

## Monitoring the Shopping Activities from the Supermarkets based on the Intelligent Basket by using the RFID Technology

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### Introduction

The passive identification devices using radiofrequency (in a contact-less manner) define a strong technology within many application fields. The RFID (Radio Frequency Identification) technology allows to the end users (to the buyers of a supermarket) the possibility of identifying a certain product in a fast and adequate manner, in accordance to its moving along the distribution/utilization process. The RFID chips can be used not only as simple identification devices, but also with a view to detect and trace the stocks or certain individual products, as well as complex devices of registering the personal data, thus having the possibility of being used on applications dedicated to intelligent cards. Within the trading field, the RFID technology can successfully replace the bar codes, offering supplementary facilities, such as: increased protection over thefts, supplementary information about certain products (for instance, their main features), and for certain chips, having writing-reading options, the possibility of updating almost momentary information as the price of goods (during promotions or with a view to fast ending of stocks) [10]. Within food supermarkets, the RFID technology can be used from registering the exceeded temperatures of sensitive alimentary products until applications of automated replenishment or automated invoicing [8].

The basic RFID systems consist of a transmitter-receiver device (reader), connected to a personal computer and a transponder (tag), and embedded within product's label. The reader represents the active unit, able to read information from a transponder or to write information within the transponder. The reader generates an electromagnetic field, by means of its antenna. The transponder extracts its energy from the electromagnetic field by its own antenna and uses this energy with a view to its own functioning [4]. After transferring the energy towards the transponder, the reader and the transponder can exchange data with the help of antennas [9].

On the international level, the global shopping system with the help of intelligent shopping basket based on RFID technology was implemented by Samsung Tesco supermarkets or Wal-Mart chains of markets from USA, but the monitoring algorithm dedicated to customers and the algorithm of classifying the buyers upon the basis of their profiles saved within database are not met, these aspects being treated in this present paper.

### Technical aspects

The proposed scenario foresees the use of RFID technology with a view to monitor the products from a shopping basket, as well as the use of wireless technology in order to transfer information between the shopping basket, endowed with reader, and the department server.

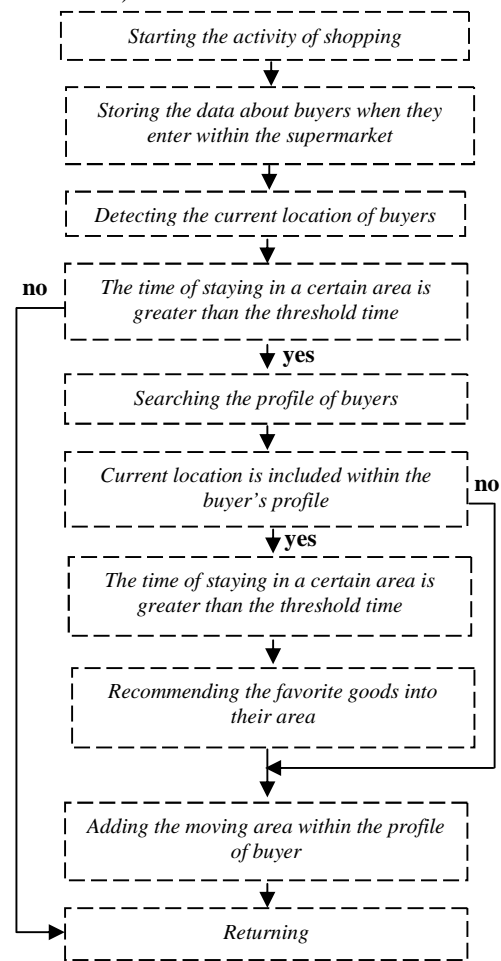
All products of the supermarket will have attached RFID tags, and each shopping basket will be endowed with a RFID reader, which will read the products from it. The shelves, on which products will be placed, will have RFID readers. Each department of the supermarket will be endowed with a RFID server that will have the part of storing additional information, as concerns the department products. The servers' network will be connected to a main supermarket server. The connection between the baskets' readers, as well as between the shelves will be made through the wireless server of the department. If the products are permanently scanned by the help of shelves' readers, then obvious records, sales' statistics or the existing stock of supermarket's products will be clearly seen. All information will be stored and monitored by the server. If the products present labels with RFID chips (named RFID tags) with the capacity of reading-writing, the reader will be able to update the information stored within tags' memory, such as those concerning prices' reductions, generated through certain promotions. The shopping baskets will be equipped with an electronic system based on a special computer, foreseen with LCD touch screen (Fig. 1).



**Fig. 1.** The shopping basket equipped with the RFID reader (Source: <http://www.itportal.com/>)

The shopping basket computer will function only based upon a user's profile, which can be accessed by introducing a unique identification number or using a RFID card for the constant buyers, this being automatically recognized by the shopping basket's reader. In this way, each consumer will be observed during his/her staying in supermarket, and his/her behavior can be analyzed. Once the shopping basket will be used by a customer, the information will be automatically displayed on the LCD monitor as concerns the data of entrance in the supermarket, the time spent on shopping, the total cost of the shopping, the number of products and the list with products added in basket. Simultaneously with adding a new product in basket, and if the buyer wishes, he can ask by means of a simply running menu, certain complex information displayed on the LCD screen, regarding the expiring date of a product, the ingredients, the number of calories contained and promotions, etc. Within a buyer's profile, saved on the supermarket server, the fact that the buyer is in diet or is diabetic and isn't allowed of consuming sweets is mentioned. This possibility can be disabled from the menu; if for instance, the shopping is made by other member of the family. If the buyer adds into the basket a product that doesn't correspond to his profile, an attention message will be displayed. If a buyer is irresolute as concerns choosing a product, some information similar to other products or for fully replacement can be displayed; thus, the position and the number on shelf of the new products will be displayed. The role of supermarket's department consists on supervising all the products and shopping baskets within the entire running range. In this way, the server will present the capacity of offering at any time the necessary information about the sales and stocks. The department's server will own a database containing the main characteristics of the products, thus offering supplementary data as comparing to those stored on the RFID tag's memory. This information is intended to supermarket's customers and for those that access the Internet site of sales. The department's personnel will be allowed to access the information about sales, stocks and number of visitors, by means of baskets' readers connected to the department's server. As above mentioned, each shelf will be equipped with a RFID reader. When a product is taken off from a shelf, it will get out from reader's incidence range of the shelf; if the product is not traced within the reader's incidence range of the basket, than the product will be placed on buyer's hand or the tag is defective (situation less probably). If a buyer changes his mind and puts the product back on the shelf, these actions will be registered within the supermarket's

database, wherewith the buyer's profile is stored. Thus, a model/graphic of a buyer's decisions and the algorithm of analyzing their patterns as concerns certain products can be created (Fig.2). The system can be divided in two parts: observing a consumer's behavior and the response to the consumer's behavior by offering supplementary information as concerns products, with a view to help the customer on choosing a product in accordance to his wishes. The possibility of observing buyer's behavior will bring for optimizing the retail sales process, by analyzing the stationing times on certain areas of shopping, or by analyzing the indecisions concerning some products and by helping the customers basing on an intuitive algorithm. For instance, if a buyer adds into his shopping basket the pizza dough, the locations of other necessary ingredients will be displayed on the basket screen (for instance, the ketchup, cheese or tomatoes).



**Fig. 2.** The model of analyzing buyers' patterns

The method of analyzing the buyers' patterns comprises the following steps:

- accessing the customer's profile from the database simultaneously with introducing the personal identification number code to shopping basket's terminal or the trustiness RFID card;
- detecting the location of buyers into the supermarket, by means of interaction between the basket (having attached a tag on it) and the shelves' readers (where the tracking unit will be taking care of); determining the time of staying into a certain area and if it exceeds the mean time established by default;

- determining the time of staying into a certain area and if it is included or not within buyer's profile and eventually an update of profile can be done;
- Establishing the products of which a buyer is interested. This analysis will bring an improvement to sales strategies, by announcing the customers of certain promotions or products by means of shopping basket screen. The analysis of buyer's pattern will determine their grouping within customers' categories upon basis of common interests. Such information as concerns the news/offers/reductions of prices will be automatically sent to the customers by means of SMS text messages or e-mails.

Within the actual supermarkets, [2] the products purchased are deposited on a conveyor's belt with a view to be scanned and then paid. Within the case presented in this paper, the conveyor's belt and manual scanning of each product will be eliminated, where the cashier's computer will communicate wireless with the reader attached to shopping basket. In this way, the cashier will achieve in few seconds information about the goods, will automatically add it into a list, the products will be subtracted from supermarket's stock and the buyer's profile will be automatically re-updated. The payment will be accomplished by cash or through a credit/debit card.

The possibility of implementing an electronic payment system will be taken into consideration. This system can be dedicated to those consumers, which own credit or debit cards, free of cashier's presence, thus offering faster operations. The system can take over, by the help of radio waves, information over the goods' total costs from the shopping basket, can extract the necessary amount of money from the credit card, can remit the card and invoice and finally allowing the open of exit gate.

All the supermarket's activities will be supervised by the central server. This will also assure the supervision of the communications with the outside part through supermarket's Internet site). The web pages of the supermarket can present two sections: one for the customers and one for the producers. The customers' web pages will allow them all the necessary information for goods trading. Moreover, having their own personal identification number, the customers will be allowed to access their profile, with a view to fill in the list of shopping, by accessing and modifying some old lists or for the on-line orders.

Supplying the supermarket with trading products can be carried out by an automated system. The managers will have access to information about offers, sales and goods of stocks, goods that have to be purchased, the level of sales or the number of visitors.

Implementing a mechanism of security [7] represents an absolutely necessary condition, because it will prevent the false pretences access to supermarket's local network and to accessing rights, also. In this way, from the department's computer, an employee will be allowed to use his password, with a view to access information about the department where he works and cannot have access to other departments' information. The managers, whom computers will be connected to the central server, will be allowed to access all supermarket's information by using their passwords.

The intelligent shopping system proposed within the paper will own an algorithm with a view to "learn" the data about new products, dimensions, quantities or packages. These will reduce or even fully impede the thievery possibilities. Moreover, by the presence of RFID checking readers equipped with gate type antennas to all exit points of the supermarket, the possibility that a person will pass with unpaid products through the gates of security will be eliminated. In the view to increase the security measures, the video cameras can be placed so that a central operator will be able to supervise multiple points, where shopping activities are carried out.

### **Advantages/disadvantages of the proposed system**

The proposed system offers both advantages and disadvantages for all the factors involved: buyers, retailers and suppliers. For the buyers, the main benefits are: saving time and effort, by eliminating the long times of waiting on queues; discounts for the orders performed or tenders by personalized promotions, based upon buyers' profile; decreased stress as concerns the progressive invoice from the cashier's screen, fact that will help on cost's exceeding; the system will be also convenient for the replenishment activities.

The main disadvantages for the customers consist in the fact they have to own minimal knowledge about computers utilization, this meaning they need time for basic learning; the retailer will have to guide and indicate those customers not used and not being able to manage very fast with the system of shopping activity. These disadvantages will be significantly decreased in time.

For the retailer, the main advantages consist on efficient improving of many operations into supermarkets (for instance: supplying, replenishment, the recommendations given to buyers within supermarket's enclosure, the forecast of sales, as well as the stock's control etc.); costs' reduction and also good organization of activities will be thus generated.

For the supplier, the main advantage consists in the fact that the proposed system will allow his integration within supermarket's activities, by the help of B2B relationships. Much more, the proposed system will help on developing the customers' knowledge on more fields, having as result the fidelity over orders to certain purchasing activities, to promotions programs solicited by the buyers

The intelligent shopping system proposed within this present paper can be truly reliable in the next future in Romania. An integrated tag is estimated to a price of about \$0.25. Massively manufacturing of millions' order could determine a decrease of price, of about \$0.07. The price can decrease simultaneously with the technology development.

As concerns setting up, within a wide department of a supermarket, which might occupy a sufficiently great area, running such a system can bring huge costs, both for the infrastructure and yearly tag's cost. Costs' saving can be taken into consideration, as regards the intelligent shopping system (reducing the thefts, increasing the sales, etc.), such an investment having the possibility of becoming on profitability character to long term.

All advantages of the proposed system consist in:

- monitoring the immediate needs of customers, as well as improving and intensifying their knowledge related to new technologies;
- measuring the price promotions efficiency;
- replenishing the supermarket on optimal conditions, by real time updating of the supermarket's inventory;
- Growing the customers' devotedness towards the supermarket.

## Conclusions

The RFID technology will be considered not just simple accomplishment of some research, but an efficient solution for companies, which will determine visibility on developing the business processes in a correct manner and of complete transparency. The intelligent shopping system can significantly change the manner in which shopping is performed, thus easing the life of buyers, always confronting with time. The retail supermarkets of the future will present significantly less checking queues, with a view to develop the own services and those of the staff, within steps of efficient performing of activities specific to shopping. An RFID implementation that assumes for the time being large expenses will become approachable in the future [1]. In many applications, the great cost of RFID technology will be balanced out by the achievement of the best solution and results of problems

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Setting up a system is proposed, in which the RFID technology will be used, with a view of monitoring the products from a shopping basket. Radio Frequency Identification (RFID) represents an advanced wireless technology, which comprises an important new solution within intelligent chips area and of automation technologies. RFID means an implementation of ‘intelligent objects’ specific for tracking entities and making easy the way of information acquisition. The data can provide any kind of information, such as: location or phase of an item within a manufacturing line or process, detecting entities or persons. The communication between the transmitter-receiver of the shopping basket with a server of the supermarket department is proposed to be carried out by means of wireless technology. Methods of analyzing the behavior of customers within the activity of purchasing products are also presented. Ill. 2, bibl. 14 (in English; summaries in English, Russian and Lithuanian).

**C. Гуржуи, А. Граур, С. О. Турцу. Наблюдение клиента в помещении с использованием RFID технологии // Электроника и электротехника. – Каунас: Технология, 2008. – № 3(83). – С. 7–10.**

Предложена система, в которой технология RFID будет использоваться с целью контролирования процесса покупки в помещениях магазина. RFID представляет новейшую беспроводную технологию, которая включает важное новое решение в области интеллектуальных микросхем и технологий автоматизации. RFID помогает внедрить «интеллектуальные объекты» с целью наблюдения за субъектами и упрощает сбор информации. Система позволяет однозначно определить место и способ получения товаров в магазинах. Предложены методы анализа поведения клиентов во время их пребывания в магазине. Ил. 2, библи. 14 (на английском языке; рефераты на английском, русском и литовском яз.).

**C. Hurjui, A. Graur, C. O. Turcu. Pirkėjo veiksmų prekybos vietose stebėjimas naudojant RFID technologija paremtą intelektualųjį prekių krepšelį // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2008. – Nr. 3(83). – P. 7–10.**

Pasiūlyta sistema, kurioje RFID technologija naudojama prekės pirkėjo krepšelyje stebėti. Pažangi radijo dažnių identifikavimo (RFID) technologija įgalina diegti intelektualias automatizavimo technologijas ir palengvina sekti objektus ir rinkti informaciją. Naudojantis technologija surenkami duomenys apie prekės vietą ir jos įsigijimo eigą. Siūloma ryši tarp siūstuvo ir imtuvo palaikyti naudojant bevielę technologiją. Pateikiami metodai pirkėjų elgsenai prekių įsigijimo metu stebėti ir analizuoti. Il. 2, bibl. 14 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).