УДК 629.4

MODERN VEHICLE ACCESS CONTROL TECHNOLOGIES AT INDUSTRIAL FACILITIES

K. O. Nagovitsyn
Kharkiv National University of Radio Electronics
Ukraine, 61166, Kharkiv, Nauky Ave. 14
E-mail: kyrylo.nahovitsyn@nure.ua

Annotation: The article explores the use of modern access control technologies for vehicles in industrial environments. It focuses on two of the most widespread solutions – automatic number plate recognition (ANPR) and radio frequency identification (RFID). These technologies are analyzed in terms of their working principles, integration capabilities, and operational efficiency. The study highlights their practical benefits in logistics, security, and automation, while also pointing out technical and implementation-related challenges. The results provide insight into how such systems contribute to improving the safety and efficiency of industrial transport access management.

Key words: ANPR, RFID, access control, vehicle identification, industrial infrastructure

СУЧАСНІ ТЕХНОЛОГІЇ КОНТРОЛЮ ДОСТУПУ ТРАНСПОРТНИХ ЗАСОБІВ НА ПРОМИСЛОВИХ ОБ'ЄКТАХ

К. О. Наговіцин
Харківський національний університет радіоелектроніки
Україна, 61166, Харків, пр. Науки 14
E-mail: kyrylo.nahovitsyn@nure.ua

Анотація:У статті досліджено застосування сучасних технологій контролю доступу транспортних засобів на територію промислових об'єктів. Основна увага приділяється двом найпоширенішим рішенням – автоматичному розпізнаванню номерних знаків (ANPR) та радіочастотній ідентифікації (RFID). Розглянуто принципи їхньої роботи, переваги в умовах автоматизації логістики та охорони, а також труднощі інтеграції з існуючими системами. Стаття висвітлює як переваги, так і технічні виклики впровадження цих рішень на сучасних виробничих підприємствах.

Ключові слова: ANPR, RFID, контроль доступу, ідентифікація транспорту, промислова інфраструктура.

RELEVANCE OF THE WORK. In modern conditions of increasing demand for automation and security, the implementation of intelligent access control systems at industrial enterprises is gaining particular relevance. The control of vehicle entry and exit is critical for ensuring perimeter protection, preventing unauthorized access, managing logistics operations, and improving the efficiency of internal business processes. Among the most promising technologies are ANPR (Automatic Number Plate Recognition) and RFID (Radio Frequency Identification), which demonstrate high reliability, accuracy, and identification speed.

INTRODUCTION. Industrial enterprises are constantly challenged with the need to organize effective control of vehicle flows. Traditional inspection methods involving human personnel no longer meet modern requirements for speed, accuracy, and security. In the context of industrial digitalization, innovative systems are being actively implemented to automate access control processes without human intervention. This article provides an overview and comparison of two key technologies ANPR and RFID their operating principles, advantages, and practical applications at industrial sites.

MATERIALS AND RESEARCH RESULTS. In modern conditions, various technologies are being actively implemented for effective control of vehicle access to industrial facilities. There are many solutions that have already proven their effectiveness in industry, logistics centers, warehouses, and other infrastructure objects. The most common among them are:

– Automatic Number Plate Recognition (ANPR);

– RFID technology.

Automatic Number Plate Recognition (ANPR) technology applies optical character recognition methods to images to read vehicle registration numbers. Dahua Technology has integrated this technology into their surveillance cameras. Thanks to this, ordinary cameras acquire new functions, increasing efficiency in areas where vehicle identification is needed.

The recognition function is implemented at the software level of the cameras. Due to a large database of images and the use of deep learning technologies, the system is able to perform license plate recognition in real time, as well as perform functions such as:

– support for license plate recognition in different languages (English, Arabic, Chinese, Cyrillic, Thai, etc.);

– high recognition accuracy (95%-98% for alphanumeric plates);

– recognition speed of up to 1 second [1].

ANPR is an integrated solution that performs a sequence of operations to identify vehicles. The system is based on the use of surveillance cameras installed in strategically important locations for effective traffic monitoring. This allows obtaining high-quality images of both the vehicle itself and its license plate.

After obtaining the image, it undergoes primary processing aimed at improving visual characteristics – lighting, contrast, and sharpness. This creates favorable conditions for further analysis.

The image is then processed by software that determines the frame with the license plate, coordinates, dimensions, and its position. After this, the system proceeds to the segmentation stage – each character is separated for further recognition.

The characters are analyzed using Optical Character Recognition (OCR) technology, which converts graphic images of characters into text form.

The final stage of the system's operation is interaction with the database. After recognition, the number is verified against available information. In case of a match, the system performs programmed actions: opening the barrier, recording the entry, notifying the operator, or other actions according to settings.

ANPR technology (Fig. 1) is used in various fields:

– monitoring compliance with traffic rules (detection of speeding, violations);

– assisting law enforcement agencies in finding stolen or unregistered vehicles;

– automation of parking systems and facilitating payment for parking;

– optimization of logistics processes through monitoring of transport routes;

– accounting on toll highways for electronic payment systems [2].

Radio Frequency Identification (RFID) is a set of technologies and standards that provide contactless identification of objects using radio signals at distances ranging from a few centimeters to hundreds of kilometers [4]. Unlike other systems, RFID does not require direct visibility or physical contact between devices.

Figure 1 – Example of ANPR technology in operation [3]

An RFID tag (Fig. 2) is a small device that stores data. It consists of an integrated circuit for storing and processing information and an antenna [5].

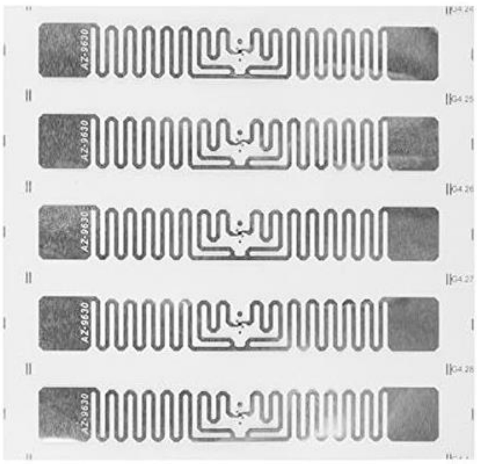
Figure 2 – RFID tag [7]

The functioning of an RFID system is based on the interaction between two main elements: a microchip and an antenna. The reader transmits electromagnetic waves that activate the tag. In response, the tag transmits encrypted information.

The advantage of this technology is the absence of the need for direct visual contact. Radio waves can pass through most materials, allowing tags to be placed inside objects.

A unique identification code is stored in the tag's memory. Modern models have rewritable memory, making them even more versatile. Readers can work both in connection with a central system and autonomously.

The RFID information infrastructure includes software that performs collection, analysis, and processing of data, ensuring the functional integrity of the system [5].

In enterprises, RFID is actively used, for example, in access control systems (Fig. 3). After completing the documentation, a tag is attached to the driver's windshield, which, when read, automatically opens passage through the checkpoint [6].

CONCLUSIONS**.** This article examined modern technologies for vehicle access control at industrial sites, focusing on ANPR and RFID. Both systems offer high accuracy, speed, and efficiency, significantly enhancing security and optimizing logistics processes. ANPR is ideal for scenarios requiring rapid license plate detection, while RFID offers flexibility and contactless identification without line-of-sight requirements. The implementation of these technologies promotes automation, reduces human error, and improves overall enterprise efficiency.

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***Науковий керівник**: Бронніков Артем Ігорович, к.т.н., доц., доцент кафедри КІТАР Харківського національного університету радіоелектроніки*