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RFID-BASED LIFECYCLE PRODUCT MONITORING FOR INSURANCE PURPOSES

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Abstract. *For an insurance company, catastrophic incidence is a rare situation which generates enormous losses in materials and human lives. Characteristics of a catastrophic incidence is that it always affects a large population of policy holders, which accumulates risks for different branches of insurance. Bearing in mind the importance of insurance for business operations in all the branches of industry, this paper presents the impact of the recent catastrophic developments on the policy of the insurance companies.*

Key words: *RFID, Insurance, Risk*

1. INTRODUCTION

Following a product from manufacture to end-user is an important problem which has so far been solved by using bar codes. A novel trend is to use RFID technology for this task, which allows product to be visible in real time during manufacturing process, including storage and delivery. Using radio waves, data are received and transferred from one business to another in a wireless mode, in real time. This unique way of labeling is so adjusted that the data on any product correspond to the data which are already in the company database or on the local host.

Using RFID, objects can be tracked with minimum human intervention. This can potentially reduce storage time and operating costs in supply chains, as well as increase visibility in the entire supply chain, in real time.

Presented in this paper is an example of using RFID technology for automatic identification and monitoring of a product throughout its lifecycle, for insurance purposes. An In Mold Labeling (IML) robot manipulator is used as an example product. Regardless of the product type, the monitoring method proposed in this paper can be used for several types of insurance, throughout product lifecycle.

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2. Insurance During Product Lifecycle

There exists a large number of insurances. Insurance of property, i.e., material goods, represents one of the principal types of insurance. Though this type of insurance is not mandatory, the property owners who do have insurance policy enjoy several advantages. Insurance policy covers property (machine, equipment) in case of a damage or destruction due to *vis major* events or accidents at work. Among other things, insurance policy covers errors in building, material, manufacture, as well as current surges due to faulty electrical installations or errors in power grid. Built-in electronic components and modules can also be covered by machine insurance [1].

The idea of product monitoring throughout lifecycle stems from relatively frequent false insurance claims by property owners, e.g., when the goods or equipment were damaged due to inadequate handling by worker. For this reason, it is important to record and monitor any changes to insured property through all stages of its lifecycle.

The lifecycle stages that a product undergoes are following:

1. design,
2. manufacture,
3. distribution,
4. marketing,
5. servicing and maintenance,
6. disassembly, followed by several possible strategies:
   - extraction of hazardous components - materials (O or H);
   - recycling of material (R);
   - re-use (P12);
   - re-work (D);
   - incineration (S or I);
   - disposal (W (waste)).

Shown in Fig. 1 [2] are all the lifecycle stages that the majority of products undergoes. It is important to note that a large number of products do not require servicing and maintenance.

In order to attain control over all product lifecycle stages (the level of control and the need for monitoring depend on the product), a platform has been developed which is based on web-based application software. The structure of this application directly depends on the product end-of-life management strategy which is defined during the design stage.

Fig. 2 shows interactive communication between the database, user (e.g., insurance company), and product (product components) through each of the lifecycle stages. It is conducted in sync with the product status changes – which are controlled by the software. This means that, at the moment of insurance claim, the users, depending on their position, can obtain required information. In addition, some users are also obliged to update the incoming information on product status changes, should they occur for any reason. In this way, each link in the product lifecycle chain (distribution, marketing, buyers, servicing, etc.) is delegated its own responsibility for continuous updating of product information. The task of the software solution is to make this task easy and intuitive for the users, while the result of product status updating is beneficial in more than one way.

Each of the users of this web-application, in this particular case – an insurance company, has an access to information and is assigned tasks depending on its status. These privileges are assigned by the software provider. In this way, not only the high quality of product information is maintained, but also the reliability of information.

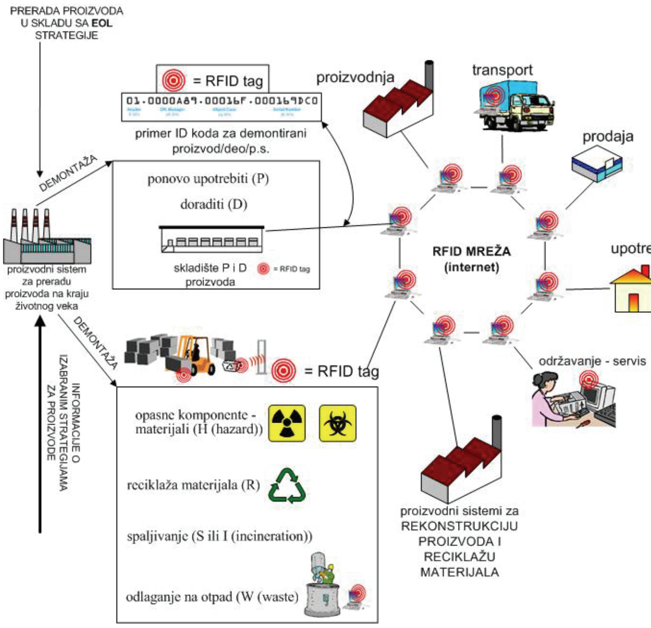


Fig. 1. Product lifecycle and possible application of RFID technology at particular lifecycle stages

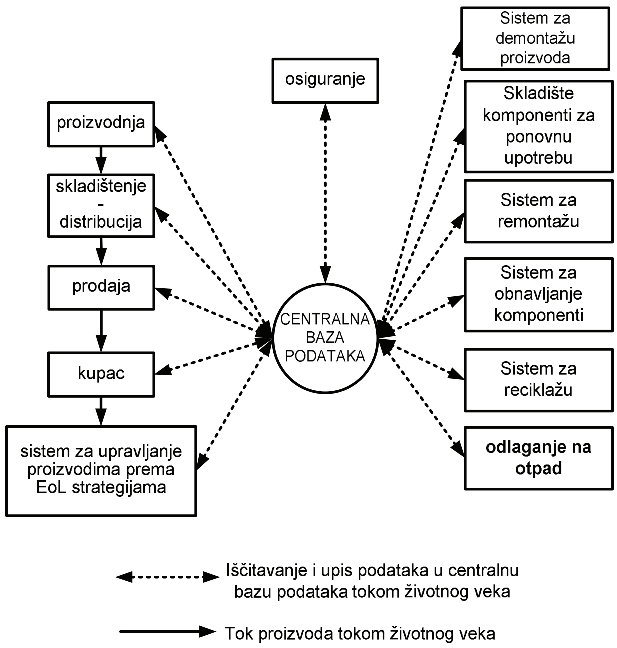


Fig. 2. Interactive communication between the database, user, and product through each stage of product lifecycle

The hardware components of such a system depend on the functions that are to be performed during particular stages of product lifecycle. However, the major component is computer which has an access to Intranet/Internet, and a web browser installed. This system provides just the monitoring function (which is the only function that particular users, e.g. insurance companies, have to perform during the entire product lifecycle. The system can be enhanced by an RFID reader via RS 232, USB or TCP/IP interface, to allow for not only monitoring of data, but also for their updating (this should be allowed to some users, during particular lifecycle stages, such as assembly. disassembly, etc). The software components of the system include a network oriented user application.

2.1. Structure of the network oriented software application

One of the pivotal points in the design of this software application is the selection of appropriate end-of-life management strategy. The strategy directly impacts the number of characteristic stages through which product must pass during its lifecycle. These stages shape the planning of communication between the base server (manufacturer's server) and the user at the moments when the product reaches particular stages (servicing, marketing, insurance, etc.) (Fig. 2).

Every user, depending on his/her privileges provided by the manufacturer, has an access to a certain volume of information for a particular product. In addition to information access, some users are also obliged to enter particular information in order to allow for correct monitoring and updating of product information.

For example, the buyer is allowed to see basic information about the product in the store. The information includes date of manufacture (the exact moment when the product left the factory), place of manufacture, country, recommended procedure for product end-of-life disposal, information on servicing available for the product (for quality assurance), etc. On the other hand, the buyer is expected to enter some basic information about the purchase (location and country of purchase, e-mail, etc). This information is required for several reasons, and depends on the user of information. If the information is used by an insurance company, it can gain complete knowledge of product state (insurance in warranty period or some other type of insurance). If the information is used by a manufacturer, then it is able to form a strategic plan for the return of the product upon the end of its operating life and/or lifecycle, according to previously adopted end-of-life management strategy. This is specially important considering the fact that, in the near future, buyers shall be held responsible for the product. Furthermore, they shall also have to provide information on the status of the previously purchased product when buying a new one.

3. Application of the System For Lifecycle Monitoring on an IML Manipulator

In-mould labeling (IML) is a technology used for labeling plastic products, primarily in food industry, immediately before the forming. Using several types of manipulators, the labels are inserted into the moulds of injection molding machines (IMM). Each plastic manufacturer requires such machines which allow short injection times [3, 4]. A short injection time also implies a short labeling time, which means that this activity should be performed in a quick and precise manner, between the two injection cycles, and after ejection of product from the mold, once the injection is finished.

The Centre for Automation and Mechatronics, Novi Sad (CAM), has developed IML manipulators (www.cam.rs), series RT-XX, and FT-XX (Fig. 3), which are completely pneumatic, and are designed to be mounted on an IMM, which allows them to access the injection zone from the upper part of the machine.

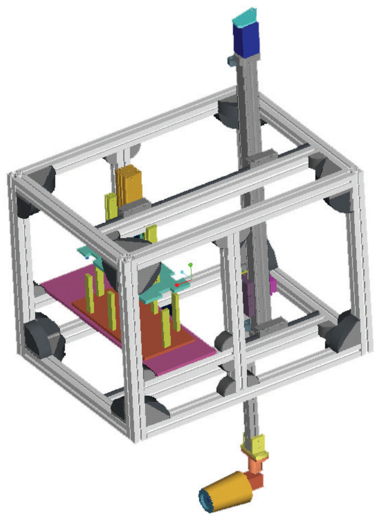
The basic idea behind CAM IML manipulator is to use RFID technology in order to monitor the number of cycles performed by pneumatic cylinders and distributors, which are constituent components of the manipulator (Tab. 1). The data on the number of cycles is critical not only for the buyer of the manipulator, and the servicing/maintenance crew, but also for the insurance company which, based on this data, can decide on damage insurance premiums.

Table 1. Basic components of IML manipulator

Component	Operating life
Cylinder	> 5,000 km
Distributor	> 2,500,000 cycles
Sensor (non-contact)	> 4,000,000 cycles
Pneumatic hose	unlimited
Programmable logic controller	unlimited
Aluminum profile	unlimited

The data, which in this particular case are written on an RFID tag, Fig. 4, (placed on the manipulator) are following:

- Type of robot (RT-XX or FT-XX)
- Date of manufacture
- Date of first start of manipulator
- Date of servicing
- Number of work cycles (manufactured parts)



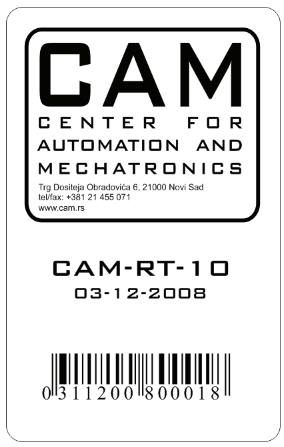


Fig. 3. CAM IML manipulator of FT series **Fig. 4.** RFID tag placed on IML manipulator

The first three data items are written just once, during particular lifecycle stages (the first two data items are written by the manufacturer, while the third one is entered by the buyer). After the data is written, the memory is protected, and can be used in read-only mode (to prevent data tampering). The date of servicing is the date when the servicing was performed and is also read-only. The data on the number of work cycles is written upon each cycle is finished. Once 10000 cycles have been performed, the memory block prevents further writing, and another memory block must be used. This prevents tampering with the data on the number of cycles, since this data is critical for machine evaluation on several accounts:

- insurance (depreciation, generally „Depreciation is not insurable loss. When assessing the damage, depreciation is calculated based on: number of parts manufactured by the tool, relative to the total number of parts the tool is designed to make; the number of machine hours (effective operation) relative to the total number of hours required by the project; tool wear degree. Once a tool has made the number of parts designated by the project, or has filled the target number of work hours, the tool is considered a discard and as such cannot be eligible for insurance, regardless of its technical state and usefulness [5],
- setting insurance premium („The amount payable is set as follows: in case of destruction of an insured item, the amount is set according to the value of insured item at the time of occurrence of insured event, deducted for the remaining value; in case of damage of insured item, the amount is set according to repair costs at the time of occurrence of insured event, deducted for evaluated depreciation and the remaining value, except when otherwise stipulated by insurance policy." [5])
- selling of used machine.

Insurance covers: inaptitude and negligence of workers, damage caused by intentional acts, repair and replacement of parts damaged during overhauls (provided it is not caused by gradual mechanical and chemical influence) [6].

In case of an attempt by an unauthorized person to alter the contents of PLC registers, or replace the PLC, the software shall halt the manipulator which can be restarted by an authorized person only. After that, the data on the number of completed work cycles are rewritten into the first available memory block which is then locked. In such case, RFID tag is used as PROM (Programmable Read Only Memory) memory. The advantages of using RFID tag in this way are following:

- RFID tag contains reliable data
- Data stored in a RFID tag cannot be altered.

Such requirements can be fulfilled by connecting PLC to a HF (13.5 MHz) RFID reader. The RFID reader is mounted on a plastic control cabinet, and fixed to manipulator's housing. On the opposite side of the control cabinet there is an RFID tag. PLC and RFID reader are connected via RS232 interface. Communication protocol is defined by the manufacturer of RFID reader, and consists of a sequence of instructions for reading and writing data onto RFID tag, as well as for editing parameters of RFID reader.

The amount of data which can be written into RFID tag memory is limited, which is the major drawback of using RFID tags. However, if an authorized person wants to check on the current state of some product (not just the data which are recorded in RFID tag memory), he/she must access the database using the web-based software, by entering the unique product identification number (in this case, a manipulator). After this, it is possible to gain access to a larger number of product information, such as:

- Which components can be used as spare parts?
- Servicing (not just the date, but description of every activity).
- Does the product contain any harmful materials?
- Does the product contain any used parts, and are some parts made of recycled materials? If so, what are the parts, i.e., how many work cycles have they left?
- Which part of the product is basic for assembly?
- Etc..

In this way, an authorized person can establish the following:

- Consistency between the data written on RFID tag and into the database. If there is some inconsistency, tampering with data can be suspected. In this case, only RFID tag data are considered valid, while the database data are discarded.
- A decision which corresponds to this person's role in various stages of product lifecycle. For example, if the authorized person belongs to servicing staff, the key information are: date of the first start of the product, date of last servicing and description of performed activities, and which components can be used as spare parts. If, on the other hand, the authorized user is an insurance company, then the key information are: product type, date of manufacture, date of first start, number of completed work cycles (manufactured parts).

Based on the gathered information, users are enabled to make decisions. In the case of servicing staff the decision might pertain to replacement of some parts (e.g. cylinders) if the number of work cycles is close to or greater than the recommended number – preventive maintenance. In the case of insurance company, the information on the number of work cycles would be used to define insurance premium in case the manipulator is damaged.

CONCLUSION

Application of RFID technology for the purpose of product monitoring throughout lifecycle has its limitations. First of all, it is reflected in the problem of memory capacity of RFID tags. In case of a larger quantity of information that need to be entered, web-based application must be used. To allow for a greater autonomy of writing and updating information on product state and other parameters relevant for optimization of lifecycle product management, RFIDs of much larger memory capacity should be used.

There is also a problem of standardization of RFID tags and readers. In order to optimize lifecycle product management, each user in the product management chain should be allowed a quick access to information stored on RFID tags. Furthermore, certain users (sellers, buyers, servicing staff, disassembly workers) should be allowed to enter required information not only on tags, but also in the corresponding database.

Reviewed in this paper is a method for product monitoring and product data updating, which is suited to requirements of particular users in the entire product lifecycle, with emphasis on insurance companies. Data can be stored not only on RFID tags, but also in a corresponding database. This method of redundant entering and storing of data has significant advantages when it comes to providing reliable information on the quality and state of product and its components, and can be used for setting damage insurance premiums.

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PRAĆENJE ŽIVOTNOG CIKLUSA PROIZVODA KORIŠĆENJEM RFID TEHNOLOGIJE ZA POTREBE OSIGURANJA

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Za osiguravajuća društva, katastrofalni događaji predstavljaju retke događaje koji izazivaju ogromne materijalne gubitke, kako u pogledu materijalnih vrednosti, tako i u pogledu ljudskih života. Karakteristika katastrofalnih događaja je da oni uvek utiču na veliku populaciju osiguranika što uzrokuje akumuliranje rizika različitih grana osiguranja. Imajući u vidu prisutnost i uticaj osiguranja na proces poslovanja u svim industrijskim granama, u ovom radu se opsuju koje su promene imali katastrofalni događaji poslednjih godina na politiku osiguravajućih kompanija.

Ključne reči: *RFID, osiguranje, rizik*