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IMPROVING THE SAFETY OF RAILWAY FROM BASIC START-STOP TO THE INTELLIGENT SYSTEM

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Abstract: Increasing railway safety is the basis of new high-speed railways. To do this, we need automatic locomotive protection in increasing the safety of railway traffic. The basic system used in this is the so-called start / stop automatic protection system type RAS 8385, which consists of a part located on a locomotive and a part located on rails. System has two parts. One is mounted on a locomotive and the other on rails. By contacting the track section and the rolling mode, the locomotive can be stopped if, after contact with the track section, the locomotive has passed faster than it should or had to stop, so the system will automatically lock and shut it down. This system is used to avoid driver errors and reduce its impact on railway safety. The previous start-stop system does not provide complete protection at open crossings, which we have from the moment of the locomotive's exit to its departure at the destination. In the world, and especially in the western Balkans, there are many unmarked crossings or crossings without secure protection against an incoming locomotive other than a warning or light signaling. Then collisions happen with catastrophic consequences. With the help of new intelligent technologies and the above system, it is possible to minimize problems.
Keywords: safety system, railway, intelligent system

INTRODUCTION

Rail is a mode of transport that statistically and practically belongs among the safest and the most efficient modes of transportation. This fact is greatly supported by the continuous development of the system for the management of railway traffic which directly affects its efficiency. The international system for a train control is (ETCS), that is well received in Europe and is expanding to other continents [2]. Teaching, there are also national systems that are generally complementary to ETCS, ie one does not exclude the other. From the beginnings of rail, we have always been a need to develop systems that can control rail traffic. For this purpose, signaling technology is constantly improved, ranging from hand signals to modern technologies. On Figure. 1 is Locomotive upgraded with protection system RAS 8385.

Figure. 1 Locomotive 441-521 with protection system type RAS 8385

All safety railway systems, starting with those used from the beginning of a railway in Europe, down to the most modern, they share the same concept - trains cannot collide if they do not maybe in the same section of line at the same time [4]. For this reason, the line is divided into sections, also known as blocks. In practice, a train is allowed to occupy only one section. Like on the Figure 2.

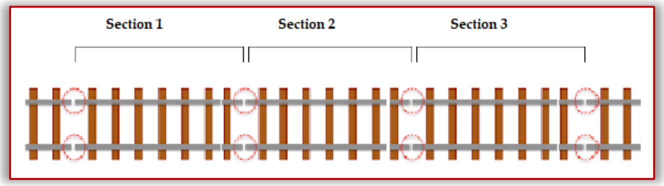

Figure 2. Railroad divided into Sections

Signaling in railway is based on automatic track sections without manual intervention. The section equipped with automatic sections is divided into sections not shorter than the stopping distance of the fastest train running on that section. The function of detecting the presence or passing of a vehicle in a particular compartment may be realized through 2 types of different equipment: [1], [4]

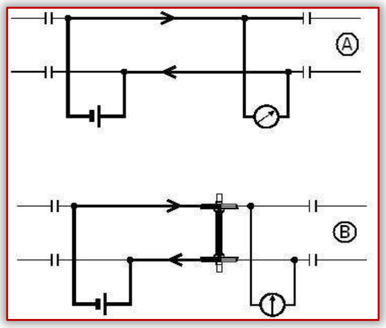

Figure 3. Free (A) and occupied (B) track circuit

An electromagnetic device (relay) realizes the track circuit, an electrical circuit that used as a conductor, the two rails of the track. The transit of a vehicle on the track causes the electrical contact on the two rails, so the circuit is closed, the relay is characterized by zero current and the block signal is set at danger (or occupied) like on the Figure 3.

On modern railway lines, at the beginning and end of each block section, equipment called an axle counter is installed. The task is to count, discovering all the axles of the vehicle fleet that travel on the track, as well as their driving direction, using two electronic sensor systems on wheels. By comparing the result for the included axes and the result for the counted axes, it is possible to know the status of the track section (free or busy). According to Figure 4, as long as the number of axes of the counted Ak2 (train exiting TS1) is not equal to the number counted Ak1 (train entering TS1), then the track TS1 will be considered "occupied". [4]

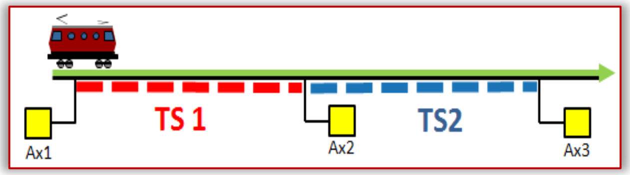

Figure 4. Axle Counters for track occupation detecting

ATP SYSTEMS

ATP Systems from the 80s upgraded rail signaling systems that are used in Europe, for increasing railway safety. The basic idea is to constantly monitor the speed of the train. They're called *ATP* (Automatic Train Protection) systems.

The basic system used in this is the so-called start / stop automatic protection system type RAS 8385, which consists of a part located on a locomotive and a part located on rails. The basic division of the Automatic train protection (ATP) have the point and continuous systems. Figures 5, 6 and 7.

Figure 5. Type LLC0512 ALPRO in direction on the cabin of a train.

ATP system RAS 8385 works on the principle of interaction of resonant circuits. A locomotive ATP device which means a device installed on a traction unit vehicle is configured to transmit or receive inductive balize information by influencing the frequencies of 500 Hz, 1000 Hz, and 2000 Hz.

The actuator, located in the central part of the device, sends a signal that activates pneumatically part of the ATP device and, if necessary, performs forced braking. The same signal is sent at the same time and according to the parts of the ATP device in the steering wheel where the light and sound signaling indicates the response of the locomotive part of the device or possible forced braking.

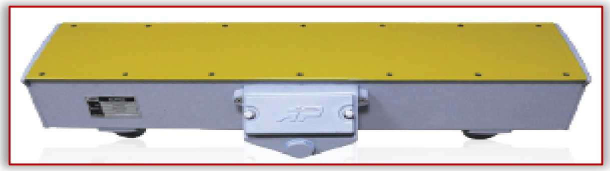

Figure 6. Rail balize

Also, this signal is sent to the recorder (located in the cabinet of the central unit of the ATP device) which records the forced braking, ie passing of the locomotive past the prohibited driving signal. On identical the ATP mode responds if the prescribed speed for the default driving mode also occurs, passing a signal with a speed limit signal.

Figure 7. Position of rail balize.

The autostop system with the central device RAS 8385 consists of locomotive and track magnets, as well as signal and control elements in the steering wheel of the vehicle. This system is based on the inductive mode of information transfer from the track part of the device to the part located on the traction vehicle and is designed to increase the safety of railway traffic [7],[8]. The hitchhiker is used for speeds up to 160km / h. [10]

Table 1. Driving mode for different top and restriction speed

Top speed [km/h]	Driving mode	500 Hz Restriction speed [km/h]	Time control [s]	100Hz Restriction speed [km/h]	Vigilance [s]
140	1	65	20	90	4
100	2	50	26	65	4
80	3	40	24	50	4

When the train is running at normal speed, ie respecting traffic signs, this device does not affect the train running mode [3,5]. Information from the rail Balise is inductively transmitted to the locomotive magnet, and from there to the executive member of the central device.

Then the driver has a certain amount of time to confirm that he has noticed a signal sign, i.e. to confirm his alertness with the vigilance button, and to adjust his speed to the prescribed speed. If these actions are not performed, the air is released in the main brake line, and the train brakes automatically.

INTELLIGENT TRANSPORT SYSTEM (ITS)

Technologies like Global Positioning System (GPS), Satellite Communication, and care used to establish communication between vehicles. Such Intelligent Transport Systems offer a communication platform to facilitate the sharing of information and knowledge within the transportation infrastructure to allow the realization of a range of safety and mobility applications [4].

ITS enables applications across three main categories, with the potential to offer significant social, economic and environmental benefits, namely:

- Safety: ITS safety applications use the communication mechanism within DSRC to create complete situation awareness for vehicles.
- Mobility: ITS mobility applications include travel and route planning, traffic and congestion management including public transport, transport network productivity and reliability enhancement, etc.
- The overall aim of the project was to research, develop, implement and trial (for potential rollout) a DSRC based Intelligent Transport System to improve safety at level crossings. The system aims to reduce and potentially eliminate rail-road crossing accidents by enabling dynamic vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications using DSRC technology. The specific aims within the scope of the project are:
- Phase 1: To develop an Intelligent Transport System (ITS) simulation platform for rail-road crossings based on 5.9GHz DSRC technology
- Phase 2: To develop an ITS demonstrator and Proof-of-Concept system
- Phase 3: To carry-out field trials at level crossing interfaces

Figure 8 illustrates the system architecture of the proposed DSRC based Intelligent Transport System deployed at a level crossing. The system is composed of DSRC enabled roadside units (RSUs) and on-board units (OBUs). The RSUs are placed at locations such as rail-road crossing active signs while the OBUs are installed in road vehicles and trains. [5]

A DSRC based ITS at the level crossing will enable communication between infrastructure nodes and vehicles in the vicinity of the crossing including trains and road vehicles. This communication will enable sharing abundant data between vehicles including basic information such as vehicle size and type, position and motion and other control information such as brake status, throttle, steering angle, etc. Depending on various parameters and conditions, the information can be shared directly using V2V communication or indirectly using V2I communication as presented in Figure 8. The information will be used by a specialized level crossing safety application to generating warning messages such as advice of an approaching train, an advance indication of a potentially faulty crossing, expected delay at the level crossing, suggestion of alternate routes, etc. The Human-Machine-Interface (HMI) used to communicate safety messages to drivers was developed to not only address the immediate safety requirements but also to promote overall long term behavioral change of drivers towards safety consciousness.

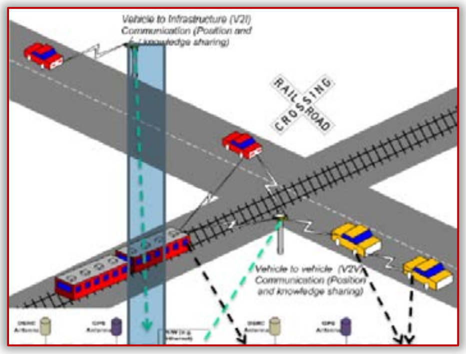

Figure 8. Arhitecture of Intelligent Transport System [5]

The number of devices we need to manage and communicate will be many times greater than the devices connected to the current Internet. The ratio of communication activated by devices concerning communication activated by humans will also be many times higher like in Figure 9.

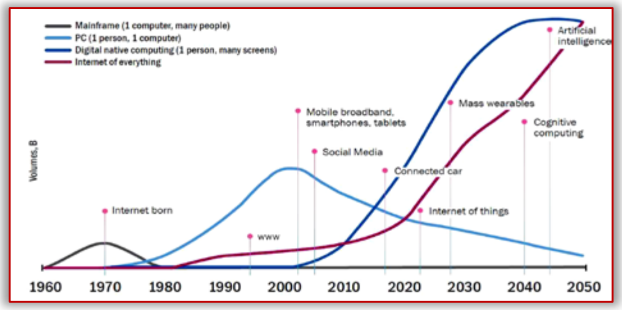

Figure 9. Prediction of the number of digital devices in the future. [6]

Autonomous vehicles have evolved from the technology of the future that was developed in laboratories to the technology that is used and can be seen on the roads like on Figure 10. Test vehicles of companies such as Uber, Waymo, Tesla and Toyota can be seen on the roads and streets of Phoenix, Pittsburgh and Boston. Although there are concerns in America about the safety of autonomous vehicles, due to the last traffic accident in which a pedestrian was killed, the question arises whether autonomous vehicles will be ready for mass access to the roads at all. The answer is yes, but autonomous vehicles will become a reality only when the 5G data network becomes ubiquitous. The current 4G network has quite enough speed if we want to share updated statuses or order a ride, but it cannot give vehicles the reflexes that people have. Had the capabilities of the 4G network been different, an accident involving an Uber vehicle would surely have been avoided..

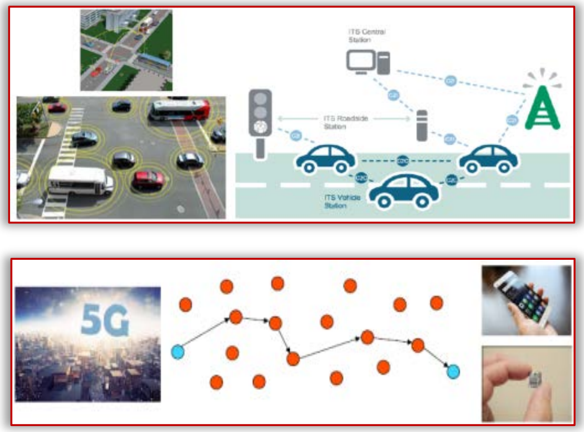

Figure 10. Autonomous vehicles and 5G network to support the development of autonomous and semi-autonomous vehicles

The new 5G network brings with it both autonomous and semi-autonomous vehicles, as well as other technologies, such as virtual reality, smart things, smart apartments, smart guards and artificial intelligence. The 5G network will enable the connection of everything around us in a 1.5 Gb network, and thus the responses, distribution and capacity of the technologies we mentioned earlier. It represents the last part of the connective technological tissue that autonomous vehicles lack, as well as to participate in events and games in real-time. The phone will also run at 1.5 GB and will be a supercomputer with an instinctive connection with other phones [10]

CONCLUSIONS

The paper describes the basic characteristics of hitchhiking devices RAS 8385, and devices for registration of events IRAS 19. Test data were analyzed using IRAS 19. Based on the obtained results, it was concluded that the hitchhiking device RAS 8385 is very effective for increasing railway safety because it can significantly reduce the occurrence of driver errors relevant to safe train running and reduce unwanted outcomes. these errors.

To make the railway system safe and efficient, signaling and train control means are required. They help prevent driver mistakes, monitor their actions, and act as needed to prevent unwanted train collisions. As the technology evolved, the initial mechanical interaction between track and train soon was replaced by permanent magnets and the development of the future most applicable system for train protection in Europe has begun.

The railway management of the region should re-evaluate their approach to monitoring safety and to set priorities for implementing safety enhancement on their respective systems. Desirably, all railway systems of the region should carry out regular safety audits and risk. The use of a Safety Management System will improve the capability of railway management to identify and prioritize level crossing safety enhancement measures. Existing technologies, such as Global Positioning System (GPS), Satellite Communication, can be employed to establish communication between vehicles. Such Intelligent Transport Systems offer a communication platform to facilitate the sharing of information and knowledge within the transportation infrastructure to allow the realization of a range of safety and mobility applications. Future safety systems are based on the development of a 5G network and connected every transport machine from car to railway machine to machine M2M.

Such a system will be semiautomatic to the automatic car or railway giving the best dose of security for everybody. With 1,5 Gb of download and almost half of upload fastness of 5G network will give us support for any kind of safety systems.

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