Types and methods of application of information technologies in the transport industry of Siberia

O A Krasovskaya and A E Chigir

Irkutsk National Research Technical University, 83, Lermontov st., 664074, Irkutsk, Russia

E-mail: chigir-1981@mail.ru

Abstract. Transport in Siberia is an integral part of human life. It is one of the important sectors of the national and regional economies. It is necessary to know how transport technologies have evolved. Development of technologies accelerates the economic growth of the region, establishes strong economic ties with developed regions of the country. The regions with a developed transport infrastructure have the most useful conditions for the economic growth. This article aims to describe the development of the transport system in Siberia. It describes the development of information technologies applied in the transport industry of Siberia. Application of the GLONASS navigation system is analyzed by the example of Irkutsk region.

1. Introduction

Currently, information technologies are being modernized and developed. They solve many problems, make the world more comfortable and better. Information technologies are used to optimize information processes, process information which is important in the market conditions.

Modern technologies are used to process a large amount of information. In the transport industry, information technologies are used to manage transport processes. The article describes main technologies used in the transport industry.

The article describes the transport system of Siberia, development of technologies applied in the transport industry of Siberia.

2. Research purpose

The article aims to analyze types and methods of application of transport information technologies, the GLONASS navigation system in Irkutsk region as part of the program “Safety of school transportation”. There are different types and methods of application of information technologies in the transport industry. The most widespread ones are GPS9 with three types of sensors, car alarms, the GLONASS.

3. Application of information technologies

The development of transport information technologies is problematic. They are expensive. Therefore, they are rarely used by transport organizations. This causes transport problems. Violation of traffic rules is one of the main transport problems which can be solved using transport technologies. One of the main problems is transportation of schoolchildren. It is difficult to implement the target program of Irkutsk region “Safety of school transportation”.

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4. Technologies applied in the transport industry

The most widespread technology applied in the transport industry is the GPS.

When using the GPS, sea and road navigation is performed. It also supports the TPMS. It can measure temperature and tire pressure for safe driving. [2]

The GPS has a rearview camera. The camera automatically switches the image from the rearview camera if you turn on the reverse gear. It expands a visibility area and ensures safety.

The GPS has a function of satellite monitoring of transport. The GPS monitors location and speed. To facilitate the control, a parking radar technology is used. It is used to facilitate parking maneuvers, alert the driver about barriers in the blind zone.

Next to the obstacle, it produces a sound and informs about the distance. The sounds are heard at a distance of 1–2 m. At a distance of 0.1–0.4 m, the sound is disturbing. The radar may be activated. The radar is operated along with the rear gear. The radars come into action at a speed of 20 km/h.

The display unit is connected to the sensors through wires installed in the vehicle body. There are wireless sensors [3]. There are three types of radar sensors:

1. The ultrasonic sensor. The principle of its operation is similar to that of an echo sounder: the sensor produces a short ultrasonic jolt (about 40 kHz) and receives the sound reflected by nearby objects. The electronic unit determines the time before radiation and reception of the reflected sound and measures the distance to the object.

Ultrasonic sensors are installed on the bumper, and the concentrated force of emitters creates a sensitivity zone. Initial devices had different emitting and receiving sensors. Only one piezoelectric element transmitted signals. The high price of the material allowed for only mechanical scanning of the rear hemisphere with a single sensor. For blind zones, additional devices are used. Ordinary sensors have only two devices. The most famous sensors use only four devices installed on the rear bumper at a distance of 30–40 cm from each other. This kind of location eliminates "blind zones". In the most complex sensors, two or four devices are located on the front bumper. Special sensors are able to use a large number of devices.

2. The electromagnetic sensor converts electromagnetic waves in the middle of two conductor antennas installed along the body. The RF signal is transmitted to the first conductor, and the second one is connected to an amplitude detector. All changes in the position of objects near the antenna zone influence the level of communication among the conductors and change the amplitude of the signal.

This type of the PDC (DP1) was applied by the Audi company. The main advantage is the lack of external violations of the body design after application of plastic bumpers: antenna sensors are installed inside the bumper.

Electromagnetic Parktronic devices are used in the USA and Europe. In Russia and the CIS, ultrasound Parktronic devices are used.

3. The lidar. The principle of operation is the same as that of the “Side Assist” type systems: after activation of the signal, the indicator light is activated.

Unmanned vehicles and auto driving systems require monitoring of the area around the car. The best way out is scanning laser range finders (lindars). They build a three-dimensional projection near the vehicle at a distance of one hundred meters. Their price is high [6–8].

Although they help drivers, it is not recommended to rely on them. The driver must monitor obstacles. Some objects are not detected by the radar; there are those ones which can cause the radar to be switched on incorrectly [4].

The radar signals when:
- there are ice, snow or other contaminants;
- moving along the unpaved sloping road;
- moving along the rough road;
- there is much noise;
- raining or snowing;
- radio transmitters are switched on;
- towing;
• parking in cramped conditions.
The radar does not respond to:
• small objects;
• ultrasonic absorbing objects;
• objects reflecting sounds.
The radar does not detect road holes, small and other dangerous objects that are in the blind zone. There are radars that control the zones around the devices allowing the driver not to encounter vehicles [5].

There is one more transport technology. It is car alarms.

The car alarm system prevents thefts of car parts and car thefts. It informs the owner and people near the vehicle with a sound or light, but it does not block a car theft or a theft of spare parts. There are different types of car alarms. The one-way car alarm is the simplest and cheapest system. It performs a limited number of functions: engine locking and door controlling. There is a minimum distance between the vehicle and the key fob for the system to function properly. As for the two-way car alarm system, information about the engine locking is received by the key fob. Figure 1 shows the diagram of the electronic unit of the car alarm which is not expensive. The diagram shows its simplicity and efficiency. When this system is switched to the “Security” mode, the consumption of electric current does not exceed 180 mA. The SA1 switch can be installed anywhere in the car. The R8 resistor and the C5 capacitor are responsible for the delay time which can be changed by selecting nominal values of these elements.

Car alarms can have or lack a feedback; they can be satellite and GSM ones. They consist of a main unit, a receiver-transmitter, a key fob, a shock sensor, a terminal for turning off the light, a limit switch for the engine compartment of the service button, and an indicator. The alarm system with a feedback informs about the state of the vehicle. It protects against thefts [9].

It does not provide full protection against thefts; however, it reduces their probability [10].

More expensive alarm systems can be connected to GSM / GPRS modules to control the alarm from the phone via SMS and receive alerts. Using this module, one can determine the location of a car (GPS / GLONASS): this information is transmitted to the key fob, telephone and website of the manufacturer. The GSM module can call recorded phone numbers, diagnose messages, notify the movement of vehicles in restricted areas, etc. There are devices used to hack vehicles.

To hack car alarm systems, code grabbers can be used (static, suppression and algorithmic) [13].
A) For static and suppression grabbers, the alarm can intercept the code.
B) Code-grabbers use an algorithm of actions required for the button to be pressed by the owner. They use radio jamming and interception of key fob signals.
C) The algorithmic code grabber identifies the alarm system based on the digital signal of a key fob and becomes a complete copy of the key fob. This method is used by car alarm systems applying KeeLoq and other algorithms to encrypt the signal from the key fob to the main signaling unit.

There are additional security measures.
A special code-security method created by the Magic Systems company is used to identify key fobs used in cryptography.

After receiving the signal, it makes sure that it was sent from its” key fob. After responding to the debut signal, it sends a request in the form of a random number. Then it is processed using an individual algorithm and sent back. The car alarm system processes its signal using the same algorithm. And if they are the same, the order is performed, and the alert is sent to the key fob. An interactive code is used for auxiliary protection against electronic hacking. There is an immobilizer which is an electronic anti-theft device [14].

Imobilizers are used for safe blocking of vehicle modules. They prevent car thefts.
The engine is blocked. If the car is stolen, it prevents it from moving. A good immobilizer will be a significant problem for hijackers.
The car owner is obliged to control the immobilizer. An electronic code key is used; there are models with manual codes. Before starting the engine, the driver inserts a code key into the slot while
the immobilizer reads the code and disables the lock. The driver can place a contactless electronic “tag” into the immobilizer area [11]. For manual immobilizers, the code is entered by the owner. If an immobilizer breaks down, it remains blocked.

Most of the immobilizers automatically switch to the protection mode when the owner takes no actions.

Immobilizers are divided into contact, contactless and regular ones.

Regular immobilizers are used. They do not have relays. This system is closely connected with the engine fuel injection controller. If there is no authorized signal, the controller will not start the engine. The engine is blocked automatically.

The regular immobilizer consists of two main parts:

- the control unit which signals the need for switching on the system;
- the key identified by the control unit. Sometimes it is activated after a password is entered.
- the auxiliary immobilizer has an electromagnetic relay where an electrical circuit breaks down after penetration into the car.

There are immobilizers operating without breaking electrical circuits (CAN immobilizers). The engine is blocked after sending messages by means of interferences. After application of auxiliary devices, it is permissible to block non-electrical systems.

Immobilizers are installed in the electronic zone. They are small which reduces probability of being detected [12].

Ninety-two percent of all Siberian companies use information technologies; over 800 thousand people have already been registered on a single portal of public services.

The navigation system GLONASS is used in the transport industry. It is well known. It was ordered by the Ministry of Defense of the USSR. This system is used for remote control and exact localization of data. The GLONASS differs from the GPS. GLONASS satellites are not synchronous with the Earth's rotation, thereby ensuring stability for themselves. They do not require additional adjustment. The basis of this system is 24 satellites moving over the surface of the Earth in three orbital planes. The GLONASS satellites are located in the medium-altitude circular orbit at an altitude of 19,400 km with an inclination of 64.8° and a period of 11 hours and 15 minutes. This orbit can be used for high latitudes (northern and southern regions), where it is difficult to catch GPS signals. The satellite constellation is deployed in three orbital planes with 8 equally distributed satellites. For the global coverage, 24 satellites are used. To cover Russia, 18 satellites are used. Signals are transmitted at a 38° directivity using right-handed circular polarization at a power of 316–500 W (ERP 25–27 dBW). In order to determine the coordinates, the receiver must receive a signal from four satellites and calculate the distance to them. If three satellites are used, it is difficult to determine the coordinates due to errors caused by the inaccuracy of the receiver clock. In 2012, the Ministry of Transport of Russia defined technical requirements for the satellite navigation equipment in order to enhance safety of vehicles transporting passengers and dangerous goods.

The GLONASS and GPS are widely used in Irkutsk region. They are used for implementing a long-term target program “Safety of school transportation”. The program is aimed at enhancing safety of schoolchildren transportation. The main threat is violation of traffic rules by school bus drivers. The GLONASS allows the dispatching service to monitor the situation in the bus cabin and prevent emergency situations. The driver has an alarm button on the panel and a microphone. In case of pressing this button, the dispatcher can promptly call emergency services. The GLONASS allows dispatchers to track the route and follow traffic rules. The integrated use of navigation and information technologies enhances safety of children and improves efficiency of school bus monitoring. According to the Ministry of Education of Irkutsk Region, all vehicles transporting children are equipped with the GLONASS system, tachographs and meet all the requirements for children transportation. 461 buses have been purchased. 22,000 schoolchildren from 910 villages are transported to schools.
5. Research results
Information technologies applied in the transport industry were described. It is recommended to develop car alarm systems. The car alarm systems have to be improved in order to reduce the number of car thefts, enhance safety of passenger and cargo transportation.

The GLONASS navigation system used for vehicles transporting schoolchildren is expressive. It is being slowly implemented in Russia. However, the system is important.

6. Conclusion
Information technologies should be used in the transport industry. The correct structure of information flows increases efficiency of routine operations when making management decisions. To process information flows, an information system of an enterprise or a process is needed. The main IT concepts are object selection rules and their quality, principles of interconnectedness between objects and the sequence of structure.

The main technologies used for reading information prepare and present data for making management decisions and performing accounting tasks. The public automated system controlling the transportation of schoolchildren using the GLONASS will solve several important tasks.

Transport information technologies will be developed in close relations with business processes in order to obtain accurate and timely data for operators and users of vehicles. The main functions that stimulate the development of information technologies are as follows: development of transportation logistics, container transportation, delivery of materials, etc.; improvement of the quality of passenger transportation and reduction of transportation costs.

Currently, computer chips used for traffic management systems are being developed. Car owners will be able to exchange information about the road surface or maneuvers. Interlocking devices that do not allow the vehicle to start when the owner is intoxicated are being implemented. A device transmitting signals to the police when an airbag is triggered, an accident has occurred or a vehicle is stolen is being developed.

Information technologies used in the transport industry of Siberia will determine its social and technical development.

References
[1] Yutt V E 1983 Electrical and electronic equipment of cars (Moscow: Transport)
[2] Kako N and Yamane Ya 1986 Sensors and microcomputers (Leningrad: Energoatomiz dates)
[3] Titze U and Shenk K 1982 Semiconductor circuitry (Moscow: Mir)
[4] Horowitz P and Hill W 1984 The art of circuitry vol 2 (Moscow: Mir)
[5] Reference book of the radio amateur designer 1990 (Moscow: Radio and communication)
[6] Vigleb G 1989 Sensors: device and application
[7] O sipovich L A 1979 Sensors of physical quantities
[8] Friden J 2005 Modern sensors. Reference book (Moscow: Technosphere)
[9] Aleinikov A F, Gridchin V A and Tsapenko M P 2001 Sensors. Perspective development directions (NSTU)
[10] Kotyuk A F 2006 Sensors in modern measurements (Moscow. Radio and communications)
[11] Pinsky F I, Davtyan R I and Chernyak B Ya 2002 Microprocessor control systems for automotive internal combustion engines (Moscow: Legion-Avtokada)
[12] AvtoVAZ: Technology of repair of bodies and body parts 1987 ed by B V Prokhorov (Leningrad: Mashinostroenie)
[13] Lavrus V S Series Informational Edition iss 1 Security systems (Moscow: Science and Technology)
[14] Mortise electromechanical locks controlled by ACS. Types and characteristics of locks Arm-systems
[15] Bargagli B, Manes G, Facchini R and Manes A 2012 Acoustic sensor network for vehicle traffic monitoring Proceedings of the First International Conference on Advances in
Vehicular Systems, Technologies and Applications (Venice, Italy) 24–29 June
[16] Ahmad F, Basit A, Ahmad H, Mahmud S A, Khan G M and Yousaf F Z 2013 Feasibility of deploying wireless sensor based road side solutions for Intelligent Transportation Systems Proceedings of the 2013 International Conference on Connected Vehicles and Expo (Las Vegas, NV, USA) 2–6 December, pp 320–6
[17] Mehrabi A and Kim K 2015 Using a mobile vehicle for road condition surveillance by energy harvesting sensor nodes Proceedings of the 2015 IEEE 40th Conference on Local Computer Networks (Clearwater Beach, FL, USA) 26–29 October pp 189–92