Traffic Signs in Urban Logistics with the Use of RFID Technology

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Abstract. Increase of the traffic safety is one of the most important issues for most countries. Our goal is to introduce the concept of the traffic sign recognition system based on radio frequency identification, which presupposes a significant increase of the traffic safety. The concept of the solution is a prerequisite for marking traffic signs with RFID transponders, on which is entered information about specific traffic signs. A vehicle equipped with RFID components for reading the transponder can read the traffic signs and offers the opportunity to inform the driver about significance of the specific traffic signs. By using this technology it is possible to minimize human error while driving and with a support system this solution can offer secondary audio-visual and real-time information about the actual situation on the road with the possibility of interference in control of the vehicle.

Keywords: Urban logistics · RFID · Traffic signs

1 Introduction

Transportation is one of the basic sectors that significantly affect the socio-economic development and growth of living standards. In passenger transport quality depends largely on satisfying the everyday needs of citizens, such as the level of accessibility to work, schools, shops, accessibility to social care and leisure activities. On the quality of freight transport impact factors such as: speed, safety, punctuality and timing of delivery date. That is why the use of modern technologies in the field of transport and urban logistics is a global trend. Most often the application delivers the benefits associated with electronic data processing, which may be inputs (after the evaluation) for decision making processes of the security elements of transport infrastructure.

1.1 Logistics of the Region

The concept of regional logistics can be defined as that part of logistics, which is focused on events in the region and accepts all the attributes of the logistics. Its outputs constitute competitive advantages of the region, such as: efficient supply in the region, quality logistics services, favorable structure of the business environment and healthy business environment, transportation availability and serviceability in the region and

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quality infrastructure. City logistics expresses the part of the regional logistics, which is oriented to the organization of traffic in space and time of social and material flows, ensuring maximum orientation in production areas, economic and social throughout the city with maximizing satisfaction. Its activity is concentrated on traffic - movement of goods and people in larger cities, where today there is a need of solving often acute. In rush hour, in traffic accidents or during events with greater accumulation of people and consequently also cars, these events can lead to absolute disablement transport infrastructure, thereby hindering the overall running of the city. Need to address the role of urban logistics was established gradually in major cities (the capital) with a high concentration of transport [1].

Due to rising motorization already smaller cities have now traffic problems already depending on the quality of transport infrastructure and transport organization. Twist in the relatively calm traffic situation in the region came after EU accession, which brought increased migration of the population and its subsequent concentration at the sites, which offering higher job opportunities. Consequently the creation of a new urban centre various linked to essential historical estates, bringing a further increase of traffic. Under the increase of individual transport especially, is also signed by easier availability of passenger cars (leases, loans, jumble sale, etc.). The structure of the control system of urban logistics formulates clear ties for the further development of the logistics system and updating the applied technologies to the definition of possible overall benefit. The structure of the control system defines the formal relationship between all major- individual elements and objects, along with other subsystems and components and determines the rules of their operation. The structure of the control system of urban logistics defines a scheme in which they a recreated technical specifications and interface design of the overall system [2] (Fig. 1).

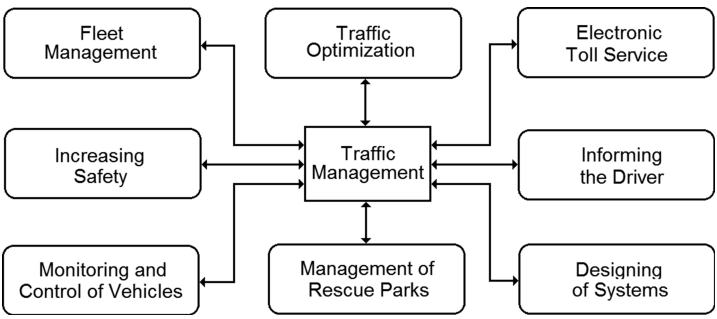

Fig. 1. The structure of management system of urban logistics [2]

1.2 Accidents

The unresolved logistical transport processes in smaller cities is often a source of collisions and subsequent congestions, which often leads to a complete meltdown of transport. In larger cities congestions are occurring without collision situation and mostly during the morning or afternoon peak hours. An important and primary role of

urban logistics is a search - optimizing transport infrastructure, i.e. search for the optimal topology transport network (optimization of transport routes, modes of transport in that area). While city logistics addresses route optimization in relation to cultural and social centre, manufacturing companies, shops, schools etc. Major transport problems faced by cities in the region are unresolved key problems of traffic, then thereto unresolved population mobility in their activities. Lacking respectively sub standard urban areas which would help to relieve the city centre from excess traffic. Another parameter which is strongly linked to the intensity of road transport, quality transport infrastructure and unsolved transport logistics is accident rate, which is in the region's roads considerably high. In the view of the frequency of transport is high incidence of road accidents recorded on local roads [2] (Fig. 2).

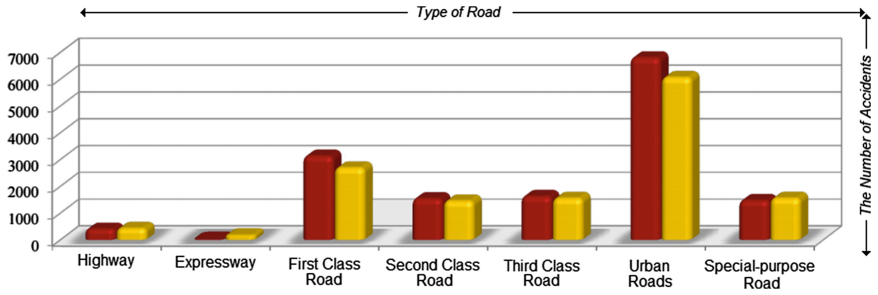

Fig. 2. Accident rate in Slovakia according to the type of road in the periods 01.01-31.12.2012 (red colour) and 1.1-31.12.2013 (yellow colour) (Color figure online)

Traffic accidents that occur most often due to failure to observe traffic signs due to carelessness and oversight of road signs because drive a vehicle is currently still the greatest extent realized by human [2]. The existence of supporting safety systems while driving greatly affects driving safety. One of the areas that have still not been solved complexly is support of the identification of traffic signs. By this is a human interaction in driving bound exclusively on the visual perception of specific traffic signs [2] (Fig. 3).

Fig. 3. The current state of the process of identifying road signs by drivers

In 2005, the Government adopted Resolution no. 445 Transport Policy of SR 2015, which defines a global objective and a number of specific objectives that include specific measures in the transport sector in Slovakia to ensure the sustainable development of mobility, conceived as long-term satisfaction of increasing needs of the

society in the required time and quality while reducing the negative effects of transport on the environment. In the so-called Operational Transport Program (OTP), it is one of the activities to support the development of intelligent transport systems and create conditions for broader application of information and communication systems and technology (ICT) to transport.

Nowadays, there are many similar systems concepts, especially in applications for road transport. Most of them use built-in camera inside the vehicle with the on-board computer, which processes visual stimuli and chosen way warns the driver about the current situation. Systems based on the principle of camcorders are dependent on the weather and daylight. Rain, fog and poor lighting make it impossible correct interpretation in these systems. The use of ICT allows very significantly reduce the negative effects arising from the operation of transport systems, positively affects the economics of the transport organizations and services, not just reduces the demands on public resources, but also on the resources of other entities transport and transportation process and enables them to rational decision-making. It also has a positive impact on improving safety and traffic flow [3].

The core elements of comprehensive solutions are intelligent transport systems (ITS), which aim to:

- increasing the safety of road-transport process
- improving the efficiency and quality of service expressed the time saved on transport;
- reducing negative impacts on the environment;
- reducing transport energy intensity;
- increasing access to transport information between all entities of transport and shipping process for their rational decision making;
- enhancing the quality of transport infrastructure and reduce costs entered into the construction of new transport infrastructure.

Our proposed solution contained in this publication provides a method for reducing respectively eliminating the possibility of overlooking road signs using a wireless identification technology, known as RFID technology.

2 RFID Technology

The principle of radio frequency identification is based on the use of wireless non-contact radio frequency electromagnetic fields to transfer data for purposes of automatic identification and tracking RFID tags placed on objects. Radio frequency identification (RFID) is formed by components developed for wireless identification.

The basic components of an RFID system are:

- Middleware consists of the control computer, database information and communication infrastructure;
- RFID reader that contains a transmitter and receiver circuit with a decoder and an antenna. Complementary solution can also be read out by integrated operating system with basic software functionality;

- RFID antenna realizing transmitting and receiving radio waves
- Transponder or the so-called RFID tag, consisting of the chip (an electronic memory circuit), and in the case of the active antenna or the semi passive tag may contain its own power supply. For these components it is then projected proper packaging structures depending on the purpose of use [4] (Fig. 4).

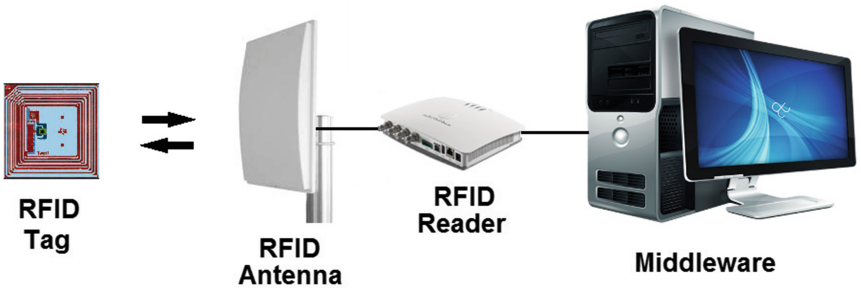

Fig. 4. The basic decomposition of elements of the RFID system

Communication between the components of RFID technology most often occurs on frequencies:

- Low frequency at 125-134 kHz;
- High frequency at 13.56 MHz;
- Very high frequency at 868-956 MHz;
- Microwaves at 2.45 GHz.

By type of power of the RFID transponders is possibly their classification on passive and active transponder. Passive RFID transponder does not have its own energy sources, and its functionality depends on the power of RFID antennas. Through antenna is generated an electromagnetic field, which serves as a power source for the RFID transponder, and also as a channel of communication between these elements [5, 6]. The active RFID tag is designed not only for the identification of objects but also to ensure the various measured physical parameters such as temperature, pressure etc. It includes power supply and thus it can monitor parameters and enhance the impact of the antenna. The applicability of the RFID system is very large, but in each application requiring the use of a system of elements that are adapted on given conditions and its efficiency can provide a full functioning of the system as a whole. Each element of an RFID system is therefore defined by the values of the reference parameter [7].

2.1 Application of RFID Tags on Traffic Signs

The principle solution is based on the appropriate application of RFID system into the microenvironment of transport infrastructure including the identification of traffic signs drivers. The present situation in which is the perception of traffic signs subjective by the driver, causing a risk of overlooking traffic signs which can ultimately give rise to

negative events in the transport communications. The introduction of the scheme provides secondary support system for perception, respectively, identification of traffic signs, which consists in electrisation of the elements participating in the aforementioned process through RFID components. System design lies in integration of RFID reader and middleware together into an integrated control unit, whose task is to manage the system itself and evaluate the collected data. Application of RFID the antenna is proposed solution to the front of the vehicle body to ensure the most appropriate position with respect to the direction of reading. We propose to fit traffic signs with preprogrammed RFID tags, which will contain information about specific traffic signs (Fig. 5).

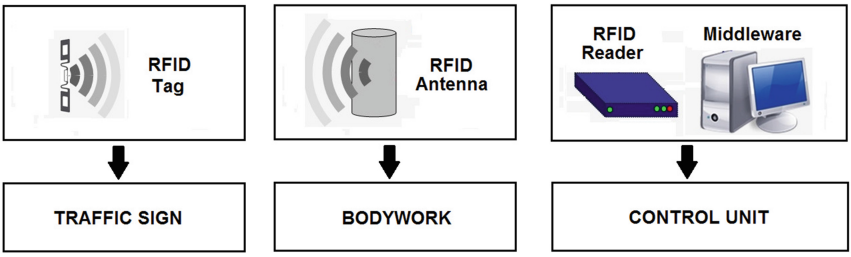

Fig. 5. Location of the RFID components with respect to the elements involved in the process design of identifying traffic signs

This solution after proper configuration of individual elements ensures electronic data collection on traffic signs. This data will provide space for the possibility of using this information both to familiarizing the driver with the closest traffic signs through visualization display supplemented by sound acquaintance, respectively interact to drive a vehicle in the form of speed reduction or stopping of the vehicle (Fig. 6).

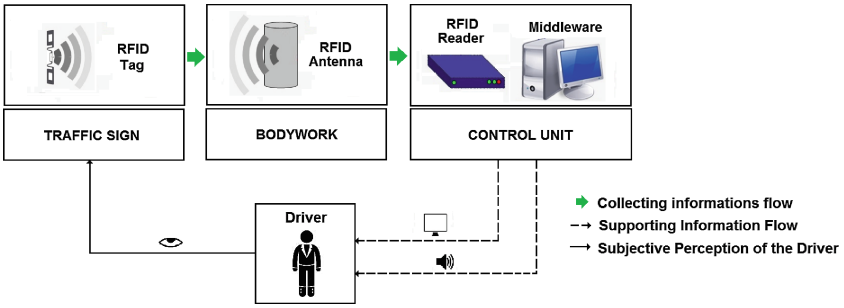

Fig. 6. Visualization of course of proposed process of informatization recognition traffic signs

Middleware system includes a database of traffic signs. Incoming vehicle equipped with RFID reader reads the RFID tag placed on traffic signs and on the evaluation of the appropriate code identifying the meaning traffic signs. At this point, the system

notifies to the driver importance of the traffic signs visual way on display PC board, respectively additional display device and sound notification.

In the following scheme is presented draft of implementation of the RFID elements in the current concept of selected elements of a motor vehicle and their activity in interaction with other elements (Fig. 7).

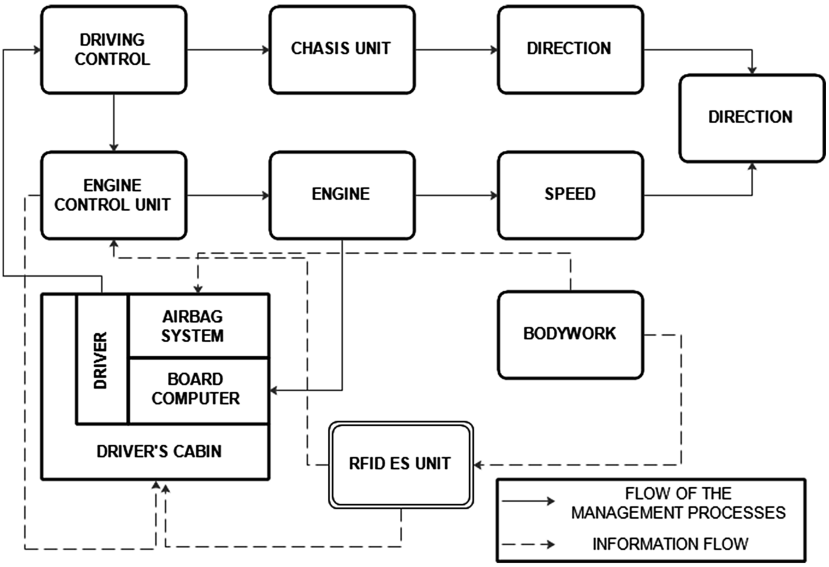

Fig. 7. The current concept of selected elements of a motor vehicle and their activity in interaction with other elements

3 Conclusion

Positive effects of this application include increasing transport safety. The application provides benefits in addition to normal traffic and the benefits of the simplification of control of the vehicle by disabled persons, as it benefits from the concept of this solution consists in the elimination and prohibition of driving a vehicle. These may be people with visual impairments in the form of colour blindness. There is also of great importance in the field of urban logistics. It actively participates in their communities, and helps to solve the basic problems of its functionality outside and inside the system. Increasing pressure on transport logistics in urban areas confirms the need for the application of scientific approach to designing of transport systems and their operation. The problems of urban logistics are almost identical worldwide. The difference lies mainly in the size of served area, density, density and quality of transport infrastructure. The needs to address the problems are also common since the advent of individual motorized transport as well as the distribution of goods by means of automobile transport devastates the environment.

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