ISSN 2409-9066. Sci. innov. 2017, 13(2): 27—32 doi: https://doi.org/10.15407/scine13.02.027

Fedukhin, A.V., Lutov, S.D., Mukha, A.A., Cespedes Garcia, N.V., and Gedz, A.V.

Institute of Mathematical Machines and Systems, the NAS of Ukraine
42, Glushkova Av., Kyiv, 03680, Ukraine, tel. +380 97 605 3732, freezware@gmail.com

BLAGOVIST INFORMATION WARNING SYSTEM FOR RAILROAD CROSSINGS

The article deals with traffic safety at ground railway crossings. An approach based on raising driver awareness via modern means of automation, computation, and communication has been considered. Blagovist information warning system for the railway crossings has been described.

Keywords: information approach, railway crossing, track gauge, radio, information board, and controller.

From the standpoint of safe operation of road and railway transport, the problem of accidents at the crossings and junctions needs to be addressed urgently. The solution of this problem depends on the technological level of equipment installed at the crossings and on the discipline of drivers of motor vehicles. Regular accidents at railway crossings in the country indicate an obsolescence of systems whose major part is designed and installed mostly in the 1960—70s. Technical obsolescence of equipment and unproductive time losses of vehicles provoke drivers to speed up the passage of crossing having no information about direction, speed, and time of train arrival at the crossing to assess the risk, which often leads to accidents.

Solving the problem of accidents at railway crossings can be achieved by upgrade of existing equipment and installation of new advanced systems, which is impossible without concerted efforts of managers and experts in the sphere of railway and road transport, road maintenance services, and road patrol of the Interior Ministry. The solutions shall take into consideration an increase in the intensity motor traffic in particular areas of roads and railways.

© FEDUKHIN, A.V., LUTOV, S.D., MUKHA, A.A., CESPEDES GARCIA, N.V., and GEDZ, A.V., 2017

INFORMATION APPROACH AS MEANS OF IMPROVEMENT OF TRAFFIC SAFETY AT RAILWAY CROSSINGS

Having analyzed the accidents at railway crossings resulting from bypass of automatic barrier (AB) by cars, or passing the railroad tracks just in front of train at the crossings not equipped with AB, one can conclude as follows. The drivers having information neither about in which direction and how fast the train is moving nor about waiting time put themselves at an undue risk. With high probability it can be stated that provided the drivers are aware thereof, the number of accidents would significantly decrease.

The poll of road users at the railway crossings has showed that almost 70% of drivers support the idea of increasing their awareness about the situation. The proposal has been also supported by the Traffic Police of Ukraine and the National Transport University (Kyiv) [1, 2].

The use of information approach at railway transport has a number of material advantages, in particular, these control and information systems are

advanced tools that improve safety of motor vehicles at the railway crossings at minimal financial costs: they are much cheaper than multilevel road interchanges or two-lane barriers installed on carriageway. These systems are self-contained and require no adaptation to the existing circuits of automatic alarm systems (AAS) and AB; they can be installed at crossings and junctions of any type and with any kind of traction and AAS systems; they are not subject to the requirements for functional safety [3] that apply to railway automation systems related to the train safety. The simultaneous use of information systems with existing AAS enables implementation of advanced systems for improving safety at railway crossings.

These advantages are a major prerequisite for widespread introduction of such systems on the railways throughout the world. The existing counterparts of proposed systems are as follows:

The 1st group — AAS without barriers, which have been installed at railway crossings with various number of tracks and motor traffic intensity for over 70 years [4];

The 2nd group —systems that inform the drivers about time before closure of AB using a countdown board [5];

The 3rd group — system for informing the staff of shunting towers about approach of the train SOP-1 [6].

The key means to provide drivers of motor vehicles with information in the 1st group systems are traffic lights and electric alarm bells. Information about approaching train is given as blinking red light and periodic alarm signal of the bell. It should be noted that such way of creating awareness differs from system of colors of traffic lights for motor vehicles (red/yellow/green), which often lead to misinterpretation or neglect of signal by drivers. The amount of information provided to drivers by such systems is minimum and tells only whether control sections before and after the crossing are free or busy, as well as signals on closure and opening of the crossing.

The systems from the 2nd and 3rd groups display information on the board, in particular, time before the closure of AB or information about approach of train 50 seconds before its passage past the tower for the tower's staff. However, to give information about time before the closure of AB is not enough for improving safety at the crossing.

Provided the drivers waiting in front of barrier are aware of time of train transit, speed, direction, and time before opening of barrier they can stay calm not trying to cross the tracks in the face of oncoming train, which will result in raising traffic safety at the crossing.

INFORMATION ALERT SYSTEM FOR RAILWAY CROSSINGS

The *Blagovist* information alert system for the railway crossings is designed to ensure a timely awareness among drivers who intend to cross the tracks about main parameters of the motion of upcoming train [2].

The solutions to be implemented within the proposed system give preference to the project in terms of creating comprehensive awareness among drivers as compared with the counterparts (AAS and countdown systems. The main advantage of the designed system is provision of full information about the following:

- Approach of moment when train will move through the crossing;
- Occupation of approaches to the crossing by trains;
- Direction of train moving through the crossing;
- Speed of train;
- Time before passage of train through the crossing;
- Release of control section after the crossing;
- Road situation at the crossing as running text displayed on the board.

The modification of *Blagovist* system for single-track railroad with two-way traffic contains two reporting points (RP) placed at a certain distance from the crossing to ensure enough time for alerting the road users. Each RP consists of track sensors (TS), an axial pin count circuit (ACC), and a radio modem (RM) to transmit information to the control point (CP) by radio channel (Fig. 1).

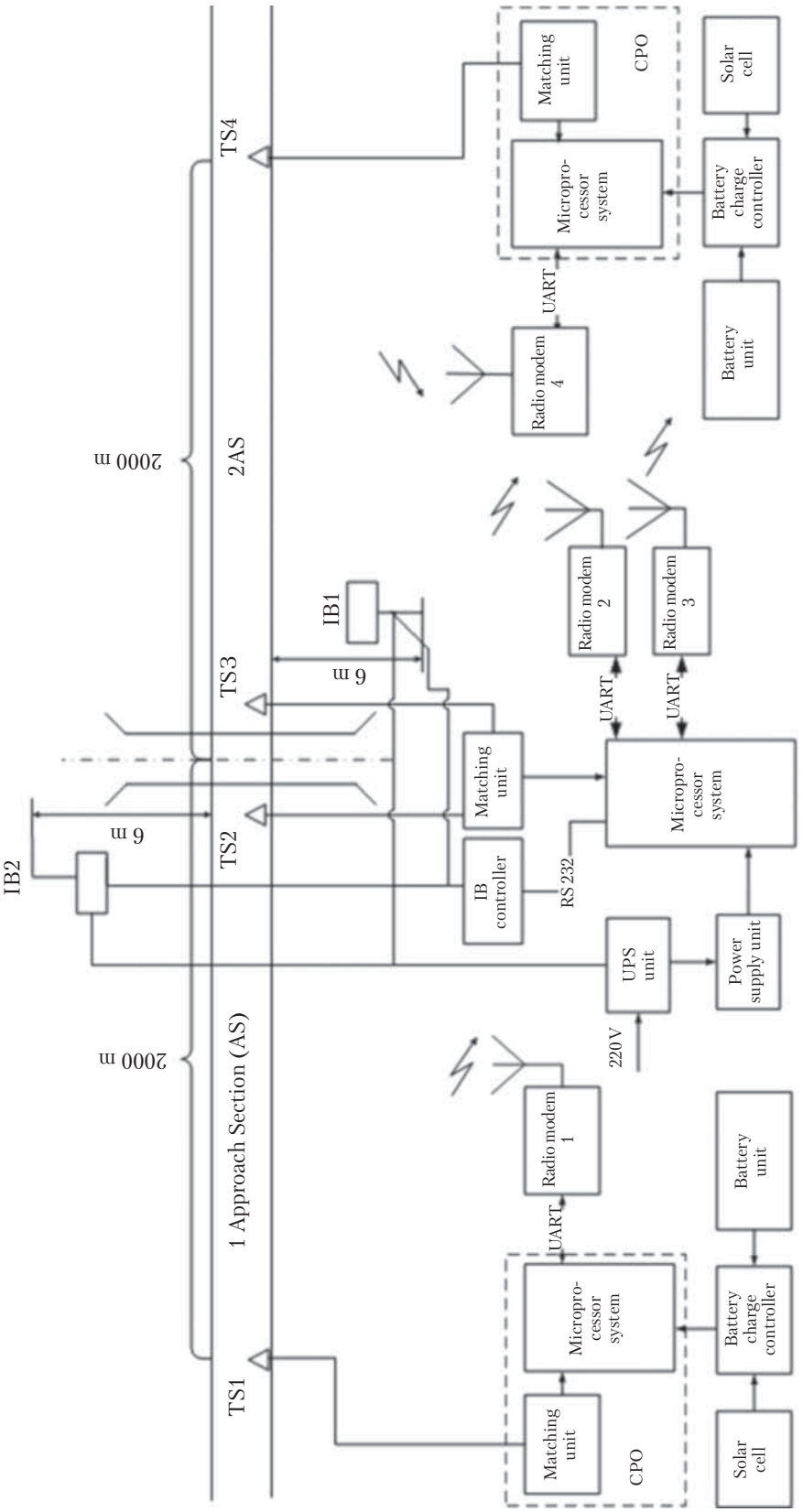

Fig. 1. Functional diagram

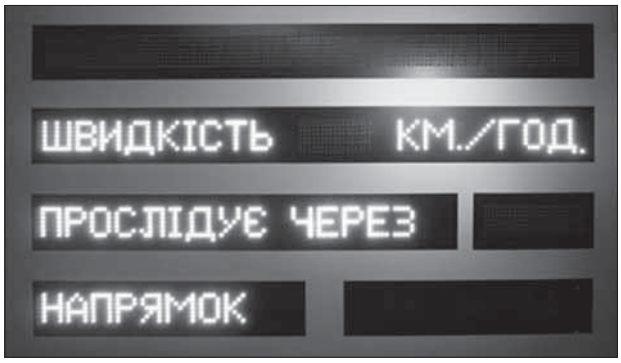

Fig. 2. The information board

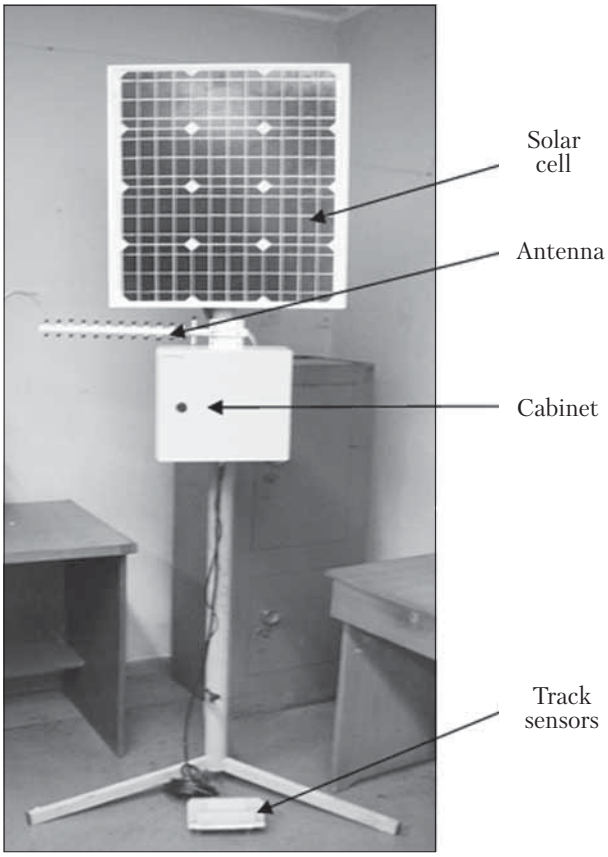

Fig. 3. The control point (demo view)

Two information boards (IB) are connected to CP (Fig. 2), one on each side of the crossing. They inform drivers and pedestrians at the crossing about approach of AB closure and moment when train will move through the crossing; time before passage of train through the crossing; direction

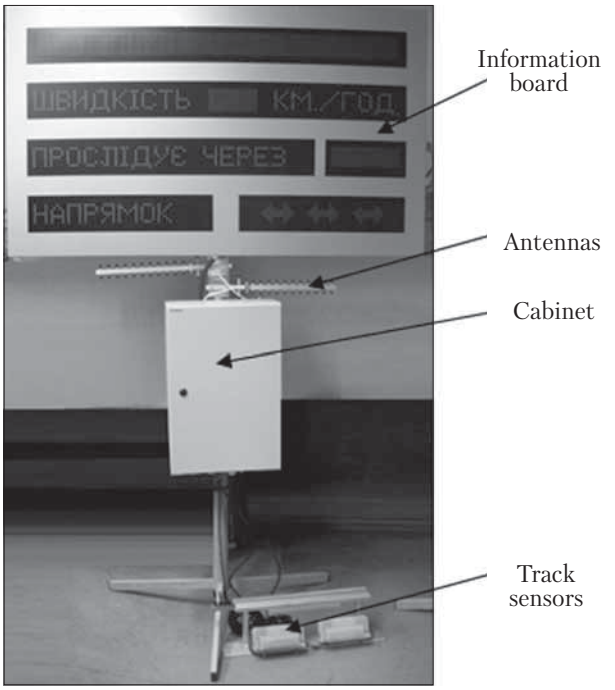

Fig. 4. The reporting point (demo view)

and speed of train. The information boards shall be installed near the crossing, on each side thereof, along the line of driver's sight.

If the control point is located at watch post of the crossing there is an option to install a video monitor for 24/7 surveillance and timely adequate response in the emergency case.

The control point is equipped with UPS unit to ensure uninterrupted operation in the case of power failure. The reporting point has an autonomous power supply from storage battery chargeable from solar cell (SC) or from ~ 220 V power source, depending on location.

The reporting point (Fig. 3) consists of track sensors; microprocessor ACC; radio modem; matching unit; battery charge controller, antenna, and solar cell. The RP hardware ensures tracking of train passing through the control area of track sensors by axis count method; measurement of acceleration and speed of train while passing through the track sensor by each carriage axis; determination of direction of train motion; transmission of information to the CP

by radio modem. The reporting point is located in metal cabinet on a typical mast used for floor traffic lights. The antenna and solar panels (depending on type of power supply) are installed on the mast as well.

The control point (Fig. 4) consists of microprocessor data processing system; radio modems; track sensors; matching unit; information boards; IB controller; power supply unit (PSU), UPS units and antennas. The CP hardware ensures reception of data from the reporting point via radio channels; processing of data received; transmission of information by communication cables to IB. The CP can be placed either in typical on-floor cabinet, in the crossing area, together with railway automation equipment and AAS, or in individual special cabinet. The IB can be placed on masts of crossing traffic lights or on separate pole, near the light. The IB shall be located in the area where they are most visible for drivers. The IBs are wet proof and based on super bright LED, which provides maximum visibility from a large distance.

Basic technical parameters of *Blagovist* system

Controlled speed of train moving past reporting point	200 km/hour
Range of train control	2.5 km
Distance for reliable reading of video information on IB	from 1 to 50 m
Size of LED board	1500×900 mm
Operating frequency of data transfer channel from IB to CP	2.4 GHz
Power consumption of CP	225 W
Power consumption of RP	2 W
Operating environment temperature	from −30 °C to +60 °C

The *Blagovist* information alert system for railway crossings can be used for both trunk and industrial railway transport systems.

Eighty percent of the system is made of components produced in Ukraine. The system is being prepared for commercial application and tested at trial stands the Institute Mathematical Machines and Systems of the NAS of Ukraine.

Large-scale application of *Blagovist* system throughout the country is anticipated to raise traffic safety at railway crossings at minimum costs for design, production, and operation. Expected effectiveness from its implementation is estimated as over 50% decrease in accidents at railway crossings.

CONCLUSIONS

Hence, the *Blagovist* system significantly raises awareness of drivers and pedestrians moving across the railway crossing and traffic safety as a whole.

The system in its various versions can be used at railway crossings of all types with different number of gauges. Its operation will enable the use of information from sensors for automated signaling system of railway crossings. The designers recommend to apply the system, firstly, at the crossings without AAS and AB, as well as at the sections with high intensity of traffic.

REFERENCES

1. Fedukhin A.V., Gladkov A.V., Mukha Ar.A. A new approach to the automation of level crossings on railway transport. *Mathematical Machines and Systems*. 2011. 3: 135—141 [in Russian].
2. Fedukhin O.V., Mukha A.A. Informational approach to the improvement of safety at level crossings. *Mathematical Machines and Systems*. 2015. 4: 145—151 [in Russian].
3. *Order No. 54 of 26.01.2007*. The Ministry of Transport and Communications of Ukraine. On Approval of Instruction on Design and Operation of level crossings [in Ukrainian].
4. Automatic systems of level crossings alarm. URL: http://lokomo.ru/scb/ustroystva-avtomaticheskoy-pereezdnoy-signalizacii.html (last accessed: 30.01.17).
5. Arsent'ev V.V. The electronic information display timing at a railway crossing. URL: http://static.scbist.com/scb/uploaded/17816_1363983451.pdf (last accessed: 30.01.17).
6. System alerts staff posts KTSM the approach of a train SOP-01. Nyzhehorodskoe OAO otdelenie «VNYYZHT» [Electronic resource] // System opoveschenyya personnel guard at KTSM approximations of trains SOP-01. URL: http://static.scbist.com/scb/uploaded/2721_montazh_sop-1.pdf (last accessed: 30.01.17).

Recieved 22.11.16

О.В. Федухін, С.Д. Лутов, А.А. Муха,
Н.В. Сеспедес Гарсія, О.В. Гедз

Інститут проблем математичних машин і систем
НАН України
пр. Глушкова, 42, Київ, 03680, Україна,
тел. +380 97 605 3732, freezware@gmail.com

СИСТЕМА ІНФОРМАЦІЙНОГО СПОВІЩЕННЯ ДЛЯ ЗАЛІЗНИЧНИХ ПЕРЕЇЗДІВ «БЛАГОВІСТ»

Висвітлено проблему створення безпеки руху на залізничних переїздах. Розглянуто підхід, що базується на підвищенні рівня інформованості водіїв за допомогою сучасних засобів автоматики, обчислювальної техніки та зв'язку, наведено опис системи інформаційного сповіщення для залізничних переїздів серії «Благовіст».

Ключові слова: інформаційний підхід, залізничний переїзд, колійний датчик, радіоканал, інформаційне табло, контролер.

А.В. Федухин, С.Д. Лутов, А.А. Муха,
Н.В. Сеспедес Гарсия, А.В. Гедз

Институт проблем математических машин и систем
НАН Украины,
пр. Глушкова, 42, Киев, 03680, Украина,
тел. +380 97 605 3732, freezware@gmail.com

СИСТЕМА ИНФОРМАЦИОНОГО ОПОВЕЩЕННЯ ДЛЯ ЖЕЛЕЗНОДОРОЖНЫХ ПЕРЕЕЗДОВ «БЛАГОВЕСТ»

Освещена проблема обеспечения безопасности движения на железнодорожных переездах. Рассмотрен подход, основанный на повышении уровня информированности водителей с помощью современных средств автоматики, вычислительной техники и связи, приводится описание системы информационного оповещения для железнодорожных переездов серии «Благовест».

Ключевые слова: информационный подход, железнодорожный переезд, путевой датчик, радиоканал, информационное табло, контроллер.