Identification based on radio frequency (RFID) - a new information technology with broad applications in economics

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Abstract: Radio Frequency Identification (RFID) is the latest and most advanced technology for automatic identification of objects and the most practical technology for data collection. RFID is an automatic identification system similar to barcode technology, but which acts by proximity without direct contact. The promoters of the new RFID technology deem that using this technology in economy is an important source of competitive advantage. The RFID technology is characterized as an "intelligent technology", being part of the AIDC technologies (Automatic Identification and Data Collection).

Key-Words: RFID, intelligent technology, label, traceability, information system, technology

1 Introduction

Often presented as new technology, Radio Frequency Identification (RFID) makes possible the identification of objects without the need for a physical or visual contact.

RFID is the latest and most advanced technology for automatic identification of objects and the most practical technology for data collection. It is in the process of earning an increasingly wide acceptance as people understand and use this method.

RFID (Radio Frequency Identification) is an automatic identification system similar to barcode technology, but which acts by proximity without direct contact. As barcode systems require labels attached to objects and a proper optical reader, RFID requires reading equipment and special "tag" or cards attached to articles to be tracked or even integrated into them. By comparison, the barcode is scanned by means of a ray’s reflection on the label which includes the code, while the RFID method uses a low power radio frequency field. Scanning the tag by radio waves does not require precise positioning of the object to be read and given that the radio frequency field penetrates any non-metallic material it is no longer required the direct contact between the tag and reader.

The RFID systems involve the existence of certain transponders (tag/ label) that are attached to objects, of readers which communicate with the respective transponders using radio frequency or regular databases that contain the information about the "tracked" objects. This technology is not entirely new technology being used to identify animals or parking fees.

Today a transponder (tag) costs less than 5 cents. The RFID tags are called "the future's barcodes". Based on a totally different technology, the radio
frequency identification is a significant innovation in comparison with optical identification.

It should be noted that each tag has a unique identifier, unlike the barcode where they represent a group identifier. The RFID tag is characteristic for a single object.

One of the problems of a store’s customers is the decrease of the time allotted to products’ payment. Using the RFID technology, the calculation of the total amount of payment is possible by moving the products among tag reader-sensors. However, it is deemed that this will not be possible soon, primarily due to technical problems involved, but due to the possibilities of fraud, as well.

The RFID tags can be copied (cloned) or disabled by various processes and thus the payment process is forged. Also, barcodes can be forged only through simple photocopying, but each product is held by a seller for payment, seller who may notice the fraud immediately. Many of these technologies are only experiments, the RFID technologies being used successfully in the past only to identify domestic animals. In this area there are laws (in some countries of the EU) which require this issue.

2. Radio Frequency Identification (RFID)

The promoters of the new RFID technology deem that use of this technology is an important source of competitive advantage. The RFID technology is characterized as an “intelligent technology”, being part of the AIDC technologies (Automatic Identification and Data Collection).

Along with the RFID technology, the AIDC technologies integrate other technologies, such as: code with magnetic strips, optical character recognition, optical cards, voice recognition, tactile memory.

The RFID systems are generally composed of three components - a reader, a tag (transponder radio frequency/label) and a data processing system, which can be based on a PC or on different microcontrollers.

The RFID systems use the radio frequency transmission to identify, classify and locate “items”, which may be objects, people or animals. The reader contains electronic components that emit and receive a signal to and from the proximity tag, a microprocessor to check and decode the data received and a memory that registers the data, which will be passed along later on, if necessary. To enable data transmission and reception of data from the tag, the reader has an antenna connected. The antenna can be integrated into the reader’s housing or can be separated, placed at distance. Like most radio frequency applications, to achieve good performance, the antenna’s diameter must be relatively large.

An RFID tag contains the circuits that control communication with the reader, generally integrated monolithic circuit. It contains at least two sections: - One that provides the communication with the reader; - Another one - memory related, having a role in storing the identification codes and other data, which is activated simultaneously with the communication.

![Fig.1 Transmission of data in and from the RFID tag](image)

When object equipped with a tag passes through the action field, the tag detects the signal generated by the reader and begins to communicate the information stored in memory. On passive systems, the RF signal generated by reader provides to the tag both temporary information and enough energy to ensure its operation. The tact signal synchronizes the communication between tag and reader, simplifying their constructive design.

The RFID systems are designed to achieve the communication of information about an object or being that travels or exists in a certain location.

The components of a RFID system are:
- Transponder/tag
- The query device/reader
- The labels’ programming device
- The antenna

The transponder (tag) provides the storage of the required data. The transponder (tag) is an emission-reception device using radio waves.

The query device is to read the information stored in the transponder and to send the data to a computer. The query device can be portable or may have a fixed position. Usually, the query device is called a reader.
The label programming device allows entering and programming data in the label, if this has not been performed by the manufacturer.

The antenna is considered as a distinct part of the RFID system, sometimes as part of a transponder; it makes possible the transfer of information between the label and the query device.

The reading distance is the distance where the label should be from the reader, so that to allow reading the information stored in the tag. This distance can vary between a few centimeters and several tens of meters.

To store data, the transponder contains one of the following types of memory: ROM, RAM, programmable non-volatile:

- The ROM memory is used for the safety data and the instructions of the operating system of the transponder.
- The RAM memory is used during communication (i.e. query and transmission/receipt of response) to store data temporarily.
- Programmable non-volatile memory is to store data for the period during which the device is in sleep mode, saving energy.

The tags can store: identification data (alphanumeric or numeric data for identification purpose or as access key to stored data), portable files (as data files).

One of the main factors influencing the implementation of the RFID technology is the cost of tags. The cost of a label is influenced by: type of label, number of bought labels, transponder’s packaging.

At present, the prices of RFID tags ranges between 50 cents and U.S. $150, depending on the features and performance. The present stage of transponders’ production allows specialists to estimate that in a few years, the price of RFID tags could reach five cents or even less. The information regarding tag prices draws the specialists’ attention because, according to forecasts made by Forrester Research, the RFID tags represent 80% of the costs of implementation.

The latest generation of labels comprises smart labels, they are intended for organizations that want to uniquely identify and track millions of items with a low cost. Examples of applications for which smart tags are recommended are: baggage tracking in air transport, packages’ identification for courier services, assurance of products’ traceability, authentication of products bearing prestigious brands, monitoring the flow of documents, handling books at libraries.

2.1 Types of RFID systems

We can identify the following types of RFID systems:

a) The EAS systems (Electronic Article Surveillance) – have a small storage capacity, one bit, but enough to detect the presence or absence of an object. It is used in retail, at every point of entry/exit from the store/department, there is installed a reading device with a large antenna to detect thefts;
b) The portable data capture systems – containing a RFID reader. It captures data which are then either sent to a host of information management via a radio link or are maintained for transmission of, through a line connection, data packet;
c) The network systems - the reader has a fixed position and is connected directly to an information management system in the network. The transponder is placed on persons or objects in motion;
d) The positioning systems - the reader in this case is placed on the vehicle, it is connected to a board computer and sends data via radio frequencies, to an information management system.

By programming, transponders contain identification data and location data. The role of such a system is to enable automatic location and to provide support for the circulation of guided vehicles.

2.2. Advantages and disadvantages of RFID systems

Regarding the implementation of new RFID technologies, much emphasis is on the advantages and disadvantages, comparing it a lot with the AIDC system (barcode) that has become omnipresent.

Compared with the AIDC technology, we find the following advantages of the RFID technology:

a) Storage capacity. Conventional tags (based on barcode) can maintain a volume of information of only 20 characters. The RFID label offers the advantage of storing a higher volume of information;
b) Speed. Unlike the AIDC technology, the RFID technology allows reading and faster communication of information;
c) Automation option. Reading the information stored in the RFID tag does not implies presence in the visual field and does not require a particular orientation of the product;
d) Flexibility. A number of RFID tags are dynamic databases. There are labels that may contain information of read/written type;
e) Selectivity. The RFID technology allows labels to respond selectively to the reader’s requests;
f) The total cost of ownership and use. The RFID tags of type read/written offer advantages due to repeated use. Labels using barcode can be used once;
g) Simultaneous reading. An RFID system can read multiple labels.

Unlike other automatic identification technology, the RFID technology does not require special operating conditions. The barcode systems need a clean environment, without optical interference. Memory cards with contact (phone card type) do not require such conditions, but the contacts must be kept clean to allow the transfer of data. RFID is ideal for severe environments with dust, high humidity, oil, etc., which are often found in industrial processes or warehouses.

The radio frequency identification systems use with memories that can be erased and rewritten a very large number of times.

The degree of security is much higher than the labels with barcodes or magnetic systems, the RFID tags are virtually impossible to copy. Therefore they are ideal in applications with high security, such as identifying persons or values;

The RFID technology is fast, the speed of reading a tag is in the order tens of milliseconds.

The tags and are resistant to harsh conditions of temperature, operation is possible in a wide range, from - 40 degrees C to + 200 degrees C.

2.3 Disadvantages of RFOD tags (labels) compared with barcode labels

a. Price. Unlike labels containing barcode, whose price makes possible today its attachment on any product, the RFID systems are more expensive. For products with low price and small margin, it is preferable to use barcode than the RFID system. For example, the RFID tags of type read/written allow programming and modifying data stored according to the needs, inexistant functionality for bar labels. Consequently, the price is only a relative comparison criterion. From this perspective, RFID is a complementary technology with respect to the traditional barcode.

b. Lack of common standards. In the field of bar coding, the efforts made at international level have led to the emergence of standards adopted by several countries. In the case of RFID, for now, the market is dominated by systems that belong to certain organizations, without being accepted and applied widely.

c. Security issues. The RFID system allows the possibility of fraud by replacing the information from a tag with other information using an RFID device (e.g. if the information includes product price). To remove this inconvenience the tags should respond only to specific devices, they cannot be "written" by other unauthorized devices.

2.4. RFID applications

The RFID systems can be used in various fields. Frequency range varies depending on field of use, specific application. There are three major bands, namely low frequencies, medium frequencies and high frequencies.

Low frequencies (100-500 kHz) are used in access control, animal identification, inventory control, car identification. In this case, the reading distance is low to medium, the average cost is low, and the reading speed is low, as well.

Medium frequencies (10-15 MHz) are used to control access to smart cards. In this case, the reading distance is low to medium, the cost is low and the reading speed is average.

High frequencies (890-950 MHz; 2,4-5,8 GHz) are used in the monitoring of railway wagons, the collection of highway tolls. In this case, the reading distance is high, the reading speed is high, and the cost is high.

In terms of overall usage, we may distinguish three distinct regulatory areas of radio frequency based communication:

- Region 1 - Europe and Africa,
- Region 2 - North and South America
- Region 3 - Far East and Australia.

Each country allocates frequencies having regard to guidelines set by the three regions. Therefore, there are few frequencies available globally for the RFID technology.


3. TRACKING

According to ISO 8402, by tracking is understood "the ability to reconstruct the history and use or locate an entity with the help of recorded identifications”.

Tracking is the process that follows the product upstream and downstream and acts so that it would leave proper “traces” (information) at every stage it
passes. It must be establishes which agents and information should "leave traces".

3.1 Objectives and advantages of tracking

- Tracking is a useful tool for informing consumers and facilitates checks and quick withdrawal of products in case of emergency (crisis management).
- Tracking allows fast and safe identification of non-compliance situations and the identification of the recipients of lots of sale improper merchandise.
- Tracking allows companies to launch two messages:
  - The product does not hide anything improper behind its production;
  - The company certifies it through a formal undertaking of liability.

These two messages establish a relationship of trust between customer and producer.

3.2 Use of RFID technologies in tracking

The “EPCglobal Network” is based on the use of RFID technologies and has been developed by the Auto-ID Center at MIT (Massachusetts Institute of Technology) in collaboration with other research institutes:
- Cambridge University in Great Britain
- Adelaide University in Australia
- University of St. Gallen, Switzerland
- Keio University in Japan
- Fudan University in China

EPCglobal manages Electronic Product Code™ (EPC), which is the international standard for the support of the RFID technology. The EPC standard is a coding system of 96 bits that provides a unique identification number to 268 million companies; each will have 16 million categories and 68 billion serial numbers for each product category, (allowing the identification each object). Each EPC code is associated with information about the product: features, manufacturer, price, etc.

![Fig.2 The EPC system](image)

The EPC™ Network system allows the identification of objects in the network via Object Naming Service (ONS). ONS is a comprehensive classification (similar to Domain Name Service) which, based on the received EPC code, provides the EPC Information Service (EPCIS) address, the local or another server, connected via the Web, where one can find information on the product.

Companies can check updated information, connecting to the database and can manage the information directly: where an object is found, at what temperature, etc.

Figure 3 shows the management of information through the RFID system.

![Fig.3 Information management through the RFID system](image)
4. CONCLUSIONS

The main areas where the RFID technologies are used: transportation and airports, animal breeding, libraries, security and safety in finance, medicine, logistics, laundry, sports - leisure boats; production; military field, passenger transportation, retail.

Compared with the AIDC technology (barcode), we have noticed the following benefits of the RFID technology: storage capacity, speed, automation ability, flexibility, selectivity, simultaneous reading, the total cost of ownership and use, simultaneous reading.

EPCglobal manages Electronic Product Code™ (EPC) which is the international standard for the support of the RFID technology.

In terms of overall usage, we distinguish three distinct regulatory areas of radio frequency based communication: Region 1 - Europe and Africa, Region 2 - North and South America, Region 3 - Far East and Australia.

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