Dvelopment the algorithm of positioning industrial wares in-plant based on radio frequency identification for the products tracking systems

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Abstract

As the title implies the article describes actuality of algorithm development of positioning industrial wares in-plant based on radio frequency grid for the construction of the products tracking systems. Requirements of international standards regulating the processes of traceability and identification are analysed. The article offers a system hardware solution for positioning of industrial wares in-plant based on radio frequency grid as well as an algorithm for determining the current storage area. Experimental studies of the developed algorithm were conducted.

Keywords: positionin; traceability; radio frequency identification; RFID

1. Introduction

Major element of the quality management system that can greatly influence its efficiency is the identification mechanism which provides the traceability of products during whole technological cycle of production. According to MN ISO 9001-87 requirements a supplier, if necessary, must set and support a method of product identification on all stages of production [1]. Traceability in production helps to provide compliance of requirements of government and international standards of quality, execute a rapid and targeted track of products during the technological cycle that, in turn, allows minimizing financial consequences. Especially important the question of tracking of products becomes if the technological cycle consists of large number of stages located on large territorial areas.

In the last few years instead of graphic marking and systems of technical vision systems companies prefer to use the radio frequency identification method. Currently radio frequency identification is one of the best information technologies used for constructing inventory control systems. Radio frequency identification is used for accounting tasks in different areas of activity, for example in logistics, libraries, shops, etc. However, the task of development and deployment of a complete system for product tracking in production still remains unsolved. Based on this one can conclude that development of new algorithms for identification and positioning of industrial wares in-plant based on radio frequency grid for the construction of the systems of product tracking is an actual scientific and technical task.

2. Setting the production requirements for the process of radio frequency identification in the products tracking systems

Let us consider base concepts of this area. Radio frequency identification [radio frequency identification; RFID] is technology of automatic identification and capture of data that uses electromagnetic or inductive connection carried out by means of radio waves for interaction with a radio frequency mark and an unambiguous read-out of its identification data by applying different types of signal modulation and data encoding. Interrogation – interaction of reader / survey device with an RFID tag to read data from it. Backscatter – the process that an RF tag uses to respond to the signal and to react to the electromagnetic field of a reading / interrogation device by modulating and re-radiating it, without changing the carrier frequency. [2]

As the operating frequency of the RFID-tag and the system there are the following ranges: low frequency (LF) - 125-134 kHz, high frequency (HF) – 13.56 MHz, ultra high frequency (UHF) - 860-960 MHz , microwave (SHF) – 2.4 GHz. Accordingly, for each range there is a corresponding standard, which specifies requirements for it. For example, the general requirements for the air interface for on 860-960 MHz frequency band can be found in the standard [3].

There are a number of standards which establish the structure of RFID tags. Standard [4] reviews unique radio frequency tags that are used for the purposes of: quality control of integrated circuits, which are used in RF tag manufacturing process; RFID traceability during their production and during their term of service; completing the process for reading information of RFID system configuration, including multiple antennas; implementation of anti-collision algorithm for inventory plurality of RFID tags, while in the zone of a reading / interrogation device; traceability of the object with the RF tag on. The standard [5] lists the requirements for the selection of RFID tags, as well as other data carriers, adhesive, face of the label material and ink. This standard specifies methods for reducing the influence of electrostatic discharge and damage to the RFID tag, as well as methods of data verification of the RFID tag. The Standard lists RFID placement and attachment rules.

It is important to point out that RFID-technologies can be subject to an attack. The most common attacks are: RFID-Zapper, cloning, Dos-attacks, attack via other RFID-tags, substitution of RFID-tags memory contents. For the protection of RFID systems experts give the following recommendations: while creating new software publish the code to third-party developers who for a fee can help find bugs, admitted in the development, and remove unnecessary functions [5].

During the system analysis of interstate and international standards requirements to the process of RF identification of products were established. Thus, to develop a radio frequency identification algorithm we must:

1. Define the task of identifying and selecting the appropriate method.
2. Develop a model and to consider all the requirements for it.
3. Determine which keywords should be used, their parameters and the range of operating frequencies.
4. To protect the system from the attacks of various kinds.

3. Development of the project hardware positioning system for wares in-plant based on the basis of radio-frequency grid

As the basic data for the implementation of functional tracking of industrial products arises in the course of its movement through the territory of the plant, it is advisable to develop a hardware solution for receiving and processing of the data. The main types of traffic information are the information about who moves the products, how, departure point and point of arrival. Receiving and processing of this information will allow to organize a permanent automatic traceability of industrial products in the plant.

The paper proposes the development of a stand-alone device, consisting of reading equipment, processing and transmission of information. The developed device is mounted on the transport device, and to ensure that the product gets delivered, plant territory is marked with RFID tags creating a radio frequency grid.

Thus, the hardware part of the system can be divided into 5 levels:

1. The RF tag for labeling storage areas.
2. Equipment to read RFID tags.
3. Equipment for collecting and processing statistical data.
4. The equipment for the transmission of data to the enterprise server.
5. Company's software and hardware.

Laboratory prototype was developed for testing the project hardware industrial products positioning system on the territory of the enterprise on the basis of radio-frequency grid for experimental studies. Laboratory prototype consists of a microcontroller, a manual RF reader, power supply unit and a laptop (Figure 1).

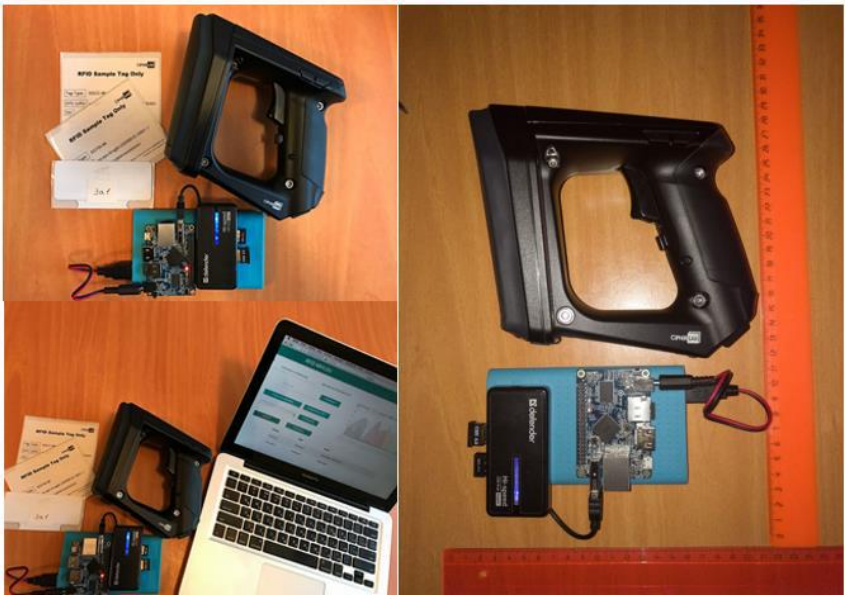

Fig. 1. Type of laboratory prototype.

4. The algorithm for determining the current storage area

In order to determine the current position of the transport device for continuous automatic monitoring of transported goods has been developed an algorithm to determine the current storage area.

The algorithm is based on statistical analysis of the number of recognitions of radio frequency tags for certain time periods t. The period of time t is the average period of time during which the transport device is moved from the beginning of the current scan area to the end (Figure 2).

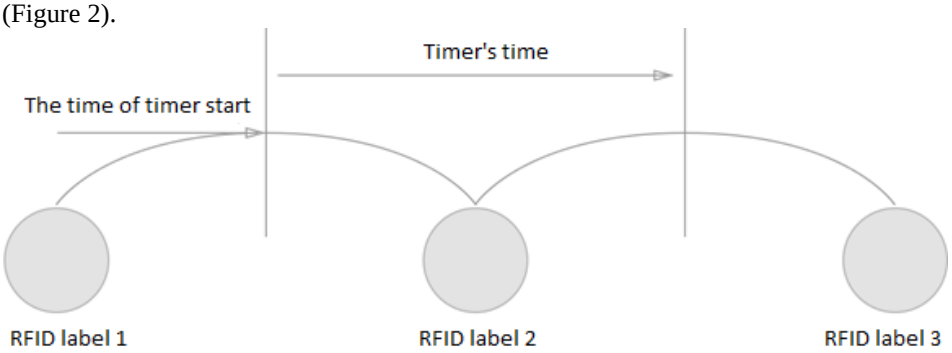

Fig. 2. Is a chart of determination of temporal interval of t.

Let the identifiers of warehousing zones be presented as a vector of I :

$$I = (I_1, I_2, I_3, .., I_n)$$

The amount of recognitions of radio frequency identifiers for the moment of time of t is presented in a kind:

$$C = (C_1(t), C_2(t), C_3(t), .., C_n(t))$$

Then determination of current position takes place by the calculation of index of k using a formula:

$$C_k(t)=\begin{cases}\max_i C_i(t), if\ C_i(t) > p\\ undefined, otherwise\end{cases}$$

Ck (t) is the maximal amount of recognitions of radio frequency k-th identifier. It means that in current moment "t" a transporting device is above the zone of warehousing market "k".

5. The experimental results of algorithm to determine the current storage area

During the experimental studies many different types of situations that are close to production were modeled (Figure 3). Among them:
- movement between two storage areas;
- move between three or more storage areas;
- movement between storage areas with the presence of "noise" (the other RFID tags, which are not labeled storage areas)
- movement between storage areas with partial overlap with non-metallic and metallic barriers.

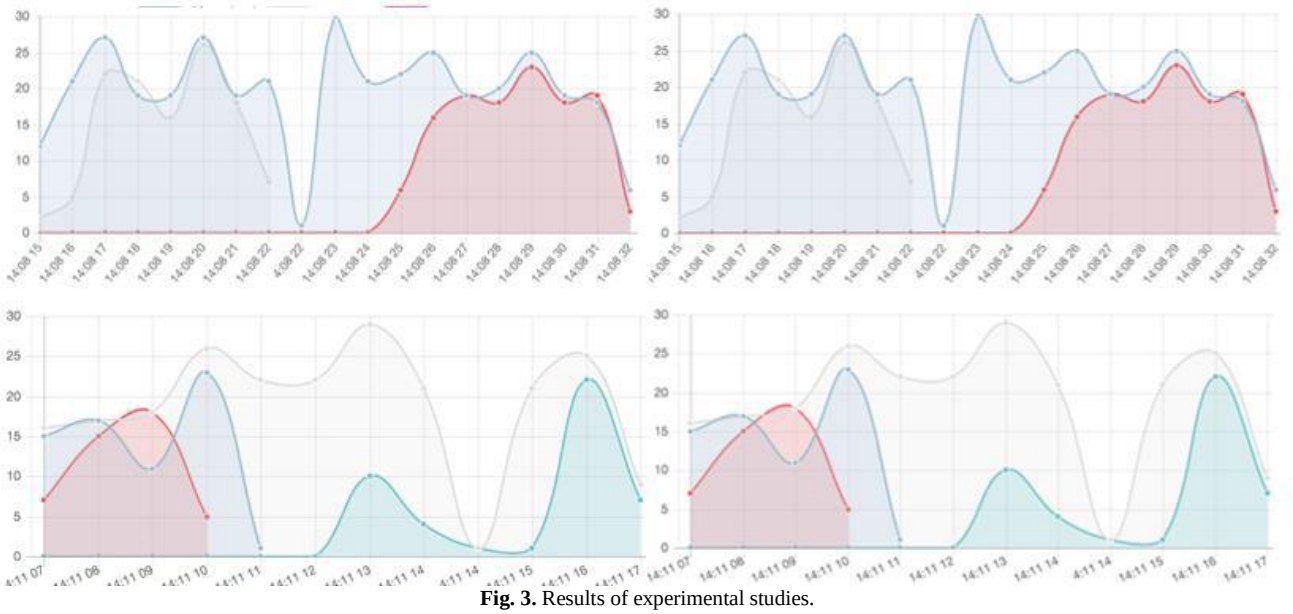

Fig. 3. Results of experimental studies.

Experimental studies have shown the correctness of the algorithm to determine the current storage area in the laboratory.

6. Conclusion

The article showed relevance of developing an algorithm of positioning industrial wares in-plant based on radio frequency grid for to create the products tracking systems. We analysed the requirements of international standards regulating the processes of traceability and identification. The article offered a system hardware solution for positioning of industrial wares in-plant based on radio frequency grid as well as an algorithm for determining the current storage area. Experimental studies of the developed algorithm were conducted.

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