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INTELLIGENT TRANSPORTATION SYSTEMS IN THE TRANSPORT PROCESS

The article is devoted to the consideration of the concept of "Intelligent transportation system" – ITS in modern society. The main world concepts of ITS development, which are aimed at the organization of road traffic in order to comply with road safety, are analyzed. The authors concluded that ITS is the most effective way to qualitatively solve road safety problems.

Keywords: *intelligent transport systems, international project, concept, traffic organization, road safety, information environment.*

Introduction

One of the main tasks of the transport industry is the road traffic organization (RTO) to ensure road safety (RS), using modern telecommunications and information technologies, as well as automation in transport infrastructure [1, 2]. The most effective way to qualitatively solve this problem are Intelligent Transportation Systems – ITS [2]. That is, ITS can be considered as the comprehensive engineering system that aims to increase road safety in order to reduce road accidents (RA) through the implementation of modern information systems. To coordinate actions to increase RTS, the transport policy of many countries is aimed at integrating ITS into the single information space [12].

Analysis of basic research and publications

In the field of motor transport, technical implementation of ITS technologies is associated with the development of telematic elements of road infrastructure and vehicles, as well as with the creation of physical ITS architecture and standards of communication interaction of all ITS entities and objects [3–11, 15–25]. It should be noted that the study of aspects of ITS is devoted to various works by P. Bernozh, B. Williams, P. Przibel, K. Starry, M. Svitek, S. Frank, K. Hatoyama, M.B. Afanasyev, E.E. Aleksandrov, O.V. Bazhynov, V.M. Vlasov, S.A. Harahan, M.Ya. Hovorushchenko, S.V. Zhankaziiev, V.V. Komarov, V.H. Kocherha, V.D. Kondratyev, V.I. Konoplianka, V.A. Korchahin., Yu.A. Kremenets, A.Yu. Mikhailov, T.I. Mikheiev, A.N. Novikov, I.M. Puhachev, V.Yu. Stepanov and others. However, scientists have not yet developed a unified strategy for the creation of ITS and their development in the information environment of transport complexes [3, 7].

Formulation of the problem

To consider the main world concepts of ITS development, aimed at organizing traffic in order to improve the safety of the transport process.

Study materials

ITS development programs exist in many countries in America, Europe and Asia. ITS is considered as one of the most effective ways to solve transport problems and road safety [1, 8–10, 11, 12, 14, 15, 18, 19, 23–25]. To analyze ITS, we present some foreign concepts of ITS strategies.

Japan's ITS strategy. "Intelligent Transport System (ITS) is a system that uses the latest advances in information technology to ensure convenient and efficient transportation of people and goods..." [15]. According to V. V. Komarov, this definition laconically expressed the purpose of ITS, but there are no indications of such aspects as the need to ensure transport safety and road safety through the use of ITS, which reduces its value [7].

Directive 2010/40/EU of the European Parliament and of the Council of Europe of July 7, 2010 on the basis for the implementation of ITS in the field of road transport and the interaction of different modes of transport [7]: “Intelligent Transport Systems (ITS) are modern applications that are aimed at providing innovative services related to different modes of transport and traffic management and allow different users to be better informed, as well as providing greater safety, more coordinated and “smart” use of transport networks...” [14]. In the above definition, the role of ITS in road safety is visible, but it is formulated less categorically.

US Code of Federal Regulations. Title 23. Part 1. Highways. Federal Highway Administration, US Department of Transportation. Subpart E - Planning and Research. Section 450 - Planning and Standards

Support. § 450.104 [7]. Definition: "Intelligent Transport System (ITS) implies the use of electronics, photonics, communications, information processing, used alone or in combination to improve the efficiency or safety of the land transport system ..." [25]. This definition provides a list of areas of technology, the use of which is a hallmark of ITS.

An interesting opinion is expressed by P. Przibel and M. Svitek in his work "Telematics in Transport" [11]. They believe that in terms of terminology in the United States and Japan, these systems used the term "Intelligent Transportation Systems" (ITS), while in Europe in most cases used the term "Transport Telematics". This name originated from the words "Telecommunications" and "Informatics" and shows the close connection between the two industries. One of the most successful definitions of the concept of "Transport Telematics" is the following: Transport telematics combines information and telecommunication technologies with the organization of traffic flows so that the capacity of the existing transport infrastructure increases, traffic safety increases and the psychological comfort of passengers increases. " In this book, the advantage of the term "Telematics", but the reader should be clear that it is a synonym for the concept of "intelligent transport systems" – ITS "[7, 11].

According to V.V. Komarov and S.A. Harahan, the concepts of ITS strategies and the implementation of ITS development projects are carried out at different levels [7, 9, 10, 12, 14]. There is a wide variety of ITS development programs at the territorial level: expressway systems, transport logistics systems, etc. For clarity, let's consider some international ITS implementation projects.

A well-known international ITS project is the Pan-European Project EDEN (European Data Exchange Network) - a European database for data exchange over the transport network, which has been implemented in many European countries since 1996 [13, 14 20]. The implementation of the project contributes to the creation of a common architecture of the network and databases serving ITS, the operational exchange of data on the characteristics of road traffic, the solution of problems in traffic and transportation control.

The structure of the EDEN network includes: European level (EDEN); Transnational level (CENTRIKO, SERTI, CORVETTE, VIKING); National level: CENTRIKO (England, Belgium, Germany, France, the Netherlands, Luxembourg); SERTI (Italy, Spain, Germany, France); CORVETTE (Austria, Italy, Germany); VIKING (Sweden, Denmark, Germany, Norway, Finland). There are three levels of hierarchy: European, regional and national. The regional level means the union of databases and networks of several countries located in one geographical area of Europe [9, 10, 13].

The structure of EDEN participants shows that some countries are involved in the implementation of several transnational projects simultaneously. This removes many of the problems with database integration.

Many countries participate in European international programs DRIVE I and DRIVE II. As part of these programs, some countries have implemented and operated new urban automated traffic control systems (ATCS). In particular, such systems are implemented in Germany (MOTION), France (PRODYN), Italy (UTOPIA), Japan (STREAM) [9, 10, 15].

Using ITS technologies, systems with new functions are created by modernizing standard SCOOT and SCATS systems. That is, it is possible to maintain the efficiency of the systems with a significant increase in transport load [17].

The functions of these systems include: monitoring of traffic flows; identifying congestion of the road traffic organization; automatic accident detection; route navigation; monitoring of travel time in real time; control over the movement of vehicles in the traffic flow, etc. [5–8]. These types of systems manage transportation and traffic.

Information support for road users (RU) during the formation and development of ITS in relation to road safety in the transport process is organized as follows: information transmission via radio channels; interactive information support; autonomous route guidance; dynamic route guidance; integration of traffic data; onboard information support; detection of road accidents; traffic control in dangerous situations; development of the management strategy in specific situations; prompt change of schemes of road traffic organization, etc. [6, 7, 8].

The set of the given functions allows to receive ITS with qualitatively new properties. The characteristic feature of these systems is the high level of information support of road user. Thus, the "transport information market" is created, in which the information service must meet the new requirements for the level of service [5].

The ability to obtain real, personalized and operational information in the process of traffic is a significant problem for most drivers and passengers [8]. To this end, the international PROMISE project aims to create databases through which ITS can inform road users about the conditions of the trip [6]. Various means of communication are used for this purpose: GSM mobile communication, Internet, peripheral terminals, electronic boards, etc. With this, the PROMISE system provides route planning and control throughout the route. The PROMISE system is operated in Germany, France, Sweden, Finland, Scotland, and the Netherlands [22].

The development of the PROMISE project takes into account the following needs of road safety in information support. First, along with general information for all road users, there is a motivation for each driver and passenger to obtain personal information. In this regard, for the commercial success of such information systems it is necessary to divide the market of information flows. Secondly, the information must be direct, prompt, characterize the situation for the user now and at a given point in the network. Thirdly, in addition to basic information when planning a trip, there is a need for additional information services about parking, transport timetables, specific information for the elderly and disabled [5, 8].

One of the main provisions of the PROMISE concept is the possibility of commercial application. Therefore, the information service is carried out taking into account the relevance, functionality, personal characteristics, cost of these services.

It should be noted that the services cover the entire logistic chain of the transportation process and road traffic: planning the regular or multimodal trip; coordination of travel time with transport schedules; booking tickets and other services; operational information about the state of the road network. To meet these conditions, the PROMISE system integrates the following types of organizations that form information flows, i.e.: information owners; information service providers; data transmission operators; distributors [15, 16]. The functioning of such structure provides constant access of road users to dynamic information about the conditions of the trip.

It should be noted the concept of the road safety system CLAIRE, developed in France for the implementation of control actions in traffic jams. This system is compatible with most existing ATCSs. The CLAIRE system produces universal solutions that do not depend on the type of technical means and management methods. The CLAIRE methodology was first applied in Toulouse and has led to the development of a coherent management strategy that takes into account the objectives of all categories of road users.

CLAIRE system carries out: collection and processing of information to assess the state of the flow and identify congestion monitoring of the road traffic organization; additional functions for monitoring situations in traffic jams; telephone notifications of road users; development of road safety and emergency response; transmission of recommendations to the city road safety system; an additional interface for specific information of various users (transmission of information for controlled road signs, information from ALLO TRAFIC telephone exchange, information about the road accident in the city ATCS).

Ultimately, all of these functions should provide the road traffic organization and the allocation of alternative routes to address traffic congestion. Accordingly, the CLAIRE system performs two main tasks. First, the identification of factors that reduce the capacity of the highway. Second, the analysis of the conditions of congestion. Therefore, CLAIRE is the optimization system that transmits the control effect to the city ATCS.

ITS is also developing intensively in the countries of Southeast Asia. For example, the structure of ITS in Kwashon (South Korea) consists of the following subsystems: traffic organization; speed control; navigation system for dynamic route determination; informing public transport passengers; fare payment; weighing vehicles in motion; parking information; different information of drivers [13, 21]. In addition, the automated speed control system continuously monitors speed modes in the four most dangerous areas. At the same time the car number, time and place of violation, speed at the moment of registration are fixed.

In this ITS project, the GPS navigation system determines the location of cars and buses, calculates the optimal routes and provides control over their passage. The information system of public passenger transport informs passengers in real time about the movement of buses according to the route network.

At the same time, the most serious development prospects in ITS have systems of payment for travel on the network of high-speed highways, tunnels and bridges. Control systems that provide route navigation have a large potential market. It is expected that investments in the road traffic organization should reach about $ 300 million.

In the 90's in the United States were clearly articulated the main stages of solving problems of development and implementation of ATCS. This is the mathematical modeling of traffic and traffic flows, the single information system, the electronic system for selecting and indicating the route, the system of assistance to drivers. Currently, the entire network of highways adjacent to major cities (Chicago, Detroit, Los Angeles, New York, etc.) is equipped with ATCS [5].

In the state of Texas, the Texas Department of Transportation has also successfully implemented the ATCS system. It is based on the combination of central hourly and central adaptive management using the library of pre-calculated coordination plans. Systems that predict the average speed and travel time on certain routes are becoming more common. Such systems have a very significant impact on the redistribution of traffic flows.

In the United States and Canada, much attention is paid to the interconnections of the urban system with the system of roads and highways in suburban areas. In Montreal, the city ATCS includes suburban highways, which is approximately 70-100 km from the city [6].

It should be noted that the leading country in the development and use of higher forms of ATCS ITS is Japan. In this country, almost the entire road network, both in cities and on highways, is equipped with local ITS of varying degrees of complexity [15].

In addition to Japan, other countries in the Asia-Pacific region are purposefully investing in the development of ITS. In some Australian cities, the SCATS control system is used for zonal control of transport controllers [19]. It is often combined with other subsystems. Much attention is paid to these issues in South Korea [17].

Thus, it should be noted that, taking into account the analysis of the world practice of the formation and implementation of ITS, when creating a national concept of technical regulation in the field of ITS, the following principles must be observed:

Firstly, each stage is characterized by specific activities.

Secondly, each stage contains their specific description and recommendations for their implementation.

Thirdly, the creation of the national concept of ITS requires the cooperation of specialists in various fields of knowledge. At the same time, the necessary condition is cooperation with European standardization committees in the field of ITS.

Conclusions

Based on the analysis of the world experience of ITS development, the following conclusions can be drawn: ITS are widely used all over the world; ITS is one of the most effective ways to solve road safety and transport problems both in cities and on country roads. At the same time, the expansion of ITS functionality for compliance with the RTS in the transport process is associated with the development of new methods for assessing the quality and forecasting of traffic characteristics in real time mode.

Thus, modern research in the field of ITS construction is relevant and in demand. But it is necessary to develop standards that define both the general requirements for ITS (physical and functional architecture) and the technologies of ITS subsystems, which is the topical issue for further research.

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ІНТЕЛЕКТУАЛЬНІ ТРАНСПОРТНІ СИСТЕМИ В ТРАНСПОРТНОМУ ПРОЦЕСІ

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Одним з основних завдань транспортної галузі є організація дорожнього руху для забезпечення безпеки дорожнього руху, використовуючи сучасні телекомунікаційні та інформаційні технології, а також автоматизацію в транспортній інфраструктурі. Найефективнішим способом якісного вирішення цієї проблеми є Інтелектуальні транспортні системи – ITC. Тобто інтелектуальні транспортні системи можна розглядати як комплексну інженерну систему, яка спрямована на підвищення безпеки дорожнього руху з метою зменшення дорожньо-транспортних пригод шляхом впровадження сучасних інформаційних систем.

У галузі автомобільного транспорту технічна реалізація технологій інтелектуальних транспортних систем пов'язана з розвитком телематичних елементів дорожньої інфраструктури та транспортних засобів, а також зі створенням фізичної архітектури інтелектуальних транспортних систем та стандартів комунікаційної взаємодії всіх суб'єктів та об'єктів інтелектуальних транспортних систем. Однак вчені ще не розробили єдиної стратегії створення інтелектуальних транспортних систем та їх розвитку в інформаційному середовищі транспортних комплексів.

Структура учасників EDEN показує, що деякі країни беруть участь у реалізації кількох транснаціональних проектів одночасно. Це усуває багато проблем з інтеграцією баз даних.

На основі аналізу світового досвіду розробки інтелектуальних транспортних систем можна зробити наступні висновки: інтелектуальні транспортні системи широко використовуються у всьому світі; інтелектуальні транспортні системи є одним із найефективніших способів вирішення проблем безпеки дорожнього руху та транспорту як у містах, так і на позаміських дорогах. У той же час розширення функціональних можливостей інтелектуальних транспортних систем на відповідність транспортних систем у транспортному процесі пов'язане з розробкою нових методів оцінки якості та прогнозування характеристик руху в режимі реального часу.

Ключові слова: *інтелектуальні транспортні системи, міжнародний проект, концепція, організація руху, безпека дорожнього руху, інформаційне середовище.*