Informatization of Rail Freight Wagon by Implementation of the RFID Technology

Michal Balog(✉) and Miroslav Mindas

Faculty of Manufacturing Technologies with Seat in Presov, Technical University of Kosice, Bayerova 1, 080 01 Presov, Slovakia
{michal.balog,miroslav.mindas}@tuke.sk

Abstract. This paper deals with the informatization of railway freight wagon using elements of IoT for monitoring the technical condition of selected elements of the chassis. The introduction is devoted to the current state of the issue of maintenance of rail freight wagons. The core of the paper is a technical solution for collecting, storing and analyzing data about the technical condition of the chassis with the use of RFID technology. Where are described each joints of technical solutions. Further discusses about the detailed monitoring of an error condition of bearing chamber by using RFID technology. In the conclusion is evaluated the technical solution using elements of the IoT and its possible impact on the safety of rail freight transport.

Keywords: RFID technology · IoT · Rail freight wagon

1 Introduction

RFID technology (Radio Frequency Identification) is one of the automatic identification systems to be used to generate, collect and speed up the processing of information, increased accuracy and automation of data processing [1]. Development of RFID technologies and possibilities of its use are unlimited nowadays. The proof is the ever-increasing expansion of RFID technology which can be applied in almost every sector, at almost any product or material, or component. Appreciation of use in rail traffic with the application of RFID technology on wagon components, apart from the safety aspects is the financial effect of which brings the RFID application [2]. By utilizing this technology for checking the technical condition of the wagon we can avoid huge disaster caused by poor technical condition of the wagon, this prediction brings in the long term the return of initial investments, reduce costs and improve competitiveness [3].

1.1 The Current State of the Rail Freight Wagons Maintenance

In current practice there is frequent occurrence of accidents, failures and downtime in railway transport, which are due to poor technical condition of rail freight wagons [4, 5]. The main cause is poorly controlled technical state of wagons, unsystematic maintenance and low prevention arising from non-existent records of technical and operational

A. Leon-Garcia et al. (Eds.): Smart City 2015, LNICST 166, pp. 592–597, 2016.
DOI: 10.1007/978-3-319-33681-7_50

parameters of railway wagons (speed, traveled distance, load respectively overloading of the wagons, etc.). This condition is acute and increasing of accidents and collisions at rail is getting worse. In consequence, considerable funds currently spent on repairs and maintenance such as vehicle fleet as well as the railway line itself and intangible assets (stations, demolished trolley, etc.). As a consequence of this state, the cargo companies devote substantial funds just for repairs and maintenance of the vehicle fleet as well as the railway line itself and immovable assets (stations, demolished trolley, etc.) [6, 7]. They are often accompanied by the loss of human lives. Considerable damages are also caused by essential operational restrictions on transport road due to its damage and subsequent long and difficult repairs. To remedy these deficiencies are in practice implemented solutions that deal with emergency situations, but not with the underlying causes. By the traffic tracking and timely scheduled maintenance of vehicle fleet we can come to the stage of preventing the entry of problem vehicles to the transport route and thus eliminate risk situations to a minimum [8].

2 Disclosure of the Technical Invention

A prerequisite for establishing intelligent wagons is suitable communication system in which sensors are connected to the system using a wireless connection. Smart wagon represents utilization of sensors, controllers, software, RFID technology and many other equipment necessary for setting up such a wagon. This technology will allow for monitoring of specific components and parts in the wagon, which might affect the running of the operation.

RFID technology can be used for gathering all the information about the freight wagon, given that is necessary to apply RFID tags resistant to the external environment. In the RFID tag can be encoded complete information on the wagon (identification interoperability, state code, custom wagon number, check digit), due to the use of this system, we can easily identified wagon. RFID technology can be used for gathering all the information about the freight wagon, given that is necessary to apply RFID tags resistant to the external environment. Using of these parameters, we can easily read from the database the essential characteristics of the wagon (the wagon length over buffers, weight of an empty wagon, loading capacity, loading length, etc.). By encrypting of electronic consignment note to the RFID tag, we can identify the sender, recipient and payer type of goods, the total weight.

Principle of technical solution consist in installation of information technology elements based on RFID technology, for each railway wagon in operation, which is requesting entry to the transport route. Using elements of RFID technology placed on the wagon, we can create the conditions that will be monitored, registered and assessed all preselected operating parameters. Based on this controlled and continuously evaluated parameters it will be possible to scheduled maintenance, continuously monitor the technical condition of the rail freight wagons, but also indicates breakdowns in real time. Signalization of the malfunction in real time enables the restriction of the operation of the damaged railway wagon, respectively immediate withdrawal from service of serious damaged wagon. Thus equipped wagons will be subject to scheduled maintenance by the amount of driven kilometres, by wear of critical nodes of wagons

respectively according to the quantity of the transported material, but also indicate unequally placed load on the wagon or overloaded wagon. Application of the components based on RFID technology for railway wagon allows uniquely identify and transfer the operating parameters of the rail system to the internal information systems, which will greatly simplify the operation of rail transport, statistical evidence, monitoring the technical condition of railway wagons and subsequent maintenance planning.

RFID tags with sensors enables the measurement of physical parameters, including temperature, pressure, as well as measuring the thickness of material wear, vibration or correct load distribution between the axles of the wagon to avoid overloading the wagon [9]. RFID technology itself is not to able measure these values, but may be connected to other elements which are designed to measure these quantities. Currently, these sensors are integrated in specialized RFID tags (Fig. 1 shows an example). Measured values that are stored in the internal memory of the label are immediately available for user. With the use of appropriate IoT applications, it is possible to monitor and analyse these information in the online mode. By using these marks with the sensors, it would be possible to monitor the operating parameters. Real-time monitoring would create ideal conditions for ensuring greater operational safety and enhance the quality of customer service by enabling online monitoring of current position of the rail freight wagon.

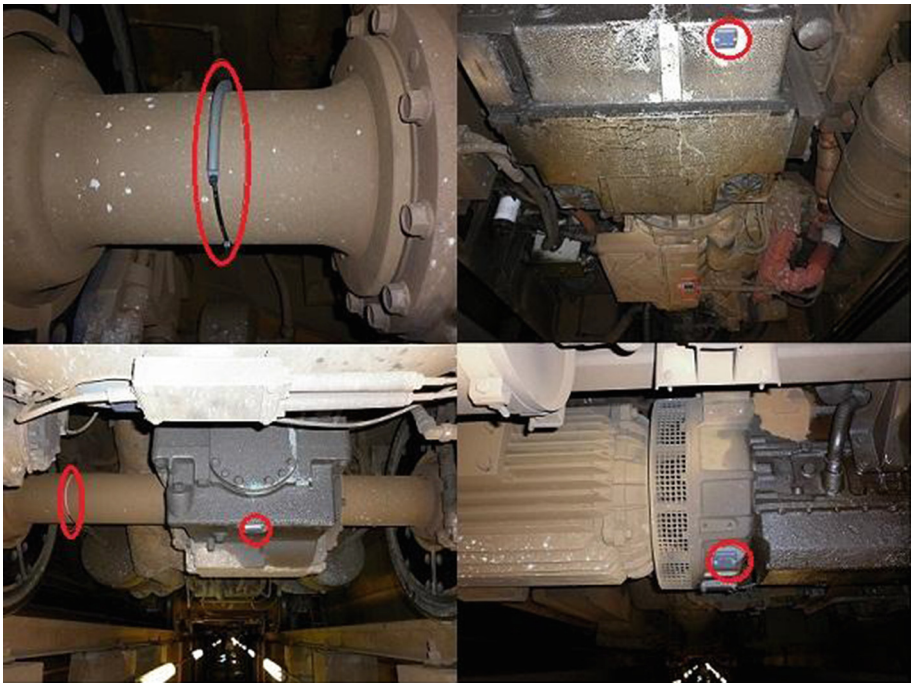

Fig. 1. Example of using RFID technology with integrated sensors for rail freight carriage.

2.1 Examples of Practical the Realization

Figure 2 provides examples of the invention embodiments. It shows the overall schematic arrangement of mutual relations and its functional parts. A smart wagon with electronic control of the technical condition is a classic railway wagon accompanied by a data switchboard **1**, which receives information from rotational-speed sensor **2**, from the temperature sensor **3**, from the pressure sensor **4**, from the wear sensor of the braking block **5**, position sensor of the brake cylinder **8** and weight sensor of the cargo **9**. Data switchboard **1** communicates with the support of the service block **6** with technical service depot and operating through block **7** railway operation while driving (train driver in the locomotive or operation staff of the railway station). Data switchboard 1 is with the wireless (radio-electronic) joints **10** connected to the speed sensor 2, with wireless joint **11** connected to the temperature sensor 3 and wireless joint **12** is connected to a pressure sensor 4. At the same time is data switchboard connected with the support of the wireless joint **13** to the wear sensor of the braking block 5, wireless connection **14** is connected to the position sensor 8 of the brake cylinder and with wireless joint **15** connected to the sensor 9 of the cargo. With the support of the wireless joint **16** is a data switchboard 1 connected to the service block 6 and with wireless connection **17** connected to the operating unit **7**.

Activity of the railway wagon with electronic control of the technical condition-classic railway wagon equipped with components of IoT and RFID technologies consist in that the data switchboard takes and stores all data from the sensors 2, 3, 4, 5, 8 and 9 and informs technical service in depot and railway operation staff about the technical state of the wagon, with the support of the service block 6, it means their checkpoints while driving. Based on this data you can evaluate the technical condition of the rail freight wagon and to limit respectively prevent (according to severity of the disorder) its further operation in transport. In data switchboard 1 are pre-set marginal parameter of status of each sensor 2, 3, 4, 5, 8 and 9 and also recorded operating parameters of the wagon (its individual nodes) and their changes. Thus prepared railway wagon is eligible for smooth and safe ride without endangering its surroundings.

Operation of the smart wagon with electronic control of the technical condition is as follows:

- Data switchboard 1 collect through sensors 2, 3, 4, 5, 8 and 9 all information about technical condition of the wagon, position of the cargo and information about all operating parameters of the wagon and also attached identification numbers respectively distinguishing marks of the wagon to those data.
- Through the rotational-speed sensor 2 the switch board evaluated parameters (speed of the wagon, mileage driven and the state of rotation of the measured running gear of the wagon). The data are used for failure free operation tracking, but at the same time allowed on the basis of driven kilometers to schedule the different types of repairs (current repair or general repair) in order to prediction of accidents and collisions during the operation.
- Via temperature sensor 3 the data switchboard monitors and evaluates the temperature of critical nodes of the wagon and hence its ability to operate and

simultaneously informs the driver and railway service personnel of the need to intervene immediately and prevent possible accidents and subsequent damages in full operation in the case of overheating monitored components.
- Through the pressure sensor 4 monitors response and ability to operate of the braking system.
- Via wear sensor of the braking block 5 (brake pad wear) monitors the operability of the wagon in terms of eligibility of the braking system and also indicates the need of their early exchanges for technical personnel.
- Via position sensor of the brake cylinder 8 is monitored and evaluated its position. In case of a negative signal from one of the brake cylinders the data switchboard limits respectively disables the start of the train until the fault is if not impossible Starting with the train until the fault is eliminated.
- Weight sensor of the cargo 9 monitors, evaluates and indicates congestion of the wagon and also uniformity of cargo storing.

Due to the fact that the interoperability of rolling stock is not given sufficient attention, occur in railway operations to frequent collisions respectively accidents, what can prevent just the systematic monitoring and recording of technical condition of the wagons. The solution is applicable in all companies operating rail transport.

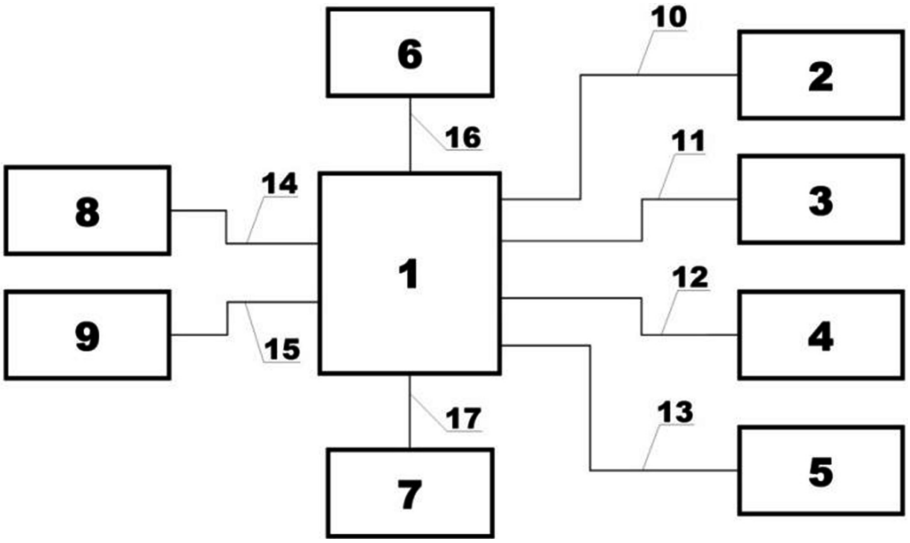

Fig. 2. Functional block configuration of devices and their interconnections of the smart wagon.

3 Conclusion

The article points out the need to speed up and improve the quality and competitiveness of rail freight. The greatest advantage of RFID applications is that it brings the possibility of reducing accidents and improves information flow. Based on the analysis of

technical condition, it can be assumed as long or how many kilometers will be able wagon fully operable. On this basis, it is possible to eliminate situations that might arise from bad technical condition of the wagon. The aim is to build a functional and modern network of information flows and data collection, that will be used by operators of railway lines, logistics companies as well as customers themselves, which will be managed everything from maintenance to transportation.

Acknowledgement. Research reported in this paper was supported by EU Structural Funds within the project "Promotion & Enhancement of Center for Research on Transportation" ITMS code 26220220160.

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