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The use of RFID technology in an integrated system for the maintenance of equipments

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Abstract

The application proposed wants to maximize the process of maintenance, the planning, in order to obtain a productive process..The idea of this application starts from the necessity of accounting and planning the repairs of equipments from the productivity sector. Technically, the system proposed is based on RFID technology, used for obtaining the traceability of equipments. The equipment has an RFID tag, which can be read and written with an RFID reader.

Keywords: *informatic system, maintenance system, RFID, AIDC*

The maintenance based on RFID technology

Radio frequency identification (RFID) is a relatively new AIDC (Automatic Identification and Data Capture/Collection) technology that keeps track of anything, especially those assets that move. RFID is a portable memory device on a chip that acts like a UPC[1] (Universal Product Code), but it is more than a UPC because this microchip can carry much more dynamic information.

The purpose of an RFID system is to enable data to be transmitted by a portable device, called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the tag may provide identification or location information, or specifics about the product tagged, such as price, color, date of purchase etc.

A basic RFID system consists of next components: an antenna, a reader including a transceiver (with decoder) managing the communication interface, a transponder (commonly called RF tag) electronically programmed with unique information

[1] The UPC was the original barcode widely used in the United States and Canada for items in stores.

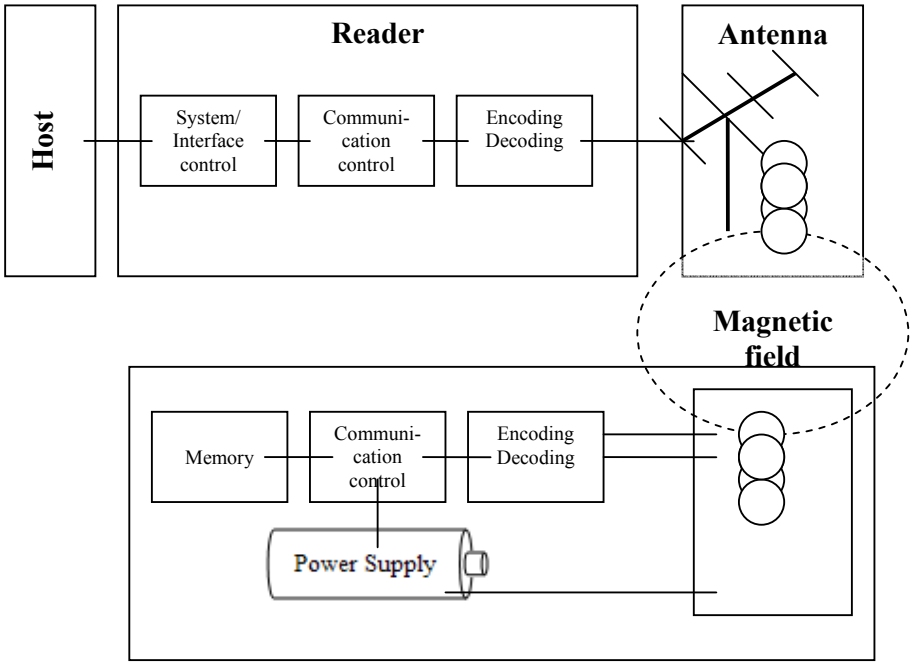

Fig. 1. RFID System function

The transponder contains a digital memory chip that is given a unique electronic product code. Also, an RFID system needs an interrogator, an antenna packaged with a transceiver and decoder which emits a signal activating the RFID tag so it can read and write data to it. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer.

The European Federation of National Maintenance Societies[2] defines **maintenance** as: *All actions which have as an objective to retain an item in or restore it to, a state in which it can perform the required function. The actions include the combination of all technical and corresponding administrative, managerial and supervision actions*.

The availability represents the capacity of a system to succeed in accomplishing the specification function, in the context of reliability, maintainability and organization of actions for maintenance.

Economically, the higher the reliability of the system and the cost of investments, the smaller the costs for the maintenance, in the way the failures are insignificant and the intensity is reduced.

On the other hand, the equipment with a small reliability and cheaper price has a higher maintenance.

In this way, a modern description of a technique system (a complex product) is made with the level of performance technique: the indicators of reliability, maintenance and availability, the cost of property for the product, other requests of security; thus, the efficiency of the system is described.

The idea of this application starts from the necessity of accounting and planning the repairs of equipments from the productivity sector.

[2] http://www.efnms.org/

In this way, having the clear situation of the equipment, we can obtain all the operations from the maintenance process without any influence or negligible influence on the production activity.

Taking into account the management of costs on cost bearers, we can manage the use of the equipment or the maintenance of this equipment, or in some cases, the abandonment of this equipment.

In this way, the application proposed makes a connection with an ERP system and we can make the transfer of accounting information.

The application aims at offering a series of information for the managers. For example:

- equipments in warranty, equipments which have the capital repair made and the data of this repair;
- the cost of the repairs for each equipment or for a type of repair;
- the times of non-functioning for each equipment;
- the number of each type of failure for each equipment and the number of all failures for each equipment;
- the components changed for each equipment, the average time for repair and for each type of repair, the number of all the repair hours for an equipment.

Technically, the system proposed is based on RFID technology, used for obtaining the traceability of equipments. The equipment has an RFID tag, which can be read and written with an RFID reader.

The next information is saved in the tag:

A. Primary information about the equipment
- number of equipment, the unique code;
- type;
- information about the producer;
- the date of the production;
- fundamental elements about the maintenance.

B. Information about the maintainability of the equipment
- date for the beginning of functioning;
- period of warranty;
- revisions planned;
- date for changing the components;
- actions of maintainability made;
- name of the person responsible for the check of the equipment;
- name of service company.

Based on the information from each tag, the maintenance department can take decisions and the information is transferred to the service company, if this company has an RFID reader.

The application with the RFID technology permits the accomplishment of some up-to-date reports about the maintainability of the equipment, as well as the transfer of some information with the tag from the manufacturer to the client or from the service company to the client and vice-versa.

The use of RFID technology makes it unnecessary to store data about the maintenance process on paper. In this way, we can read any information about the history of the equipment at any time, information which is saved in a database stored in the RFID tag.

This system for reading/writing for the tag can be extended also to the service companies or production companies. In this way, all these companies may have the history of the equipment and the information can be used inside the company owning the equipment.

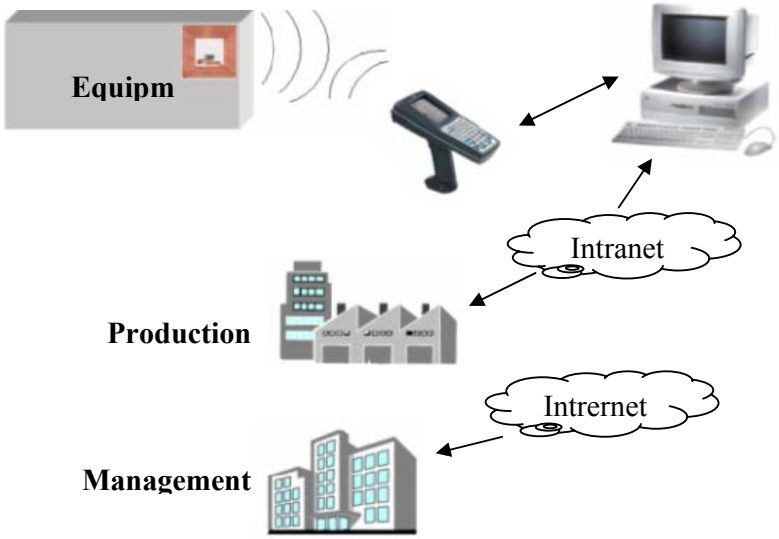

Fig. 2. The function of the system (technical presentation)

The application proposed wants to maximize the process of maintenance, the planning, in order to obtain a productive process. Based on planning, we can obtain reports with potential graphs of equipments or their availability, so we can produce a planning for the optimal production.

The information flow in the process of maintenance we proposed:

Step 1. The RFID tag contains financial data about the previous maintenance process for the equipment. These data are partially taken from the management department, partially from the service company.

These data contain the equipment code, the initial value, the value for each repair. Starting from these data, financial reports are issued for the equipment, which are transferred to the management department.

In addition, the tag contains technical data about the maintenance process made. These data contain information about the repairs made, the components changed, the actions made and the warranty.

Step 2. All these data are analyzed by the maintenance department, which takes some new decisions based on this information.

The maintenance department can decide the necessity of repairs. Also, the maintenance department can decide the necessity of corrective maintenance for the unexpected failures.

Step 3. The management department decides the planning process: if the process of maintenance is profitable, the equipment is kept; if not, the management department can decide the abandonment of the equipment.

Step 4. Having the acceptance from the management department, the maintenance department sends a command to the service company.

The tag from the equipment which will be repaired stores some information about the other repairs, the components changed, the actions made.

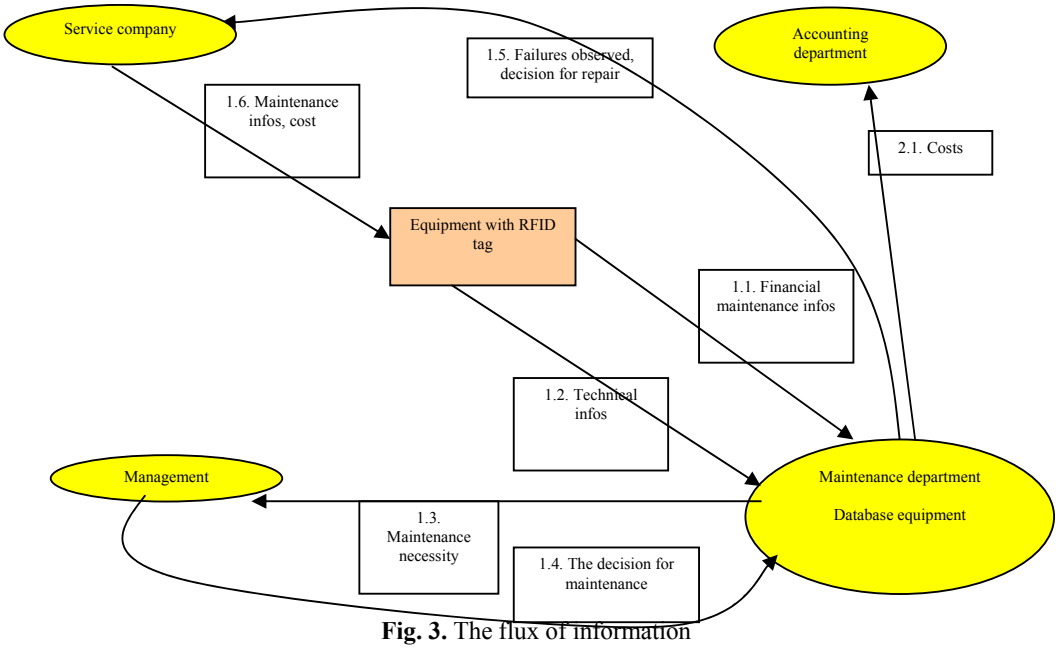

Fig. 3. The flux of information

The advantages of RFID technology

While RFID will probably never completely replace bar codes, it has distinct advantages over the barcode. For example

- **No line of sight** is required;
- The tag can stand a **harsh environment**;
- **Long read** range;
- **Portable database**;
- **Multiple** tag **read/write**;
- **Tracking** people, items, and equipment in **real time**;
- **No human intervention required to scan** a RFID transponder.

No line of sight requirement. - The optical nature of barcode requires labels to be "seen" by lasers. That line-of-sight between label and reader is often difficult, impractical, or even impossible to achieve in industrial environments.

Barcodes must be visible on the outside of product packaging. RFID tags can be placed inside the packaging or even in the product itself.

The tag can stand a **harsh environment**. - Tags can be read through a variety of substances such as snow, fog, ice, paint, crusted grime and other visually and environmentally challenging conditions, where barcodes or other optically read technologies would be useless.

In order to function properly, a barcode reader must have clean, clear optics, the label must be clean and free of abrasion, and the reader and label must be properly oriented with respect to each other. RFID technology enables tag reading from a greater distance, even in harsh environments. The readability of barcodes can be impaired by dirt, moisture, abrasion, or packaging contours. RFID tags are not affected by those conditions.

Long read range - RFID tags have a longer read range than barcodes. Low-frequency RFID systems (30 KHz to 500 KHz) have short transmission ranges (generally less than two meters). High-frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer longer transmission ranges (more than 30 meters). In general, the higher the frequency, the more expensive the system.

Portable database - RFID tags, on the other hand, have electronic memory similar to computer or digital camera to store information about the inventory or equipment. This information can be dynamically updated. An RFID tag can store more data than a barcode.

Multiple tag **read/write** - RFID tags can also be read in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. RFID tags have read/write memory capability; barcodes do not. The read/write capability of an active RFID system is also a significant advantage in interactive applications such as work-in-process or maintenance tracking.

No human intervention required to scan a RFID transponder - whereas in most applications an RFID tag can be detected "hands off."

The limitations of RFID technology

There are greater issues today that make RFID in use a real problem. Following is an overview of many of these issues:

- Tag **cost**;
- Variations in RFID **frequency standards;**
- The **need for power** of passive TAG - RFID;
- The **need to attach** to products a tag;
- **Malfunctioning** RFID readers;
- **Frequency clashing.**

Tag cost - Higher-functioning tags cost as much as $5 to $6 per tag, while passive tags being mandated today can be in the 20 cents to $1.25 per-tag range.

Variations in RFID frequency standards - The USA and EU have different frequency standards, other parts of the world have also announced frequency ranges of their own, and some are different from both the United States and European standards. As a result, companies shipping internationally must be aware of the different frequency ranges as they test their RFID capabilities. The Federal Communications Commission (USA) has adopted new regulations for the use of improved RF identification systems in conjunction with commercial shipping containers. This order raises the maximum signal level permitted for RFID systems operating in the 433.5 to 434.5 MHz (433 MHz) band, which the Federal Communications Commission said would result in “more reliable transmissions with greater range” than allowed by the previous rules.

The need for power of passive TAG - RFID - The limitations of passive RFID arise from the need of these tags to absorb enough power from the reader to transmit the stored tag data. In order to accomplish this, the tags must utilize directional antennas large enough to intercept the needed power from the reader. The view that RFID does not need a “Line-of-Sight” between the tag and the reader has to be modified as follows: Tags must be facing the reader, and a direct line must exist between tag and reader unobstructed by any metallic or liquid object, or other tags.

Malfunctioning RFID readers - Companies must plan fallback procedures for the cases when readers do not function properly and develop strategies for knowing when readers are

malfunctioning. Though a few reader suppliers have recently announced the capability to detect reader failures and alert workers when failures occur, today that's easier said than done.

Frequency clashing - RFID readers are manufactured to use a certain frequency range. Early RFID pilots have shown that other radio-frequency-based technologies often clash with RFID readers when frequency ranges overlap.

Conclusions

If the bar code is the present, the RFID will be the future. The bar code has a large field of use, because it has a long history.

We can observe that the bar code labels are inexpensive (but not reusable), reliable to read, can be printed before production or printed directly on items, must be read one at a time and line of sight is required, they must be written once with limited data and have a limited read range.

The technology has many benefits to offer. Its stumbling point seems only to be a variety of issues outside the technology itself: marketing problems, false promises, and a lack of standards. Industry members, however, have become painfully aware of these problems and are trying to do something to remedy the mistakes of the past. If they are able to successfully unify the industry with standards, deliver on future promises, and convince end users of the technology's benefits, then RFID's future looks favorable.

The application proposed for the maintenance of production equipments based on RFID technology may be integrated into an ERP at the level logistics-production. In this sense, the application wants to establish some data transfer with the financial-accounting department and human resources department.

As far as the management department is concerned, the application transmits information for the decisional process.

The application proposed is based on a client-server architecture and it has 2 levels: one local level (Intranet) and one level as a web application on the Internet.

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Utilizarea tehnologiei RFID într-un sistem integrat pentru mentenanța echipamentelor

Rezumat

Aplicația propusă eficientizează procesul de mentenanță, planificarea acestuia, în scopul obținerii unor procese productive performante. Ideea originală a unei astfel de aplicații porneşte de la necesitatea contabilizării şi planificării reparațiilor mijloacelor de producție, sau care au legătură cu procesul productiv. Tehnic sistemul imaginat se bazează pe tehnologia RFID, utilizată în scopul obținerii trasabilității echipamentelor. Astfel, fiecare echipament dispune de un tag RFID ataşat care are posibilitatea de a fi scris şi citit cu ajutorul unui cititor RFID.