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Intelligent management technology of transport system

J. SZPYTKO[a], P. HYLA[a]
[a]AGH University of Science and Technology, Faculty of Mechanical Engineering and Robotics,
Mickiewicza Ave. 30, 30-059 Krakow, Poland
EMAIL: szpytko@agh.edu.pl, hyla@agh.edu.pl

ABSTRACT

The globalisation poses new challenges in the management of the individual areas of human life, particularly in the transportation. Therefore all useful techniques, especially ITS (Intelligent Transportation Systems) are sought. The ITS improves transportation safety and mobility and enhances productivity through the use of advanced communications technologies.

KEYWORDS: transportation, telematics

1. Introduction

In the result of applying the Information Technology (IT) in areas of the man activity, telematics can lower costs of technical devices operation. Techniques comprised by the telematics (both special software and tools) are more and more modern. A demand for so-called Intelligent Transport Services (ITS) and Dynamic Traffic Management (DTM) of means of transport are still in progress, both on long transport distances and in automated and integrated manufacture plants [30, 31, 33].

So-called intelligent management of the transport system is a subject of several scientific publications and practical solutions [1, 2, 6, 17, 33], which are more and more often directed to problems of safety and operation reliability of transport systems [7, 13]. The paper is focusing on the design methodology of the telematics systems in transportation.

2. Telematics solution in transport systems

In transport systems a quick reaction to variable user needs and used transport system availability [34] and to surroundings conditions (e.g. atmospheric, movement intensity, random events) are the significant factors. The safety level of transport devices operation may be improved through better integration solutions of man/ operator - device set, e.g. VHI type (Vehicle-Human Interaction), as well as man - device - environment set [27]. The new integration solution of operator and device is the Voice Command System (VCS). The VCS system is a new natural form of interaction between human and the device. Communication with transport devices with the help of the voice reduces the man's distraction and improves his concentration. Operators can focus attention on control process and this considerably improves the transportation process safety. The

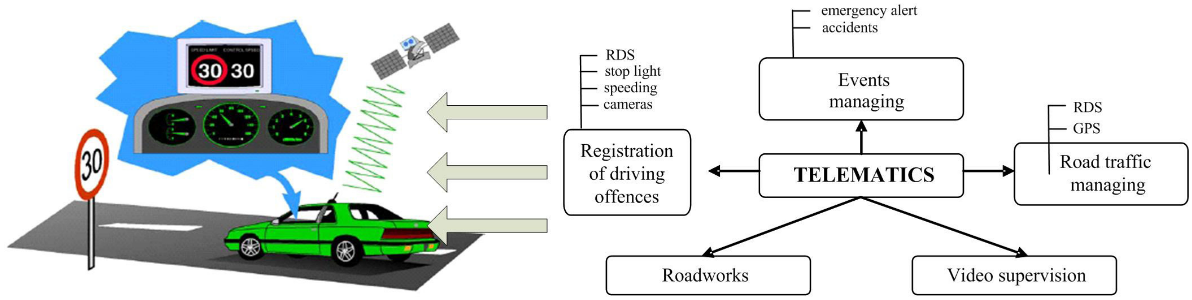

Fig. 1. Operation way the speed limitation system ISA type

application solution example is the Advanced Assistance Systems Driver (ADAS) [29].

Additional system support, especially driver's visibility during a night or poor visibility journey, is the Value-Added Services type system (VAS). The other operators' conveniences are ISA type (Intelligent Speed Adaptation) [3] systems that make possible atmospheric conditions and visibility on-line analysis, which results in the vehicle speed reduction to a safe one independently of action taken by the driver. The use of mentioned systems in practice has direct influence on safety of transport vehicles operation process - Figure 1.

To raise the level of operational safety of transport vehicles on route, the Variable Message Signs (VMS) are also important. According to [5, 25], the VMS with changeable content warning can raise road transportation safety by around 30%. Signs of changeable content are also a part of Automatic Speed Limiting System (ASLS type).

According to the Technical Research Centre of Finland, the method of presentation of graphical message has also influence on the effectiveness of the VMS system: warning presentation with the diode board flash is more beneficial in practice [23]. Integration of warning systems about weather conditions together with VMS system gives effects in the form of the average speed decrease by about 8-10 km/h on the designated road section.

Telematics has significant participation in productivity shaping of transportation systems [15, 20]. Thanks to early information concerning operational parameters of the vehicles and on possible inconvenience on routes obtained from transportation process, the management of movements without collisions is possible. The above causes also a reduction of transportation time and used petrol cost. Telematics helps to develop various services [14], e.g.: for passengers [1, 4], transport vehicles trajectory tracking, parking, ticketing, information several types, on-line cargo tracking [18] with the use of: Short Message Service (SMS), Wireless Application Protocol (WAP) and internet.

Several telematics based services may be identified in water transport [9]. The examples include: Automatic Identification System (AIS) [26], Vessel Traffic Services (VTS) [21], and are focusing on position, speed, type of carried out cargo and others useful for effective harbour and transport fleet management.

In the rail transport European Train Control System (ETCS) and European Rail Traffic Management System (ERTMS) are in use, as well others, especially based on GSM and GSM-R in the International Union of Railways UIC format, e.g. EIRENE [10, 22, 24]. The presented systems are used for transport vehicles and cargo tracking, non-collision trains' management, as well as their safety control devices.

In the aircraft transport the key in telematics service is the Air Traffic Management system (ATM), which in the future will be replaced by the Aeronautical Telecommunication Network system (ADS) [9]. The telematic systems operating in the aircraft business in dynamic way (based on time and space positioning) are getting various pieces of information about aircraft operational parameters and tracking, as well as accompanying environmental conditions, which are useful in transportation fleet management and decision making support under aircraft operation in different flight phases.

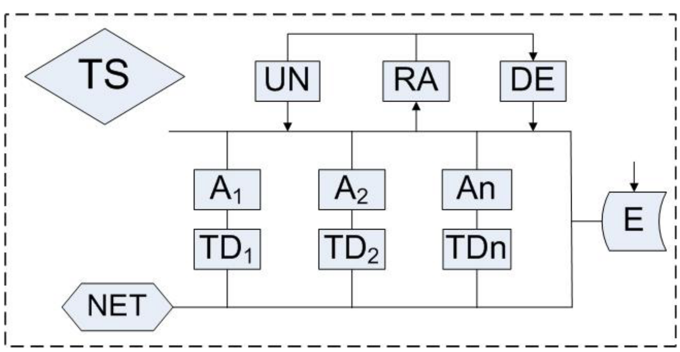

Fig. 2. Transport System oriented to activity

3. Integrated transport system

The transport system (TS) oriented towards determined actions with the participation of people and freight is presented in Figure 2. This system composes of several single elements and relations between them:

An - *n*-th *Activity type* realized through the *n*-th transport vehicle that is an object of monitoring,

DE - *Decision-Making system* in the field of the transport system actions assessment based on both quality and quantitative requirements (parameters) formulated by the user as references (possible actions' effects: continuation, correction and stoppage),

E - *Environment*, including actions taking into consideration the infrastructure of means of transport and atmospheric conditions and others, all this properties are objects of the monitoring,

NET - *data transmission NETwork*,

RA - *Result of joint Activities* of all transport vehicles involved in transportation process based on the effects of qualitative and quantitative analysis,

TDn - *n-th Transport Vehicle* with the operator set responsible for the completion of determined action, which operational properties are an object of monitoring,

TS - *Transport System* dedicated to the completion of actions focused on people or/ and cargoes,

UN - *User Needs*, actions formulated taking into consideration qualitative and quantitative requirements expected by users of TS.

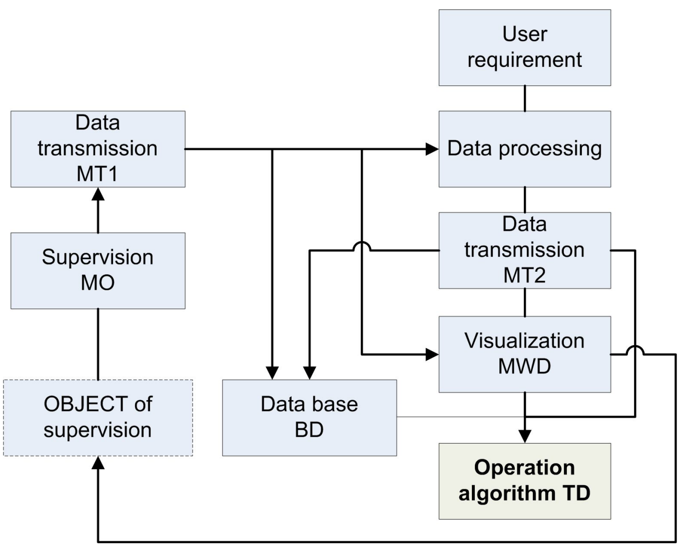

Fig. 3. Decision-making process in the Integrated Transport System

Transport system [33] managed by the coordinator has determined properties:

- is open to any actions which have been designed and undertaken by the user (open system) and are possible with the determined transport vehicles use in defined time and space (any infrastructure and surroundings),
- makes possible the sequence of operations carried out by the selected transport vehicles and focused on defined target (configuration-ability) based on fixed energy outlay (the financial effort can be a different measure),
- enables a flexible access to the information (flexibility) being characteristic of determined transport vehicles, surroundings and implemented actions: acquiring the information from different sources, transmission and receipt of the possessed data in any place and time, possibility of the intentional processing of information and its determined linking for decision-making purposes,
- devices' actions realization can be an object of the optimization in harmony with the quality criteria established by the user (e.g.: time, safety, cost, user satisfaction) and as the result of applying the appropriate control techniques of the system (controllability),
- enables to analyze the transport system effectiveness (effectiveness) expressed with undertaken actions (achieving established targets) and costs which have been incurred on system operation including achieved safety level (both outside and internal) and operation reliability.

Formulated properties can be obtained using (Figure 3) [33]: supervision module of the system based on its selected operational parameters (MO), information transmission module (MT), data processing module (MPI), visualization module of technical means (MWD: transport vehicles, devices supporting decision - making process) and database module (BD).

Each transport vehicle and the environment are described with selected operational parameters that are a subject of registration with sensors (MO). Then collected data is transferred using information transmission module (MT) to database (BD) module (where also historical data is archived) or is visualized (WD) in real time for decision - making processes or data processing (MPI). The data processing module (MPI) enables directed analysis and synthesis of data acquired from different sources considering the strategy expected by users in decision-making process in system control. The designing process of integrated transport system should cover the following stages:

- formulating the main aim/ target of the transport system,

- determining the method of achieving the formulated target, which results in the system structure and relations between individual elements of the system, and necessary controls,
- identification of known answers in the field of: aiding the operator decision-making process and controls, data acquiring from surroundings and visualization, communication between elements of the system, transport vehicles management process control, undertaken process cost analysis,
- designing the methodology of data obtaining from the transportation process under operation for proper control needs (methods, tools) and for complete decision-making system (considering both qualitative and quantitative requirements) with required safety and operational reliability levels,
- construction and testing designed transport vehicles solutions,
- implementation as well as both operation and improvement processes of the transport system.

The technique supporting management process of transport system is most often addressed to: operator, surroundings, communication set between elements of the transport system and management. The example solutions applied in transport systems are:

a) for the operator of a transport vehicle:

- *Driver Assistance Systems* (DAS) [16] which is a mobile system installed in transport vehicle supporting the decision-making process (vehicle localization, assessment of driver psychophysical predispositions, assessment of the technical status of transport device),
- *Collision Avoidance Systems* (CAS) [11] warning the operator about possible dangerous events,
- satellite navigation systems, e.g.: GPS (*Global Positioning System*), GLONASS (*russ. Globalnaja Nawigacjonnaja Satelitarnaja Sistiema*), and GNSS (*Global Navigation Satellite Systems*) [19],

b) for the transport vehicles:

- traffic measurement system [12] installed permanently into the roadway surface, e.g.: induction loops type (vehicle detection, vehicle speed measurement), piezoelectric sensors (vehicle dynamic weighing), CCD type cameras (transport vehicles traffic flow intensity measurement, vehicles identifications),
- accident warning systems of CNS type (*Collision Notification Systems*) as a stationary use and based on mobile digital cameras set: place identification of a possible unfavourable event, necessary save potential qualification,
- environmental pollution monitoring set (permanent and mobile types) [2], e.g. *Emission Modal Analysis Model* (EMAM) including momentary speed and acceleration of the vehicles, MOBILE-2 including vehicle engine starting technique, engine technical state, environment temperature,
- meteorology type devices [35] installed along the road infrastructure which are sources of information about current weather conditions for transport vehicles operators and others services,

c) for connection between transport system elements:

- *Dedicated Short Range Communication* system type (DSRC) and package data transmission of cellular network operators GPRS (General Packet Service Radio) type [33],
- dedicated transfer information systems [35]: satellite links, devices using radio waves and cable connections (traditional or fiber-optic) and wireless (Bluetooth), VMS type (*Variable Message Signs*) information boards and arrangements of transmission short text messages, for example: radio transmission of the RDS type (*Radio Date System*) with the encrypted short text information at the FM channel given parallel with radio news,
- diode type signs and arrays of variable information content [35], put on special structures and visible for transport vehicles operators, which support their decision-making process,
- transport vehicles automatic identification systems, e.g.: Automatic Vehicle Identification (AVI), Automatic Identification Protocol (AIP), Radio Frequency Identification (RFID) [33] and intelligent Tags, automatic plates number of transport devices recognizing system ARTR type (pl. *Automatyczne Rozpoznawanie Tablic Rejestracyjnych*),

d) for transport system management:

- adaptation control for the road traffic PIACON type method (*Polyoptimal Inteligent Integrated Traffic Adaptive CONtrol*) [1],
- dispatcher service control of the public transportation passengers' DISCON type (DISpatching CONtrol) supporting the punctual and reliable service taking into consideration: traffic, number of passengers in process, passengers relocation needs, number of disposed transport vehicles [1],
- environment-friendly transportation management system TEDMAN type [1] including ecological aspects of transport devices operation process,
- industrial means of transport, in particular large-size rail transport [28, 32].

The formulated above areas of problems are included in engineering intelligent management technology of transport system.

4. Conclusions

The paper presents the concept of the intelligent management technology of transport systems with the use of known IT type techniques. The telematics systems result in direct design for people and cargo displacements needs. The transportation systems that are an object of integration and decision making coordination management are finally increasing both quality and quantity expectations of process users. The so-called intelligent techniques involved in controlling of transport vehicles are focusing mostly on increasing their safety, operation reliability and effectiveness of undertaken decisions.

Integrated transport systems' using the computer-aided technology in transportation processes experience rapid development. The above take effects of increasing safety and operation reliability of transport systems and its total operational cost. Essential problems occur in effective adapting the operator to the new working surrounding, as well as in rapid adaptation of the existing transport system (structure and relations) to the new quality and quantity needs of the user into known (or unknown) environmental activity.

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