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Analytical Model for Automating Purchases using RFID-enabled Shelf and Cart

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Abstract

RFID (Radio Frequency Identification) technology offers the skill to provide many services and facilities in the retail environment. The RFID technology is assessed for use in retail stores to replace barcodes system. In this paper a model which adopts RFID equipped shelves and shopping carts for automating purchases in stores is presented. It aims to banish counters where and scanning and billing of items using bar-code is done, thus eliminating long queues. In the first instance, the shelf is transistorized with a weight-sensing mat which is integrated with a RFID reader, thus making a shelf smart. The second instance illustrates a shopping cart, equipped with a tag and a weight-sensing mat integrated with a RFID reader that can verify the purchase of the items as the items are dropped into the cart. It communicates with a database via server to automatically bill the shopper for the purchases. Customers are benefited since long queues are omitted, thus improving time efficiency. It has been found that with this setting, it helps the retailers as well, as he gets more space for merchandising additional products which was earlier dedicated to point-of-sale terminals and can now provide better service to the customers. The fixture aims to help stores to orbit their own products, and also make sure that commodity is restocked. This paper compares the proposed model to the existing system on various factors and proving it to be better.

Keywords: RFID, Smart shelf, Smart cart, Weight sensors, RF Tag, RF readers.

1. Introduction

RADIO FREQUENCY IDENTIFICATION (RFID) technology accredits detection, recognition and relation of an item to a unique recognition code which is tagged with an RFID tag. Elongating this concept, it is possible to make a system that automatically unearths and catalogues every item, also automating purchases and banishing the long queues, thus improving time efficiency. This analytical model lowers the likelihood of failures and provides an easily scalable and reliable network backbone.

In this paper, the model design substantially lowers the overhead and the issues of earlier proposed method. Even when there are a lot many customers present in the store, there will not be any slump in the behaviour of the system. Each customer is recognized by the ID of the cart s/he chooses for the purchase. When customer starts purchasing, s/he puts the article into the shopping cart. The tagId of the product is wirelessly transmitted by the reader to the Base Station using the IEEE 802.15.4 (ZigBee Protocol) over the ZigBee network. The Base Station at the point-of-sale terminal has a database that stores information of all the products and generates the bill corresponding to the tagID of the cart. After the customer is done with shopping, s/he then heads to the payment terminal to pay the bill, where they are assisted by an attendant. Here payment is done for the already generated bill for a particular tagged cart.

The organisation of this paper is as follows: Section 2 bestows the system design in detail, Section 3 gives the working of the smart shopping model, Section 4 gives the Process Flow Charts, Section 5 outlines the performance and cost analysis Section 6 gives the conclusion of the paper.

2. Design Idea and Block Diagram

The model has been targeted to gear all the frameworks, discussed above. The model features a weight-sensing mat integrated with an RFID reader, a ZigBee transceiver placed on a store's shelves, which is designed to spot alteration in the weight of products piled on them. This weight-sensing mat which is integrated with an RFID reader do not only quantify of the weight on them, but also sanction backend software to evaluate the quantity of articles and spot as where the products are placed on the mat, depending on the extent of pressure expended on these sensors.

This system also has a shopping cart which is tagged and is equipped with a similar mat, with a difference that here the weight-sensing mat is integrated with an RFID reader, a ZigBee transceiver and LCD display. It detects an item when the customer picks it from the smart shelf and drops in the cart. This smart shopping cart keeps an account of the bill made by keeping running total of their purchases which is being displayed on the LCD.

The tagId of the item is relayed by the cart’s reader to the Base Station using the IEEE 802.15.4 (ZigBee Protocol). The Station at the payment terminal uses a database to generate the account of all the products bought by the customer. The customer is assisted by an attendant. Bill is ready, just the payment is made. The block diagram

shown in Fig. 1 gives a detailed view about the system being proposed. It shows the in-store component, the cart components and the shelf components.

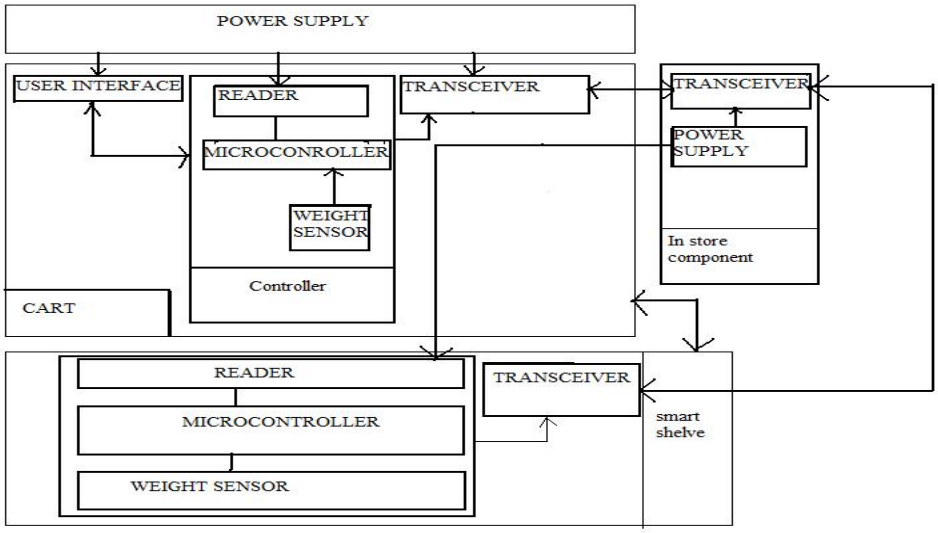

Fig. 1: The block diagram proposed.

Block Descriptions

1. User interface:

This part of the system has the LCD screen in order to help the user to see the transaction. This is monitored by controller.

2. Controller:

In this part lie the reader and the weight sensors. The reader transmits the tagID to the microcontroller which looks up the entries on the database at the back-end.

3. Transceivers:

This block in particular is to prevent theft. The transmitter on the cart gets the signals from the microcontroller depending on the data from payment station.

The model assures that the system gives the same conduct even with many shoppers are present in the store shopping at the same instance.

3. Working of Smart Shopping Model

On getting into the grocery store, customer will first pick a Smart Shopping cart. Each cart is tagged thus having a tagID. The customer gets an article that s/he desires to buy, the smart shelf's weight sensor detects the change in weight and triggers the reader. The reader detects the tagged smart cart. The substance is registered in name of tagged cart for purpose of verification. When the shopper puts the item in the cart, weight sensor in the cart detects it, triggers the reader. Reader now reads the tagID on the article. The tagID of the item and the cart ID are sent in a single Zigbee packet as two different fields to the back-end or server via Base station. The Base Station receives this information from the shelf. This information is regarding the weight change on the

shelf. The database has the details like: the tagId, name of the product, price and weight from the cart's reader. Corresponding to the received information the weight and the price values are kept aside. At the Base Station, the value of weight which is attained from this cart's reader is compared with the weight that was detected by the smart shelves reader, and then appropriate action is taken. Now the bill is generated simultaneously taking into consideration price of the item. If the shopper wishes to not buy the item, he removes it from the cart and puts it back on the shelf. Weight is sensed again triggering the reader. Reader detects the tagID and transmits the following information to the back-end and increasing the quantity of the items put back on the shelf. The shelf's reader is activated as well. This information is also sent to the back-end server. At last, when the customer ends with his shopping, s/he goes to the payment counter and pays the already prepared bill.

The cart's reader range should not be extended beyond the horizontal cart limits; so that it does not read the items kept on the shelf or in the other carts. Its reader range should be within the cart's limit. The cart's range can be vertically increased so that, if some items are kept at the bottom of the cart, will be detected.

4. Process Flowcharts

Process flowcharts have been made depending on the idea proposed.

Two cases have been considered

- Case1: when item is put into the trolley while a shopper passes the alley.
- Case 2: when item is removed from the trolley,, when the shopper does not want to buy the article

Case 1:

The value of flag is set to be zero initially when the cart is empty. When the weight sensor senses the item, flag becomes 1. The value of the sensed weight is put in some variable, for example W8. Price of the item is selected from the table in database which is maintained at the server. Bill is generated corresponding to the price of the item. Value of flag and W8 is set to '0'. This is done so that next item can be sensed and similar process will be followed.

Case 2:

In this instance the case is considered when items are present in the cart. The present weight is calculated. When an item is removed the falg1 is set to '0'. The new weight is put in another variable. The price is selected in accordance to the difference of both the weights. Bill is generated. If the weight in cart is zero bills value is '0'. Else the w8 is set to '0' and falg1 is set to'1'for the next item sensing.

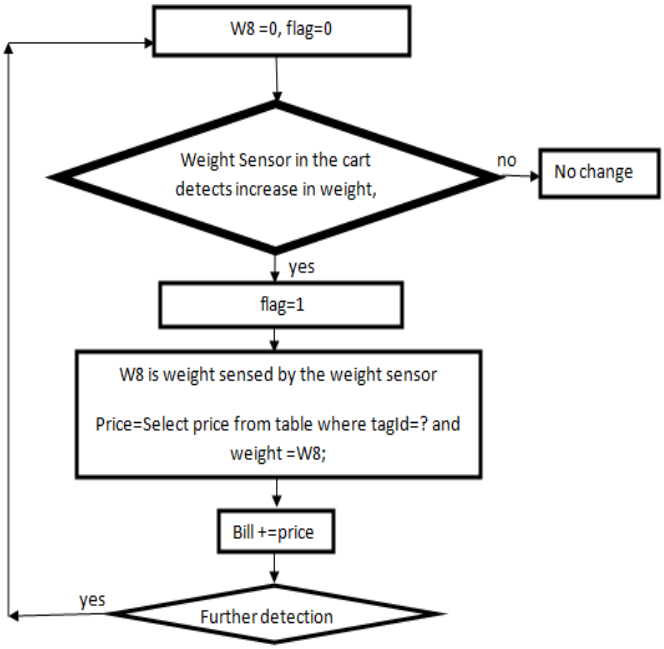

Fig. 2: The Process Flowchart proposed considering Case1.

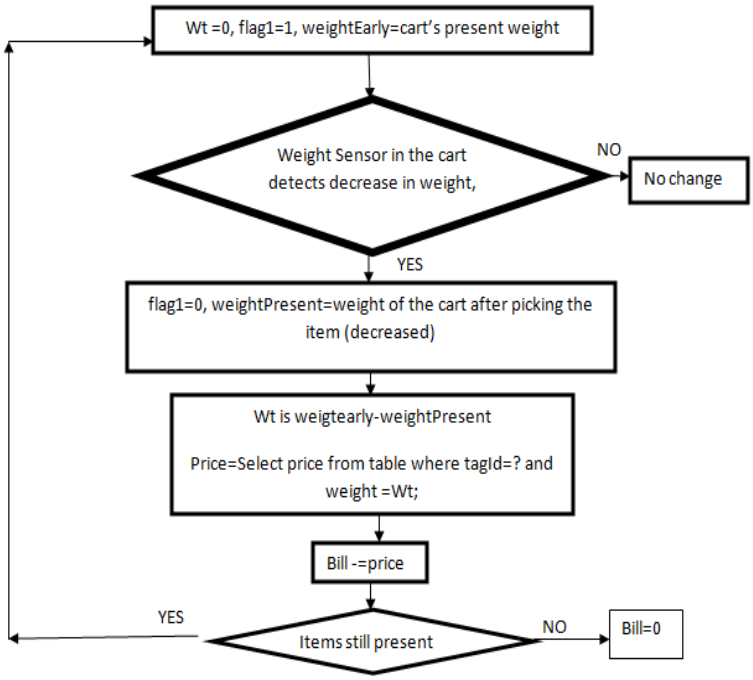

Fig. 3: The Process Flowchart proposed considering Case2.

5. Cost and Performance Analysis

From the Table1 and Table2 below, it is evident that the proposed model is more beneficial than the existing model in terms of performance and cost.

Table 1: Showing that the proposed model reduces the overall cost of the system

Proposed Model	Existing Model
1. The system is intelligent so manpower will not be required.	Manpower will be required, thus increasing the cost of the system.
2. The initial cost may be more since the readers and sensors are used in the model, but the running cost is negligible	The initial cost is less but the running cost is extremely high.

Table 2: Showing that the proposed model gives better performance.

Proposed Model	Existing Model
1. The items will be restocked immediately, since the central database maintained, informs the attendant. Thus better services and eliminating time wastage.	Attendant gets no information that the item needs to be restocked. Thus, wasting consumer's time since, the customer will not get the item that he requires as it will be out of stock.
2. The central database can also keep the expiry date information of the commodity, so the attendant gets the information that the items should be removed from the shelf.	The expiry date information of the item is not received by the attendant. Thus, the items are not removed from the shelf. It may lead to customer's picking expired articles.
3. Model proposes to make a central database, thus eliminating manual Billing	Manual billing is done ,thus wasting time and decreasing the efficiency
4. The LCD on the cart assists the customers, how the items are affecting the bill Customer can remove the items according to their convenience	The customer is unaware of the fact that how the items are affecting the bill. In case a person is not carrying enough money, then he will have to remove the items at the billing counter after knowing the total bill.

6. Conclusion

The model is successfully revealed for developing a Smart Shopping System which automates the whole billing agenda. The system which is proposed is highly dependable, authentic, trustworthy and time-effective. The benefits of using this agenda in terms of cost and time effectiveness can be summed up as:

- The salary amount given by the mart to the employees will reduce since the manpower will decrease as the whole system is becoming smart.
- Cases of theft will be controlled, which further adds to the cost efficiency.

- The time efficiency will shoot up incredibly as waiting queues will be eliminated. More number of customers can be dealt in same time where a few customers were being served

The initial cost of the model may be high but the in subsequent years the model will be beneficial as compared to the barcode or manual system. Model can be advanced to prevent the loosing of the shopping cart with the help of already applied tags. Since, the current proposal also does not consider the items whose cost is less than the tag, solving this issue will be considered in our future work to make the system even better.

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