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Road and Rail Infrastructure V

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SUPERVISION OF ROAD INFRASTRUCTURE BY APPLYING INTELLIGENT TRANSPORT SYSTEMS WITH SPECIAL REVIEW ON BOSNIA AND HERZEGOVINA

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Abstract

Today in world the road infrastructure is actively monitored, primarily for the safety of all traffic participants, but is also actively tracked for traffic organization, timely response to newly emerging situations that can endanger infrastructure users. Supervision and tracking of transport infrastructure is important from several aspects. By constantly tracking traffic infrastructure and turnover, it is easy to spot potential problems and dangers that occur at a particular location. For active supervision of the road infrastructure is necessary to use modern technology. The use of intelligent transport systems in road infrastructure supervision can be used for preventive action and elimination of potential dangers to infrastructure users. By managing from the supervising center, intelligent warning systems located on motorways, give the possibility to drivers to timely warn at certain risks and difficulties in traffic infrastructure such as certain infrastructure damage, driving time conditions, traffic accidents, black spots, warning about certain works on the infrastructure, and various other driver information, essential for traffic safety. Certain devices installed on the roads are intended to send information on the state of the infrastructure to the main control center. The supervisory center, with timely information, has the ability to actively manage traffic and preventive action. The control center has a special function in the case of traffic accidents through the transmission of information to the urgent services. Particular attention is paid to road infrastructure supervision in large cities where there is a high frequency of vehicles as well as on the highway. This paper presents an overview of the use of intelligent transport equipment for road infrastructure supervision and the advantages of surveillance. The paper shows the review of supervision of road infrastructure in Bosnia and Herzegovina with special emphasis on Corridor Vc, using intelligent transport systems.

Keywords: intelligent transport systems, traffic, security, supervision, road infrastructure

1 Introduction

Effective, efficient and secure road transport brings great economic benefits whose results have multiple effects, above all on market accessibility, greater movement of economic goods, but also greater investment and employment. The urbanization of the population and the increase in the number of vehicles led to traffic congestion, which had a direct effect on the level of safety and security of the road transport infrastructure. Together with the increase number of vehicles on the roads is increasing the number of drivers and passengers traveling on roads, thus increasing the number of traffic accidents.

Safety and security in road traffic is a very important issue: statistical data show that in 2016 more than 25.670 people were killed on EU roads, which is a small town of medium size, and in 2014, 213.032 people have been seriously injured. Most of accidents occurring on rural roads, about 55 %, and 37 % in the urban area, and 8 % on highways. In Bosnia and Herzegovina, in 2016, 321 people killed on the roads (FBiH 185, RS 130 and Brčko District 6), while 1,809 people were injured (FBiH 1,077, RS 703 and Brčko District 29), and 9,379 people has suffered easier bodily injury (FBiH 6.409, RS 2.878 and Brčko District 92). The use of advanced technical-technological and management solutions in road traffic increases safety, reliability of transportation, efficiency, but also contributes to the positive effects of reducing negative impacts on society and the environment. Combining hardware and software creating intelligent transport systems, that have the primary purpose of increasing the safety level of all traffic participants, better informing the passengers and actively controlling traffic.

2 Road Infrastructure and Intelligent Transport Systems

Road infrastructure is a very important factor in traffic safety. Well-designed road infrastructure can help all participants to use it in a safe way and can significantly reduce the risk of accidents. Today, during the design and construction of road infrastructure installed intelligent transport systems (devices) in order to enable certain communication between infrastructure and vehicles that are moving at the same. Road infrastructure containing certain intelligent transport systems is called an intelligent road. Intelligent roads are upgrading classic roads, compared to classic roads have additional features such as: better information to drivers, traffic management, security, surveillance by video system with smart cameras and etc.

The aim of the device is to react to events on the roads, gathering data on various events, data analysis, and providing timely information to other systems in order to inform all the participants, about certain sections of road infrastructure. This is possible solely by using certain sensors that have the ability to react to certain changes such as light, heat, pressure, electric or magnetic field, concentration of certain gases, air flow rate and wind, thereby generating a specific electrical signal which shows the status of the device. At the output of these sensors, the most commonly electrical signal is further transmitted to the control part of the system. For Intelligent transport systems are important sensors generated by the development of microelectronics and nanotechnology. The most commonly installed sensors on road infrastructure are: infrared remote sensors, infrared temperature sensors, lecture acoustic sensors, magnetic, optoelectric, image sensors.

The primary mission of intelligent transport systems in traffic is measuring changes, quick reaction and response to irregularities that occur on the road infrastructure. Intelligent Transport Systems (ITS) can be defined as holistic, control, information and communication upgrade to classical transport and traffic systems, which enables significant improvement in performance, traffic flows, efficiency of passenger and goods transportation; safety and security of transport, ensures more comfortable travelling for passengers, reduces pollution, etc. The importance of intelligent transport systems has also been recognized by the European Union which has defined a framework for the development and use of ITS in road traffic through a series of directives. Through the Road Traffic and Security provisions in 2008., the European Union started an action plan for the development of intelligent transport systems. This Action Plan is based on eSecurity initiatives (2011. name eSecurity has been changed to iMobile) and Action Plan is identified priority actions. With Directive 2010/40 / EU The European Union has defined priority areas for the development and use of Intelligent Transport Systems in Road Traffic:

- 1) Optimal use of road, traffic and road data,
- 2) The continuity of traffic and freight management within ITS services,
- 3) ITS applications in the field of road safety and protection,
- 4) Connecting vehicles with traffic infrastructure.

When planning, developing and introducing intelligent transport systems it is necessary to ensure that there is communication and flow of information between vehicle-vehicle, vehicle-infrastructure and infrastructure-infrastructure. In order for the entire system to function and perform its task, it is necessary to use standardization of the process, standardized communication mode, standard message formats and information between vehicles, infrastructure and infrastructure and vehicles. In the selection of ITS solutions, should take into account several criteria such as safety, efficiency, compatibility with the existing system, standardization, quality and reliability. Today we have a lot of solutions for intelligent transport systems for road infrastructure which can be classified into several groups:

- ITS systems for the management and maintenance of road infrastructure,
- ITS systems for managing incident situations on road infrastructure,
- ITS systems for Informing the passengers on road infrastructure,
- ITS systems for informing emergency services in the event of an accident,
- ITS systems for Supervision weather conditions on road infrastructure.

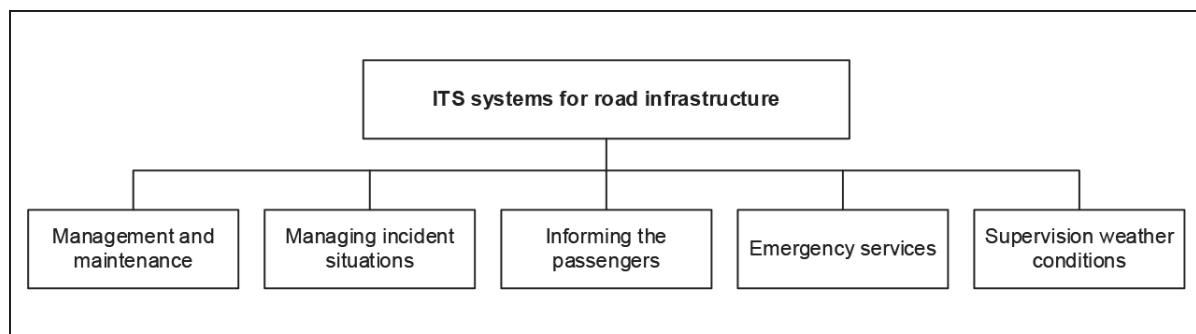


Figure 1 ITS systems for road infrastructure

Intelligent systems for the management and maintenance of road infrastructure have the function of signaling management, control of ventilators to maintain ecological conditions in tunnels, the occurrence of certain irregularities and damage occurring on road infrastructure. Sensors embedded in the road infrastructure communicate using wireless systems with systems that are installed in vehicles, and thus are exchanged informations between infrastructure-vehicle. These systems are called cooperative, and their main advantage is to compose different systems into one whole that works efficiently and safely.

Systems for managing incident situations have the function of controlling, managing and eliminating incidents, detecting and clearing incidents as well as predict and prevent them. Informing the passengers on road infrastructure uses displays to provide relevant information to all participants on roads. The information that being show on the displays is information about weather conditions on the road infrastructure, information related to incident situations, redirection, speed limitation, crowd and others.

Intelligent transport systems for informing emergency services in the event of an accident, it combines several processes to enable rapid and efficient information and emergency intervention, firefighters, police and other relevant services.

The European Union has decided that all Member States must have in place of an e-call system in all new models of passenger cars and light vans by March 31, 2018. All vehicles should be equipped with Global Positioning System (GPS) modules and GSM (Global System for Mobile Communications). In the case of traffic accidents, the e-call system would be activated on the basis of the sensor installed in the airbags and would automatically call the emergency service.

Systems for Supervision weather conditions on road infrastructure consist of a set of different sensors that measure temperature, pressure, humidity, visibility, concentration of gases in tunnels, airflow rates and wind. This sensors are built into the infrastructure and are associated with road weather stations.

3 Supervision of road infrastructure by applying Int. Transport Systems

The increase in demand for transport of goods and passengers increases the number of vehicles on the road infrastructure. This leads to an increase in the demands placed on road infrastructure, but also greater risk of traffic accidents and damage to road infrastructure. These requirements have prompted a new approach to solving problems and speed up the introduction of intelligent transport systems in road transport. To have active supervision on road infrastructure, it is essential that all intelligent transport systems installed on the infrastructure be integrated into a one whole, which enables central supervision of infrastructure. Until today, various systems have been developed to help supervision the infrastructure of road traffic. In the narrow sense, road infrastructure supervision can be observed through:

- Intelligent roads,
- Intelligent vehicles,
- Intelligent intersections,
- Indicative Intelligent Transport Systems,
- Intelligent tunnel management and
- Supervisory centers

Intelligent roads are roads that have the capability to communicate between infrastructure, vehicle and supervision center in case of an accident or congestion. Intelligent Roads have the function measurements of traffic and traffic flow, infrastructure vehicle classification, traffic flow analysis, remote control traffic flow, toll collection via “smart” cards. Tunnels can also be included in the constituent part of the intelligent road, but in practice the tunnel management is most often disconnected from the management of the rest of the infrastructure.

At the complete concept of road infrastructure supervision using intelligent transport systems, intelligent vehicles play a very important role. The communication that intelligent vehicles realize with infrastructure are of utmost importance for the supervision and management of the infrastructure. Vehicles that have the ability to collect and process data from the environment as well as the ability to auto-adapt themselves are called intelligent vehicles. An example of increased use of intelligent vehicles are cars that have built-in accessories like sensors and self-parking devices. Intelligent vehicles have built-in sensors and devices that enable the driver and the vehicle:

- Receiving travel information in real time,
- Sensors for automatic detection of collisions,
- Adaptive cruise control,
- Prevention of vehicle crash on the back,
- Detection of obstacles in front of vehicles (pedestrians, vehicles, etc.)
- Internet access and mobile network,
- vehicle diagnostics (failure on certain parts of the vehicle),
- Navigation and routing of vehicles (vehicle parking),
- Detection and recognition of vehicles in the environment,
- Communication with intelligent vehicles in the environment.

All of these elements significantly affect the safety of both driver and other traffic participants. Intelligent vehicles have the ability to communicate with the infrastructure and share information about incident situations, obstacles, weather conditions that are written down during the route and forwarded to the supervision center. There are vehicles equipped with technology that communicates with the semaphore and emits a signal according to which the semaphonic device after analyzing the signal determines whether the vehicle is priority in the intersection. For supervision traffic and infrastructure in cities, most frequently used is intelligent intersections, which are equipped with special devices that enable adaptive control light signals, based on detectors and specific algorithms. Particularly important is the safety impact on the emergency

vehicle leakage. With the use of modern devices and intelligent transportation systems for traffic at the hubs, a high level of traffic safety can be achieved, increased mobility of vehicles, and thus reduced transport and environmental pollution costs. An integral part of intelligent intersections is video surveillance that enables surveillance and analysis of the situation at the intersection and provides an insight into the realistic picture of the situation at the intersection. In this cameras incorporate a microprocessor located in the image detection device, through which data processing and situation analysis are performed. Demonstrative Intelligent devices are used to display information forwarded from a sensor that tracks the state of the infrastructure or the supervision center. Indicator systems include screens for showing information on roads or devices installed in vehicles. Screens show warnings on roads in related to the incident situation on the roads, information on more passable roads, information on the weather conditions on the roads, and specific information related to a particular road.



Figure 2 Demonstrative Intelligent transport systems on highway [12]

In 2004, the European Union adopted a directive on minimum safety requirements for tunnels in the trans-European road network (DIRECTIVE 2004/54 / EZ). Tunneling management and supervision works on: individual fans, CO measurement, tunnel visibility measurement, speed and air flow measurement, tunnel power supply system, tunnel lighting (tunnel lighting distributor control), Tunnel backup power supply, SOS monitoring, water tank system and fire alarm system and fire protection, pedestrian passage. Intelligent tunnel management implies that the tunnel must be equipped with variable light signals within the tunnels that are connected to the supervision center. A video surveillance in tunnel with automatic image processing, can detect the incident and alert the control center. Procedures are automatically triggered, other traffic participants are informed of the incident that occurred in the tunnel. This is a quick reaction that allows intelligent tunnel management, and automatically informs emergency services as soon as possible.



Figure 3 Intelligent tunneling management – Incident situations [13]

The control center combines all of the above mentioned intelligent transport systems used for road infrastructure monitoring and management. All data and information coming from sensors, devices from the infrastructure and vehicles are forwarded to the supervision center where they are processed. Depending on the information being processed, the reaction of the supervision center also depends. The supervision center also receives information from an intelligent road, analyzes and provides feedback on any changes that other participants

in the traffic infrastructure should know. Special emphasis is placed on the monitoring of the situation in the tunnels, on certain parts of the road infrastructure which are marked as risky and certain intersections with a large flow of people and vehicles. In order for the controllers to have as realistic a picture as possible on certain roads, video surveillance is linked to the infrastructure cameras, certain damage to the infrastructure can be noticed. Through the control center there is the ability to control light signals on individual sections, control ventilators in tunnels and etc.

4 Supervision of road infrastructure in Bosnia and Herzegovina

Bosnia and Herzegovina has a partially built highway A1, which is part of the Pan-European corridor Vc and the European international route E73. The planned length of the highway is 338 km, and so far it has been built in two sections, totaling 131 km (FBIH 97 km and RS 34 km), and 246 km are under construction or in the plan. The total length of the main and regional roads in BiH is 8.893 km. Taking into account the data on the length and type of road infrastructure it can be concluded that there is little possibility for the introduction and implementation of intelligent transport systems. Regarding the supervision on road infrastructure in Bosnia and Herzegovina, it is divided into the supervision and management of the Federation of Bosnia and Herzegovina, supervision and management of Republika Srpska and Brcko District. In the Federation of Bosnia and Herzegovina, the JP Autoceste of the Federation of Bosnia and Herzegovina manages the infrastructure of highways and fast road. Highway A1 that runs through the Federation of Bosnia and Herzegovina is supervised by JP Autoceste through 2 Center for Traffic Maintenance and Control (COKP) at two locations, Drivuša and Zviriči. Traffic on all sections of the highway is supervision and managed through variable dynamic signaling, tunnel flow – ventilation work, LED lighting, co-ordination of all incidents or accidental situations, in cooperation with fire service and other emergency services if needed.



Figure 4 Center for Maintenance and Control of Road Traffic FBIH- JP Autoceste [14]

In Republika Srpska, the infrastructure management of highways and fast road has been awarded to the Public Enterprise Autoceste Republike Srpske. Framework Strategy for traffic of Bosnia and Herzegovina for the period 2015-2030 is planning to introduce an intelligent transport system in Republika Srpska, which should offer road users a set of services such as providing timely information to users. On the constructed highway Gradiška – Banja Luka E-661 and the Banja Luka-Doboj highway (in construction) it is envisaged the introduction of the Traffic Supervision, Control and Control System. It is anticipated that all the subsystems of this system integrates the Center for maintenance and traffic control Laktaši, and expected is to be center in operation for two years. In Bosnia and Herzegovina there is currently no built any intelligent intersections or roads, but there is only partial control of the tunnels on the highway Vc. Tunnel 1.mart is a long 2.900m with modern LED lighting and is equipped with all security systems, variable signaling, fire alarm, hydrant network, radio, mobile and internet connection, video surveillance, and is managed by the Center for Traffic Maintenance

and Control (COKP) Drivuša. This tunnel is equipped with variable signaling, allowing quick response in incident situations.



Figure 5 Tunnel “1.mart” [15]

Individual traffic supervision centers are being developed in Bosnia and Herzegovina. Due to the complex arrangement of state and legal regulations, there is currently no single supervisory center. In the near future, it is not planned to build because some entities are planning to develop their own supervision centers.



Figure 6 Overview of supervision centers in BiH

The road infrastructure development strategy in Bosnia and Herzegovina is based on Framework Strategy for Bosnia and Herzegovina for the period 2015-2030. Through the framework strategy, special focus and attention is not paid to intelligent transport systems, so it is expected that both the transport sector in Bosnia and Herzegovina and road infrastructure will lag behind for the countries in the environment which have adopted national programs for the development and introduction of intelligent transport systems, both for traffic and road infrastructure.

5 Conclusion

An active investment in building a new road infrastructure based on intelligent transport systems is one of the basic conditions for a sustainable development of a country. This approach has also been recognized by the European Union, which has adopted directives requiring all Member States to adopt national strategies for the introduction of intelligent transport systems in traffic.

The research that has been carried out on the introduction of intelligent transport systems into road infrastructure has led to improved supervision and control, to preventing and reducing accidents and damage, reducing the impact of human factors on vehicle management procedures and increasing passenger safety. This way contributes to the overall safety of travel and use of the roads. The security aspect of traffic should be included in all services and functional areas of intelligent transport systems. Analyzing the framework strategy for Bosnia and Herzegovina for the period 2015.-2030., focus and attention on intelligent transport systems are not monitored and it is expected that the transport sector in Bosnia and Herzegovina will lag behind for countries in the environment that have their own national development programs and the introduction of Intelligent Transport Systems in traffic based on the EU Directives. The supervisory centers in Bosnia and Herzegovina are currently in three locations (2 in FBiH and 1 in RS), while Brcko District has no control center. Such an approach is decentralized and it will be necessary to link the above-mentioned supervision centers in the future in order to actively break down the information relevant for road traffic and infrastructure.

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