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THE SIMULATION OF PRODUCTION LINE AND WAREHOUSE MANAGEMENT BASED ON RFID TECHNOLOGY THROUGH 3D MODELLING AND ANIMATION

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The RFID technology is complex, combining a number of different computing and communications technologies to achieve desired objectives. This article primarily deals with the simulation of production line and warehouse management based on RFID technology, through 3D modeling and animation. It describes the various components of a RFID lab (a laboratory for the automatic identification of goods and services), which consist of a production line and a warehouse management system based on RFID technology. This paper characterizes and describes the processes which are take place in the laboratory as well as the technologies which are used. The paper describes production line processes and warehouse management. It sets up and describes 3D models and animations created to capture the whole process in the laboratory.

Keywords: *RFID technology, 3D models, warehouse management, simulation*

1. Introduction

RFID technology is complex, combining a number of different computing and communications technologies to achieve desired objectives. Each object which has to be identified has a small object called a RFID tag stuck to it. Each RFID tag has a unique identifier that enables additional information about each object to be stored. Devices known as RFID readers wirelessly communicate with RFID tags, with a view to identifying the attached RFID tags, as well as enabling information stored in the RFID label to be read and updated. Our department has focused on research in the field of automatic identification and data collection. The established RFID lab (laboratory for the automatic identification of goods and services), which consists of a production line and a warehouse management system based on RFID technology, acts as a model in the article, depicting the process of automatic identification in a conditions similar to operational conditions.

2. About the RFID lab

RFID lab means laboratory for the automatic identification of goods and services. The core of the system for the identification of goods and services through RFID technology is known as SAP. It is therefore a real system that is used in practice and through logistics processes can be simulated in the laboratory. The data format conforms to GS1 standards. The formats in this specification are defined, and are available for use. Resolution of the data involves AI application identifiers, while tags are the format used by EPC – Electronic Product Code. An Electronic Product Code can be characterized as a number encoded in electronic form and stored in a storage medium such as a chip. EPC is an internationally standardized system that is used to identify objects and goods uniquely throughout the supply chain. The laboratory for the automatic identification of goods and services is designed to present RFID technology in various parts of distribution chain and provide a platform for partner companies to test applications for their customers. RFID lab is also intended to cooperate with universities to enable the project's own research and development, as well as to create space for joint projects. As has been already mentioned above, the University of Zilina, Faculty of Operation and Economics of Transport and Communications is one of the partners of the laboratory and is represented by members of the Department of Communications.

2.1. Description of the Processes and Equipment

In this section we characterize production line and warehouse management processes simulated through 3D models and animations.

The main objective of the laboratory for the automatic identification of goods and services is to present RFID technology in the following processes:

- Receipt of material - entered from SAP.
- Application of RFID labels to the desired material.
- Simulation of production (SAP applicator gate) and finished products.
- Labelling of pallets and crates through Smart Labels.
- Palletizing and packaging.
- Warehousing.
- Simulation of the store with RFID support.[1]

2.1.1. Entering the Production and Application of Labels

The process of the identification of goods begins with selecting the quantity and type of material from SAP. It is possible to enter:

- EAN product number (a product serial number will be generated from SAP ERP).
- Batch number.
- Number of boxes (representing products).

After all transactions are done, all information about content and label design is sent to be printed. This is done on the bottom side of the RFID tag. This has an adhesive surface. The upper side has a backup bar code and other necessary information.

Design ‘template’ label boxes include:

- in text form:
  - Product name (20 alphanumeric characters).
  - Batch Number (10 alphanumeric characters).
  - Date of manufacture (YYMMDD - 6 numeric characters).
  - Serial number of the box (four numeric characters).
- Bar code EAN13 (the product number assigned in SAP ERP) (the bar code must be in accordance with ISO / IEC 15420).
- RFID tag - EPC 96-bit format (GTIN (product number) + serial number). [1]

Before sending data to a ZEBRA printer, it is necessary to configure the parameters for RFID printing and set the printer for network printing. This allows the printer to print a label (the label) and encode the EPC number onto the tag. The conveyor belt is up and running. Figure 1. shows two conveyors, the applicator of labels produced on the Zebra printer and two RFID gates.

Figure 1. Simulation of production

2.1.2. Simulation of Production, Entry into the Warehouse

Entry into production:

At the end of the first belt, on which there is the printer and the label applicator, is a RFID gate. This is tasked with reading all smart labels or RFID tags located on boxes. Scanned data from each unique tag is transferred to the SAP system by requesting a Web service, then taking the number and batch and comparing them with required number to be produced. The SAP report shows which product is in production.

Output of the production:

In the laboratory, the production process is not simulated. The actual process of production should be located in the same place as the two associated conveyors. At the beginning of the second conveyor is the next RFID gateway. This reads information about the product coming from the production line; in our case the box.

The finished products fall into a pallet fence, which is located at the end of the second belt. In this range, the tag is placed on pre-recorded data Datamax printer. This printer is not involved in the system, and the system knows which products (boxes) contain a tag.

Palletizing:

Pallets containing finished products are hand-labelled with pallet tag numbers. A forklift truck is used to transport the goods to the warehouse through the door "KODYS / Vectra [2], where the contents are assigned to the pallet tag. A situation may arise in which the number of products scanned at the production exit gate (second gate) does not match to the number of products scanned at the KODYS / Vectra gate. If this happens we recommend turning on the puttee range and the gate area will try to read all tags. The process continues only with the number that was loaded by the gate. "Here we get the answer to the question: ‘Are there any products that get lost?’ [2]. In this way we obtain a unique identification needed for the storage of goods.

Figure 2 shows RFID gate and puttee. [2]

Figure 2. RFID gate and puttee

2.1.3. Warehouse Management

This process occurs in the laboratory to simulate inventory control, warehouse management, automated storage management and unloading, inventory stocks, and orientation in the warehouse using RFID in conjunction with reading the barcode label on the shelves.

Figure 3 shows a mobile terminal being used in a RFID lab.

Figure 3. Mobile terminal

The mobile application was created with SAP ITS Mobile Technology. Operations in mobile applications are as follows:

Storing:

The terminal of storage operation is selected. Subsequently, the RFID sensor will load the number of pallets to be stored. At the destination site the bar codes will be scanned. The location of the pallets in the goods reception area will be controlled. The SAP ERP is based on data which has been entered. It creates a storage command and a menu with the goods which are stored in the new storage location.

Bin transferring:

The terminal selects the bin transfer operation. The RFID reader will load the number of the pallet intended for storing and warehousing, and at the destination site the bar code will be scanned. The SAP ERP is based on data which has been entered and creates a warehouse order together with a list of goods stored in the new storage location.

Removal - issue of cost center:

The terminal selects the removal operation. Pallets are loaded via the RFID reader and then selected the number or type a number of cost center. The SAP ERP is based on data which has been entered, and creates a warehouse order and material evidence, the range of material on it is removed and the pallet in the system disappears. [1]

3. RFID Technology

Radio frequency identification is a wireless data collection technology that uses electronic tags which store data, and tag readers which remotely retrieve data. It is a method of identifying objects and transferring information about the object's status via radio frequency waves to a host database. RFID is not necessarily a direct replacement for bar codes, but as the costs of RFID systems continue to decrease, the functional utility of RFID will greatly surpass that of bar codes. [7]

3.1. Components of an RFID System

An RFID system is a set of components that work together to capture, integrate, and utilize data and information. This section describes some of them. The components are as follows:

- Sensors, Tags, Antennas, Readers.
- Connectors, Cables, Networks, Controllers.
- Data, Software, Information Services.

3.1.1. RFID Tags and Frequencies:

An RFID tag is a small device that can be attached to an item, case, container, or pallet, so it can be identified and tracked. It is also called a transponder. The tag is composed of microchip and antenna. These elements are attached to a material called a substrate in order to create an inlay. [8]

Tags are categorized into three types based on the power source for communication and other functionality.

- Active.
- Passive.
- Semi-passive.
- Semi – active.

Carrier frequencies

Today, there are four carrier frequencies implemented for RFID that are popular globally: 125 KHz, 13.56 MHz, UHF ranging from 866 to 950 MHz depending on national radio regulations, and microwave frequencies of 2.45 GHz and 5.8 GHz. There is also the frequency range 430-440 MHz, which is allocated to amateur radio usage around the world. The ISM band 433.05-434.790 MHz is located near the middle of the amateur radio band. The amateur radio band has emerged as an RFID channel in a number of applications. The frequency range has been called the 'optimal frequency for global use of Active RFID'.

3.1.2. RFID Reader

The second component in a basic RFID system is the *interrogator* or *reader* (Figure 4). Readers can have an integrated antenna, or the antenna can be separate. The antenna can be an integral part of the reader, or it can be a separate device. Handheld units are a combination reader/antenna, while larger systems usually separate the antennae from the readers. The reader retrieves the information from the

RFID tag. The reader may be self-contained and record the information internally, however, it may also be part of a localized system such as a POS cash register, a large Local Area Network (LAN), or a Wide Area Network (WAN). [6]

Figure 4. Mobile Handheld Interrogator

4. The Simulated Production Line And Warehouse Management With RFID Technology

This chapter describes how the processes of the product line and warehouse management were simulated in the laboratory for the automatic identification of goods and services. This simulation of production processes and warehouse management uses RFID technology.

4.1. 3D Modeling and Animation

Due to the proximity of processes that are performed in the RFID lab, this application was accompanied by 3D animation. It is a process related to the transfer of data over a LAN, where a SAP SERVER communicates with other devices and equipment separate from the server.

4.1.1. Modeling

In order to animate the models it was necessary to create a final scene. This consists of a number of 3D models whose work is described in this subchapter through words and pictures. [4]

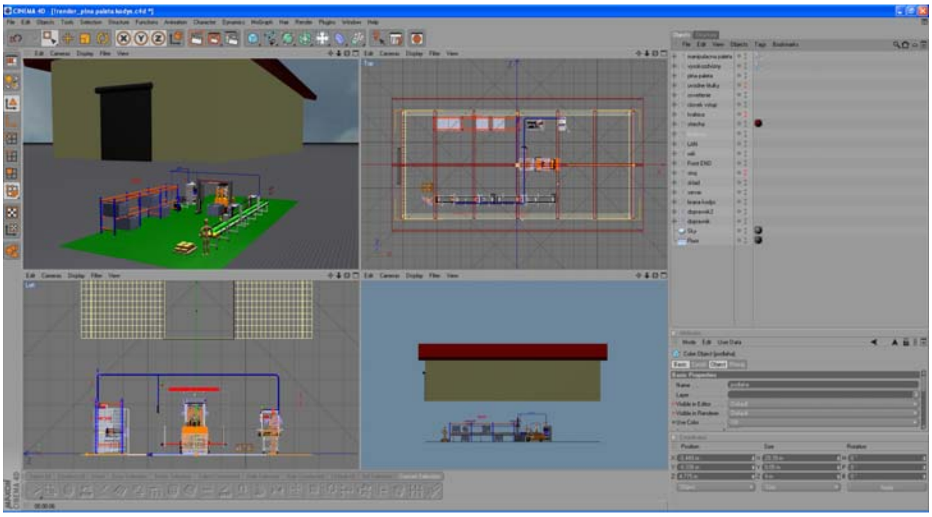

Figure 5. Work Environment of the program Cinema 4D R10 at modeling RFID lab [2]

Figure 5 shows the preview of the work environment. Cinema 4D R10 was used to remodel likenesses of all the objects, and place them in the final scene. The Y axis of the building was moved for clarity in the picture. Preview the template of modelling, which is designed for modelling objects in the program Cinema 4D R10. Units of length used Cinema 4D R10 uses meters as units of length. Generated models were modeled in scale, the reality that the observed ratio of the various parts of models.

Conveyor belt number 1, modelled according to its design drawings contained in the instructions for its maintenance, together with the printer and Zebra RFID gate No. 1, is shown in Figure 6.

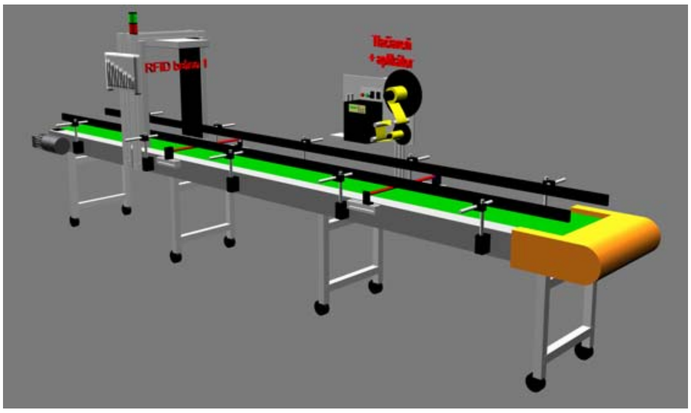

Figure 6. Model of the conveyor belt, printers and ZEBRA RFID Gate No. 1[2]

The following sections of individual processes were modelled in a similar way to the previous conveyor belt number 1. They are:

- Conveyor belt number 2.
- Zebra printer and label applicator.
- RFID Gate KODYS / VECTRA.
- Store.
- Server.
- Building.
- Wood pallets, boxes.
- Forklifts and pallet fence.
- FrontEnd.

4.1.2. Animation

When the scene was modeled the animation was made by technical parts of the scenario. All animated scenes were created with 25 images (frames) per second. Frames will be referred to below by letter. Animation took place in the layout window in the program Cinema 4D R10 by templates Animation. Here a timeline has been added to the standard view (Timeline) shown in Figure 7. [4]

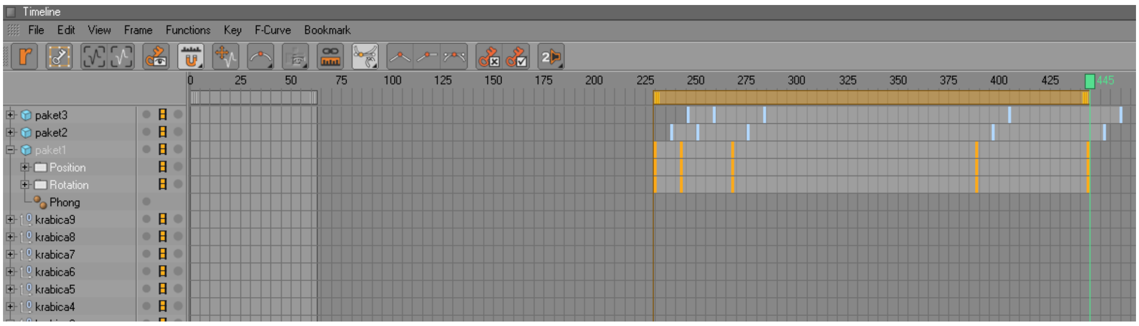

Figure 7. The time line window in the program Cinema 4D R10

The following scenes of individual processes were animated:

- Goods Receipt - this part featured the animation motion model of a forklift truck, which carries a variety of materials for input into production.
- Data from the Frontend pass to the server and then to the printer ZEBRA – this animation was used because of representations from - where transmit data after entering production.
- Data from the RFID gate No.1 forwarded to the server – the animation showed the transition of data from RFID gate No. 1 to the server after reading an RFID tag placed on the box. First it was necessary to animate the movement patterns of boxes on the model conveyor belt.
- Data from the RFID gate No. 2 forwarded to the server.

- Data from the RFID gate KODYS / VECTRA forwarded to the server.
- Applied Ethics.
- Entering Warehouse.
- WiFi router and server. [2]

Exporting of animation

Finally, it was necessary to export our animation (rendering of scenes). It is divided into set of rendering parameters and rendering using Net Render Cinema.

Set rendering parameters:

Export of video was the same after completion of each animation. They made two kinds of settings, export animation. The first was a video animation at 267 x 150 resolutions, due to faster rendering. This video served to check that everything was as requested.

The second set of exports was made up to suit the requirements of the animation, which was verified in a video with lower resolution. The second set of the exports was as follows: video resolution 1280 x 720 pixels with a size relative to the first the final format was 16 at the ninth were all selected frames. The number of frames per second (frame rate) was 25th AVI format was chosen for better picture and the possibility of creating a video with higher resolution.

Render using Net Render Cinema:

It was about two programs that allow the resulting animation rendering on multiple computers involved in the network. Condition was imposed as an animation project. The first program was Net Render Server. The running conditions were created at the beginning of rendering network.

5. Conclusion

RFID is a very useful and exciting technology. It seems that everywhere one looks there is some article about RFID and the huge benefits its technology promises. Moreover, there are many examples that demonstrate how this technology is fulfilling its potential. This article is intended to bring opportunities for implementing RFID technology in the storage and production lines Through the use of RFID lab a specific model example has been realised. The results of the modelling and animation of each scene are applications that simulate the processes in the RFID lab. Through these applications it may be easier to understand warehousing operations based on RFID technology. This article is part of the projects described below, which, together with the afore-mentioned application, will improve the learning process at the Department of Communications.

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