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TELEMATICS SUPPORT EXPLOITATION OF TRANSPORT DEVICES

The paper aim is overview of the known literature related to the telematics application in transport devices operation. This elaboration shows the directions of telematics development in transport. Chosen examples of application of telematics in means of transport were described here, and the own solutions in the range of application of telematics systems in the overhead traveling cranes exploitation process were shown.

TELEMATYKA W EKSPLOATACJI ŚRODKÓW TRANSPORTOWYCH

Przedmiotem artykułu jest analiza stanu wiedzy w zakresie stosowania telematyki w eksploatacji środków transportu. W opracowaniu sformułowano kierunki rozwoju telematyki w transporcie oraz scharakteryzowano wybrane przykłady jej zastosowania w praktyce. Przedstawiono własne rozwiązania w zakresie stosowania układów telematycznych w procesie eksploatacji suwnic pomostowych.

1. INTRODUCTION

Telematics is a field of science that integrates telecommunications and informatics [8] in the range of information processing with their effective transfer to the points, where it can be used to achieve specified quality of the action. Modern telematics gained economic potential from increasing capabilities at drastically decreasing costs for telecommunication links, as well as for data processing. Transportation is one of the field in which telematics systems are applied.

Application of telematics in the means of transport is a subject of many publications. Their authors are focused on the following questions [1,2,4,9,14,15,16,18]:

- identification of the subject, monitoring,
- identification of location of the transportation means in the work space,
- providing of communication between specified transportation means,

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- supporting of the decision process in the range of managing the motion of transportation means, management,
- supporting of the transportation means service process,
- transport control.

Using telematics in many various fields of human's activities enables the reduction costs of technical means exploitation and negative environmental impact, as well as increase transport safety and capacity. Techniques supporting telematics (including expert software and tools) are rapidly developed. There are increasing requirements for the *intelligent* transportation service and for the dynamic management of the transportation means' motion, both in the long distances, and in the integrated/ so-called intelligent automated transportation-production companies. Many of problems related to the transport management and control with support of IT technologies have been presented and discussed during the *Telematics in the transport systems* conference series organized by Silesian University of Technology, as well as in other publications: Journal of Signal Processing: Image Communication, Journal of Computer Standards & Interfaces, International Journal of Transportation Research and others.

The subject of this article is analysis of the state of knowledge in the range of using telematics in exploitation the means of transport.

2. TRENDS IN TELEMATIC'S DEVELOPING

Telematics' solutions are more and more frequently used in all transport categories, especially in air, sea, land (road, railway) transport as well as in materials handling and works transport where modern technologies based on informatics, optoelectronics, automatics and telecommunications applications are also employed.

The development of telematics solutions is guide on increasing transport devices movement's safety and fluency, as well as the transportation complex systems [18]. Telematics' solutions support the management process of compound transportation systems, especially in the fields of:

- transportation network optimization,
- effective using of databases for the needs of control and prediction,
- supporting of control of transports' means movement,
- monitoring of vehicles and loads moving (especially hazardous cargo),
- transport service.

According to Frost & Sullivan consulting company report [19], devices and software used in the telematics supporting transportation will be developed rapidly in the close future. The accessibility of GSM network and the standardization of system architecture cause the general access to the telematics service (*Messaging* for example). An essential element of telematics' development will be a competition in the range of transportation systems' exploitation costs reduction, and gaining clients. Additional elements, which stimulate telematics development, are transportation optimization and development of integrated transportation politics and electronic tax-taking systems.

Analysis of available literature shows, that specified applications of telematics in the transportation contain the following questions:

- identification of a load and/or mean of transport (static, dynamic), identification an monitoring of position of a load and/or mean of transport (static, dynamic) in the work space, record of information and database, optimization of utilization the exploitive potential in n – numerous system, providing the dedicated elasticity of utilization the exploitive potential, optimal managing of the means of transport in the production system,
- supporting the decision process in the range of means of transport movement management (container transportation, centers of loads distribution, parking place occupation) and the expert service in the case of events, which can menace the transportation system, means of transport control (entirely automated and semi-automatic AGV, *Automated Guided Vehicle*) in the set variable infrastructure (individual device: manually controlled by the operator, automatic supporting of the work supervised by the operator – setting the transportation extreme terms and its realization by the automatic device, control of many devices - automatic supporting of the work supervised by the operator from the central level), prognosing of means of transport movement intensity and work out the ways of its minimization,
- generating the information in the form of assistance code in the case of *danger* events (joining of means of transport in the system built with interactive subsystems supervised by central unit),
- active systems which can inform the operator in the range of: gaining the expert help, possible threats/security, realization of specified service / needs of passengers and operators (operator – device *interface*).

3. EXAMPLES OF USING THE TELEMATICS IN TRANSPORTATION

Telematics is used to monitoring and controlling all the transportation categories, especially in the intermodal system [12,15], Fig.1. Telematics find employing mainly in sea and air transport, but more and more frequently modern solutions are used in other transportation systems.

In the road transport, there are used GPS transmitters installed in vehicles, enable to send wireless information about vehicle position and velocity to the dispatching centre (mobile phone, radio station).

Then, position and speed of the vehicle may be visualized on a map. Additional information (which enables safe travel using vehicles) are road marks with variable content. Other applications of telematics are automated parking systems in the cities.

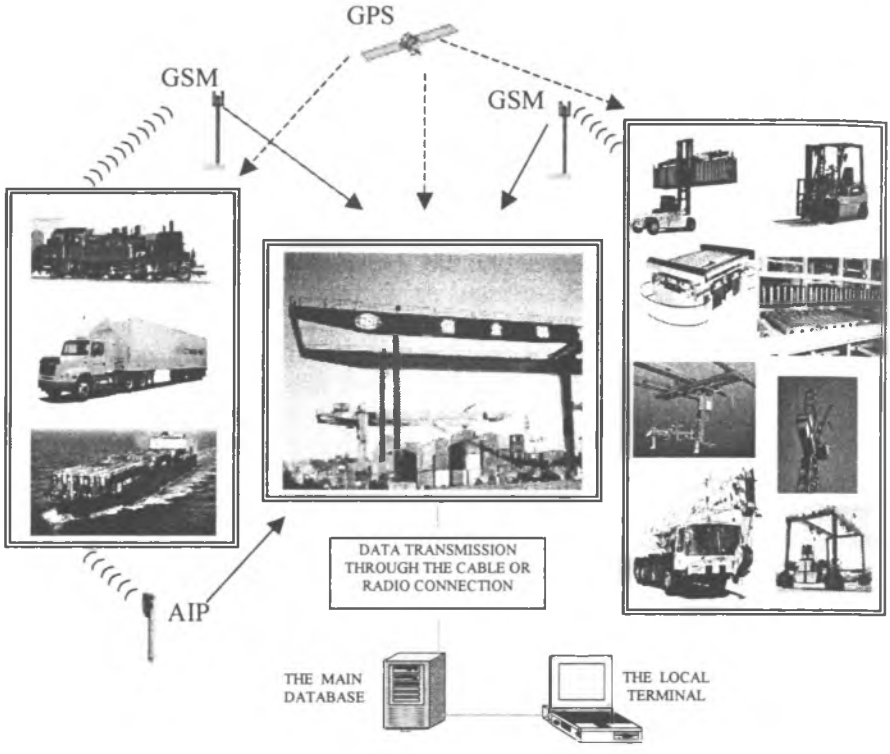

Fig.1. Integrated transportation system consisted of *n* means of transport

Monitoring methods based on the Global Positioning System applied in road transport are adapted also in the railway transport. GPS systems are supplemented by radio - or satellite data transmission technologies (GSM, OrbCom, Inmarsat) [3]. Operator's continuous access to the essential information during train exploitation (especially high speed trans) allows ensuring required security level. There are researches conducted to apply GSM-R system (Fig.2) to provide the radio communication in railway transport [10].

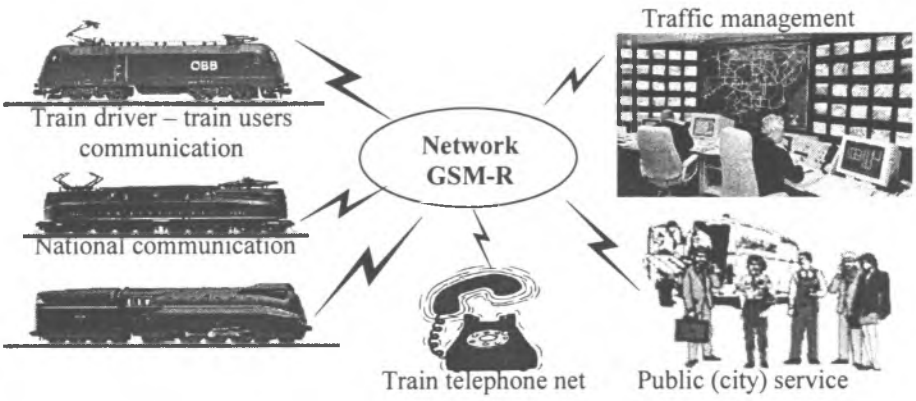

Fig.2. The GSM-R platform conception

In sea transport, telematics find applications in management systems of boats and barges moving and managing of information about the cargo. The telematics' solutions improve sailing safety using radio and satellite navigation.

An essential problem in the air transport is traffic control during air traffic intensity, with simultaneous safety ensuring. The air traffic prognoses show the rapid growth of passenger flights, it may cause logistic problems; they can be solved using telematics. There are operator/man – mean of transport interfaces intensively developed in the air transport [2].

Telematics systems are also employ in materials handling (works transport), in the use process and means of transport service process [13,16]. The example is mobile vehicles [17] and automatic AGV trolleys (*Automated Guided Vehicle*) [6], the shelf gantries used in high-storage storehouses and the gantries in the container centers. There are also elevator-supervising systems by Kone and Otis [7] and mobile robots [5,11].

The example of information flow for the decision needs in the container terminal, using telematics is shown in the Fig.3.

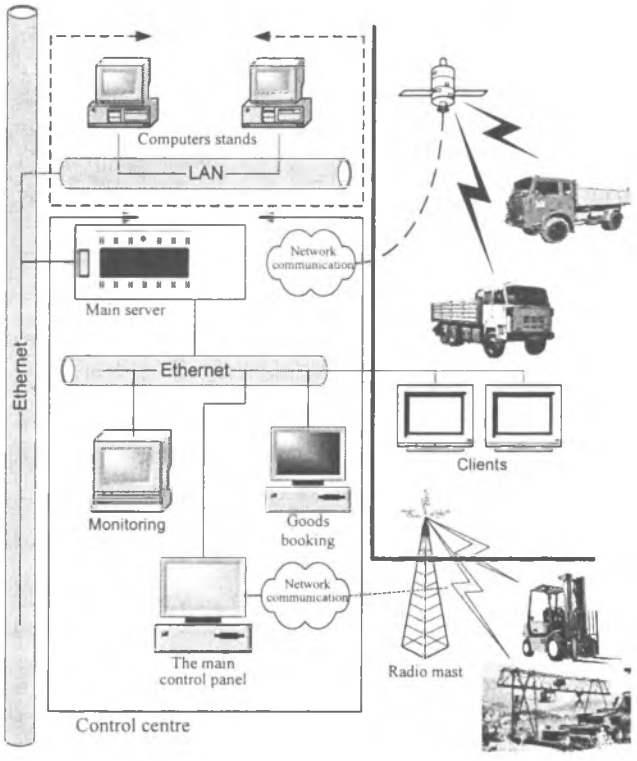

Fig.3. An example of information flow in the container terminal

In materials handling devices telematics' elements are used in:

- load and mean of transport identification,
- identification of position of transportation means and a load in the work space,
- means of transport movement management (container transport, loads distribution centers),
- automated means of transport control (AGV, gantries, shelf gantries).

Presented in the Fig.4 control-monitoring system of an overhead-traveling crane was elaborated and realized on the real object, the two-spars overhead crane with Q = 12,5 [t] hoisting capacity and bridge width L = 16 [m] working in the workshop.

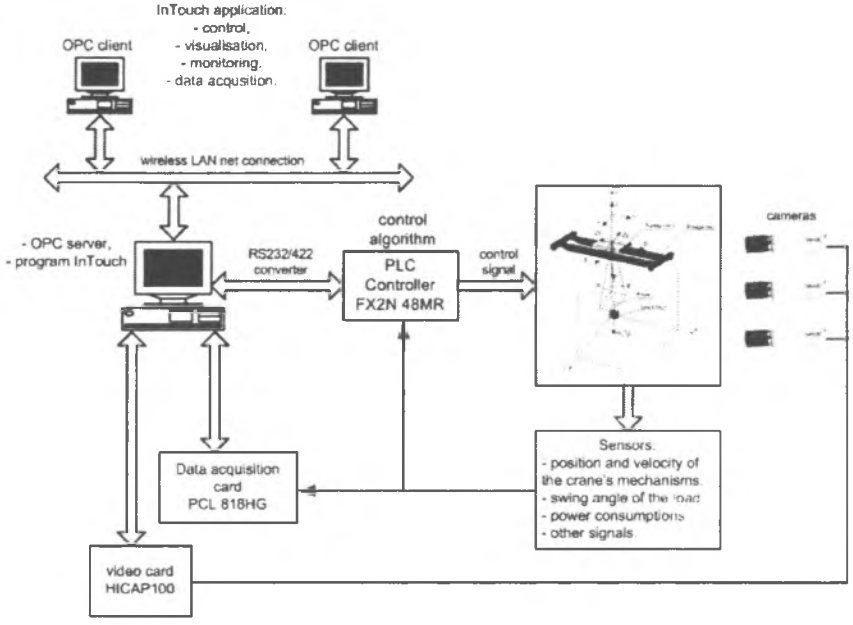

Fig.4. Control and monitoring system of an overhead crane

The aim of the realized system was crane's movement mechanisms control, visualization and monitoring chosen exploitation parameters of the device. System was based on PLC (*Programmable Logic Controller*) controller and PC computer with HICAP video card, data acquisition cards type of PCL 818HG and InTouch SCADA program. In the presented system the following subsystems can be distinguish:

- control system with PLC controller witch realizes control algorithm of crane's movement mechanisms (bridge, trolley and hoisting mechanism) equipped in frequency inverters enable to smooth velocity and torque change,
- measurement circuit composed of sensors enable to measure the exploitation parameters for control and monitoring purposes (e.g. position and velocity of crane's movement mechanisms, swing angle of the transported load and power consumed by driving mechanisms) and PC computer with data acquisition card type of PCL 818HG for measurement signal gathering,
- visualization and monitoring system built using HMI (*Human Machine Interface*) tool, InTouch program on PC computers connected by wireless LAN net connection.

Application built in InTouch program allows providing desired position of the load in three dimensional space and monitoring crane's movement and selected exploitation parameters measured by sensors. InTouch program communicates with PLC controller by using OPC standard communication. OPC server enables connection between PLC controller and other PC computers with OPC clients (InTouch applications) using wireless LAN net connection. Proposed solution enables to realize operator's stand over crane's cabin as well as dispatch room where transportation process in workshop could be monitored and supervised. Presented example of control-monitoring system based on telematics solutions helps in decision process during realizing transportation tasks. Views from the cameras directed on

crane's working spaces enable better operator's visibility that is often limited from crane's cabin (Fig.5).

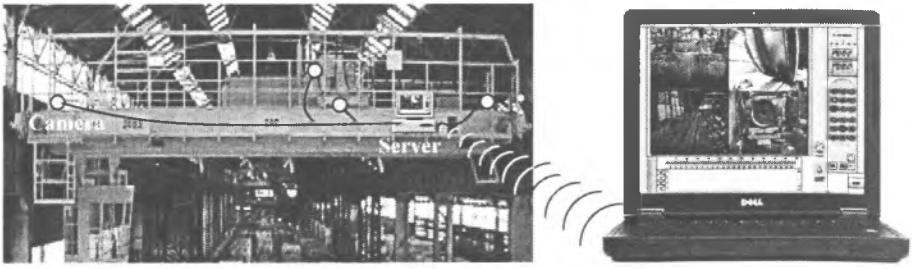

Fig.5. The research object and device remote monitoring

4. CONCLUSIONS

Telematics in the essential way improves safety and reliability of transport systems, enables optimizing cargo motion routes and reduces the costs. Telematics is currently the important parts of transportation infrastructure.

The key question in transportation system safety and reliability is its ability to gain the output products (information), generated by the participating in transportation process, and then integration for quantity and quality evaluation, and processing to output products useful in the decision process.

Telematics, using techniques such as informatics, optoelectronics, automatics and telecommunications, helps to reduce costs of transportation potential management, improves the security and reliability of the transportation service and the decision process automation. Modern telematics methods offer a huge application potential in teleservicing, having impact on most engineering disciplines.

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BIBLIOGRAPHY

[1] BARTCZAK K.: *Telematyka transportu.* Logistyka, s. 50-52, nr 1, 2000.
[2] BARTCZAK K.: *Wyniki prac badawczych i wdrożeniowych w dziedzinie telematyki transportu w krajach UE.* Przegląd Komunikacyjny, s. 16-19, nr 10, 2001.
[3] HECHT M., JANIK M., RIECKENBERG T., SALZ D.: *Telematyka w kolejowych przewozach towarowych – transport ładunków niebezpiecznych.* Technika Transportu Szynowego, z.1, s. 6-13, Warszawa, 2000.
[4] KORVER W., HARRELL L.: *Definition of European Transport Systems.* FANTASIE Deliverable 13, Delft, TNO-INRO, 1999.
[5] KORZEŃ Z.: *Logistyczne systemy transportu bliskiego i magazynowania.* IliM, Poznań, 1998.
[6] KWAŚNICKI Z., KOWALCZYK T.: *Wózki indukcyjne Robotrans.* Logistyka, s.35-38, nr 4, Warszawa, 1995.
[7] KWAŚNIEWSKI J.: *Dźwigi osobowe i towarowe. Budowa i eksploatacja.* Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2004.
[8] MUELLER J.: *Komputeryzacja łączności.* WKiŁ, Warszawa, 1983.
[9] OCHIENG W. Y., SAUER K.: *Urban road transport navigation: performance of the global positioning system after selective availability.* Transportation Research Part C: Emerging Technologies, v. 10, Issue 3, p. 171-187, June 2002.
[10] RADZISZEWSKI W., MARKOWSKI R.: *Rola systemu GSM-R w procesie zapewnienia interoperacyjności i mobilności w polskim transporcie kolejowym.* Transport XXI wieku, s. 489 - 495, Warszawa, 2004.
[11] SCHILLING K.: *Tele-maintenance of industrial transport robots.* Proceedings of 15th Triennial World Congress, Barcelona, IFAC, 2002.
[12] SZPYTKO J.: *Kształtowanie procesu eksploatacji środków transportu bliskiego.* Biblioteka Problemów Eksploatacji, ITE, Kraków - Radom, 2004.
[13] SZPYTKO J.: Integrated decision making supporting the exploitation and control of transport devices. Monografie, UWND AGH, Kraków, 2004.
[14] SZPYTKO J. (Ed.): Engineering Achievements Across the Global Village. Library of Maintenance Problems, p.536, IT-NRI, Radom, 2005
[15] SZPYTKO J., KOCERBA A.: Telematyka narzędziem jakościowego kształtowania transportu. Automatyzacja i eksploatacja systemów sterowania i łączności, Akademia Marynarki Wojennej, s. 169-176, Gdynia, 2003
[16] SZPYTKO J., KOCERBA A.: Telematic in supervision of manufacture transport devices, Zeszyty Naukowe Politechniki Śląskiej, Transport, z.55, nr 1657, s. 417-422, Gliwice, 2004.
[17] ULATOWSKI W., MASŁOWSKI A.: Pojazdy sterowane automatycznie. Pomiary Automatyka Robotyka, z.10, s.28-31, Warszawa, 2003.
[18] WAWRZYŃSKI W.: Telematyka transportu – tendencje rozwojowe i ograniczenia. Transport XXI wieku, s. 523-529, Warszawa, 2004.
[19] Frost & Sullivan's: Analysis of the European Commercial Vehicle Telematics Market. Report.
[20] Proceedings of the Conference on *Telematics in the transport systems* series, Silesian University of Technology, 2001-2004.
[21] Journal of Signal Processing: Image Communication.
[22] Journal of Computer Standards & Interfaces.
[23] International Journal of Transportation Research.

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