems, traffic management traffic arteries of the city, state, region due to its modularity. The general view of the technological scheme of monitoring complex system, intelligent traffic control and monitoring of cars on motorways is presented on the Figure 2. The scheme consists of the named main blocks.

For example, built-in airbag car sensor triggers after car accident on the road. It turns on an onboarder delivering special low power emergency stop signal. Transceiver GSM connection to the amplifier is installed on the car, which amplifies the signal directly proportional to the airbag has been deployed.

Activator signal receives the amplified signal and switches on a warning triangle and a turns on soundtrack with increasing frequency on the instrument panel and displays of road users. The activator signal can be used as mobile phones, GSM-navigators et al. Increasing emergency stop signal allows to judge the degree of accident, to increase the time for decision

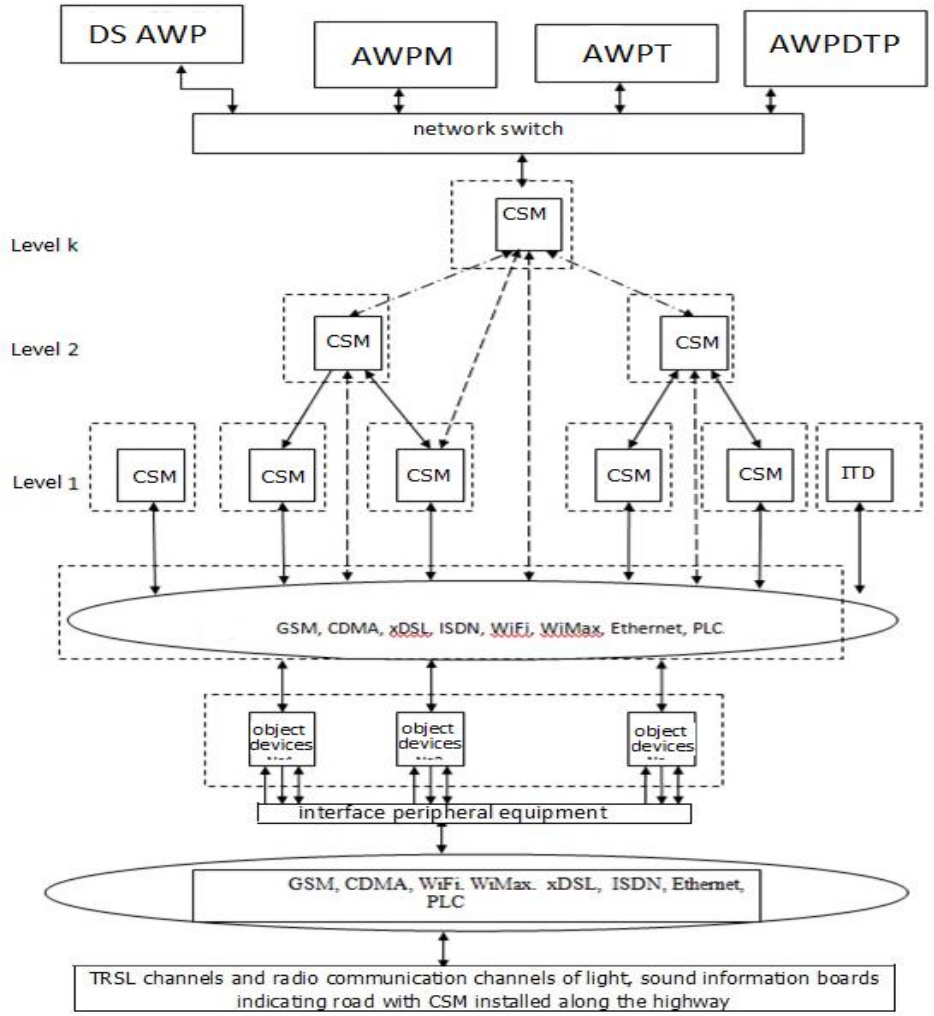

Figure *2*. – General view of the technological scheme of the complex system of monitoring and intelligent scheduling and monitoring of vehicles on motorways with the name of the main unit. 1, 2, 3 - central station scheduling, control and monitoring (CSM); 4 - Car object devices (OD); 5 - Interface modules with 6 channels of communication (IM); 6 - unit wire channels and wireless communication channels; 7 - individual terminal device (ITD); 8 - Cell means of individual radio modem, fax, pager; 9 - interface peripheral equipment; 10 - transceiver radio channels, channels of sound and light display placards road (TRSL); 11 - database server and display automatic workplace (DS AWP); 12 - automatic workplace Manager (AWPM); 13 - automatic workplace technologies (AWPT); 14 - automatic workplace duty traffic police (AWPDTP); 15 - Network Switch; Level 1 - regions, autonomous station CSM 1; Level 2 - territorial station CSM 2; Level k - For the regional level, regional CSM 3.

and emergency braking as compared with the time obtained by visual channel and therefore this is allow to increase the braking distance and break the chain of accidents.

Complex system monitoring and intelligent car dispatching on motorways includes object devices (OD) of cars with airbags and overload shock sensor in the form of instruments for monitoring and control, equipped with modules for interfacing with communication channels, and the associated central station intelligent system contour intelligent dispatching and monitoring (CSM). System complex can be a network of object devices OD and central stations station 1, 2, 3.

Three levels of the system. UCM for receiving and / or transmitting signals alarm, alert, etc. that functions as a centralized point of observation (CPO) is performed at least on three levels: the

level of regions, independent UCM 1 and / or territorial UCM 2 and / or regional level, regional UCM 3. UCM 1, 2, 3 is provided with an interface of adaptive exchange with cars` OD, each of which is equipped with onborder, and GSM radio wireless signal transmitters. Each onborder is compatible with car gyroscope to navigate in three dimensions. The GSM radio wireless signal transmitter is activated from OD when there is a collision of at least two cars. The signal from OD is sent out to radio wireless devise UCM that is performed, for example, as a mobile communication module of industrial standard GSM.

Navigation systems. OD 4 vehicle may be provided with at least one individual terminal apparatus 7, for example, in the form of individual cellular radio device 8, modem, fax, pager, etc. is compatible through interface of peripheral equipment (IPE) 9 at the time of collision with a radio transceiver channels and communication channels of audio and visual information displays (KRSC-10)- road indication with UCM 1,2,3 that are set along the highway. KRSC-10 works with OD 4 of each car for a recommendation to reduce the speed and activate emergency braking systems of moving cars. The master station UCM 1,2,3 of the central control point is a regional center and may contain personal computers made in the form of a database server and display the automatic workplace (DS DAW) 11, automatic workplace Manager DAW 12, automatic workplace DAW 13 of technologist and automatic workplace 4 DAW 14 of traffic police that are connected through communication interface, network switch 15 and cluster module into a single information network. Modernized protocol modes equipment UCM 1,2,3 upgraded protocol FMC may be introduced into the system through the database server workstation DS DAW 11, a block of wire channels and wireless channels 6, 8 and the communication interface 9 for controlling the peripheral equipment with a predetermined amount of feedback and the type of peripheral equipment KRSC-10 10 and OD 4 of cars.

During the monitoring and tracking processes of a moment of the collision, at least, of two cars, Monitoring Centre fixes using an adaptive exchange interface with the object device of each car with one coordinate point relative to the three axes, identifies the time of a collision and cars that are moving on the traffic lane where there is the traffic accident.

Feedback from onboard equipment. OD sets feedback with board equipment OD-4 of cars that are moving close using data about navigation signals of the collision, turns on the visualization the information about approaching accident and recommendations to reduce the speed on the instrument panel and on the glass display of windshield and / or rear view.

KRSC -channels and radio communication channels of light and sound information boards of road display with UCM, that are set along the highway in adjusted mileage, are fixing the moment of a collision at the same time. These systems define recommendations for inclusion braking systems of moving cars on displays of each car.

Signals about the accident and all moving vehicles is automatically transmitted mainly through the channels of wire, radio, GSM connection by the system of contour scheduling, including DAW of Manager, DAW of duty traffic police, DAW of ambulance.

Hazard notices. *Example of specific performance.* In the normal state of OS 4 cars can be transmitted / received to / from the station 1, 2, 3 at specified intervals only the control and test signals and controls its inputs and / or ports. Upon receiving a signal from the car accident peripheral equipment life support systems and safety, process equipment system objects does OU 4 analyzes it, determines the nature of the signal and its priority, if necessary, modifies, and generates a notification for subsequent transmission to station one, two, three. To transfer notices through the available channels six or programmed delivery notification (PSTN, GSM, CDMA, xDSL, ISDN, WiFi, WiMax, Ethernet, Internet, PLC, radio, etc.) and through the module five interfacing to channel six transmits a notification to the FMC one, two and three in accordance with a predetermined route, and priority.

Upon receipt of the station one, two, three, four control signals OC analyzes it, determines the nature, generates and transmits to the outputs and / or the port control commands via a network switch

five system database server workstation eleven for the sustenance and safety of the facility and / or processing equipment.

Station 1, 2, 3 provides reception, analysis and processing of notifications from DU 4, transmission / reception with the specified frequency test signals to / from the Shelter four, signaling the control of OS four, status monitoring, technical means and channels of communication 6, forwarding or relaying notifications from / to station one, two, three other levels according to the specified route.

In a complex system introduced upgraded protocol modes FMC equipment through the database server (DB APM) and an interface for exchange of feedback control to specify the number and type of peripherals interface comprising channels six, eight classes PSTN communication, GSM, CDMA, WiFi, WiMax, xDSL, ISDN, Ethernet, PLC and radio, decentralized management of local management areas four OC car. System unit is equipped with a set of communication channels containing a wired channel and / or radio channel and / or GSM-channel and / or GPRS for two-way communication interface between the peripheral equipment four OC vehicle through objects peripheral equipment, such as radio channels represented established along highway through the database server (DB AWP).

The principle of operation of the system complex. Served on command and central control UCM runs technological cycle started. After inclusion of workstations ARM eleven - fourteen ARM-based personal computers loaded specialized networking software and start testing all components of the peripheral equipment of the system with synchronization of a single astronomical time for all FMC one-three. When working ARM eleven - fourteen workstations as part of UCM, an important condition for a single workstation readiness to work is the willingness of the file server. Upon completion of testing and timing is determined by the operating configuration and a list of the faulty peripheral equipment, taking into account existing serviceable equipment selected one of the plans coordinate the management of the selected algorithm, with all peripheral equipment involved in a particular configuration. The resulting information is fed to the UCM in processed form on ARM eleven-fourteen professionals who either make their own decisions on the organization of traffic on either continue to work on the chosen algorithm. The system is designed for non-stop operation.

In ARM UCM is possible supervisory control arrangement as a single road, and a group using the menu items in "Control Mode" from the main menu or the ACT commands can be set directly from the card.

Discussion of results, analysis and comparison with existing analogues. The National Commission on the Motor Vehicle Safety (NHTSA) discussed the suggestion to make the auto manufacturers to equip all new motor vehicles communication system that connects all of the cars on the road in a single network, which will contain all the information about each car - right down to the number of passengers. The network will have access to all relevant authorities, including the police and the NSA. This system is called "vehicle-to-vehicle" or VtwoV - allow the vehicle to get in touch with each other by radio (both Wi-Fi) and perform the exchange of information. On the roads of the United States of America will be built a kind of "auto-Internet", the purpose of which is to improve traffic safety, and at the same time to put all the cars under the hood of the state as a special central computer will be fully knowledgeable about cars and their owners [3]. In addition, interactive communication in an emergency situation, in our opinion, does not contribute to the security of its resolution

In the Republic of Belarus to introduce similar mobile network Carnet. Mobile application developed Carnet metropolitan programmers supported by the traffic police. Currently, it is available for download to owners of devices with the system iOS. Not for a long time the application will run in test mode, and then planned to launch a version for Android

Mobile application for drivers an opportunity for interactive communication, during which you can exchange information about changing traffic conditions, emerging issues and emergency situations and others. Specialized social network, will provide an opportunity to transmit information

on accidents of traffic police on the roads in the form of photos with geolocation to post [4]. Nevertheless, the lack of it is that the emergency information on the possibility of the development of AST is not automated.

The results of patent search let us to find several analogues of the system in question. For example, the way to monitor the status and location of vehicles in which the data is transmitted in the scheduling and monitoring of onboard equipment installed on mobile objects, the center monitoring, including the definition of the coordinate location and other parameters of motion of moving objects. This method is performed according to the navigation signals received from satellites of the global navigation system, such as GPS or GLONASS and / or cellular field pattern. At the same time there is a transfer of data on the status of the individual subsystems of mobile objects, while data is being transferred, such requests or commands from the monitoring center to the avionics on the airwaves, using site-terminal standard cellular mobile networks, such as GSM-network and / or site-transceiver repeater channel [5]. This method is used primarily for the monitoring of stolen vehicles in the case of data transmission in the UHF band signals may be imposed by several moving objects to each other, which reduces the efficiency and reliability of the monitoring and control of mobile objects, and in some situations may lead to an inability to monitor and management.

Also is known the process for monitoring and communications system for high speed highway vehicles, in which data is transmitted from the onboard equipment installed on mobile objects, the center of the monitor, including the determination of the position coordinates and other motion parameters of moving objects, using data from the navigation signals received from a global satellite navigation system, such as GPS or GLONASS and / or cellular field pattern and the transmission of data on the state of individual subsystems of mobile objects. In this case, data is being transferred, such requests or commands from the monitoring center avionics [6].

A disadvantage of the above solutions is that the cellular channel does not fully cover the whole area, as it depends on the terrain, on the density of transmission and reception antennas. Reliability of communication depends on the weather conditions. In the case of data transmission in the UHF band signals may be imposed by several moving objects to each other, since there is no such channel synchronization data, thus reducing the efficiency and reliability of the monitoring and control of mobile objects, and in some situations may lead to an inability to monitor and control moving objects.

Conclusion

The new complex system of monitoring and intelligent dispatching of vehicles solves the problem of preventing the development of an accident on the system type by early warning drivers about the risk of AST.

In comparison with the existing analogues the new system complex of intellectual scheduling, centralized control, monitoring and telemetry allows to send and receive notification not only on the subscriber telephone lines, but on any existing or prospective communication channels by adding modules for interfacing with the appropriate communication channel; the complex provides high rate notices and the possibility of transmission of control commands from the UCM at the Shelter through bilateral communication channel.

The system complex doesn't have the above-mentioned disadvantages of existing analogues: violation of the rights to private information, creating difficulties for the decision-making process while driving a car in an extreme situation by verbal communications, etc.

The complex is a local system of monitoring and intelligent dispatching of vehicles with the function of automatic notification of an extreme situation – the onset of AST and reflects only technical parameters of moving cars, excluding personal information, as well as psycho-emotional engagement of messages. This information-technical complex is designed to stop the development of an accident at it's start point, due to early warning of drivers who are in danger of being engaged in an extreme situation. Early informing and warning of drivers about the AST hazard lets to overcome the lack of time for safe car braking.

In addition, the complex allows to ensure traffic management by providing:

• the possibility to adapt the system using new developments in order to optimize traffic flows;

• the possibility of setting to work for different levels (generation) of traffic management organization, up to the organization of real-time management.

The system complex can be combined via remote communication lines with at least one another similar master station of the central control point to ensure the organization of traffic management of the whole region (district, country).

In the complex system UCM can be equipped with a digital map of all crossroads in the highway management system, with the ability to link to the vehicle's coordinates via GPS and / or via GPRS and to provide a "green wave" passage at a given speed and coordinated real-time control.

The system can be equipped with a navigation module with the ability to inform users via GSM and / or GPS channels about the current value of the traffic flow in specific areas and emergency occurred.

Experimental-industrial development of the system is carried out on the territory of the community of independent states (CIS).

Thus, the system complex in question is the most optimal way to solve the problem of improving the safety of motor vehicles by equipping them with an information device that generates and transmits information – a special emergency stop signal to road users in the case of the AST occurrence and growth.

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