2nd International Conference on Current Research Trends in Engineering and Technology
© 2018 IJSRSET | Volume 4 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

RFID based Smart Trolley for Supermarket

Marmik Soni, Raj Shingala, Naimish Bhanderi, Rahul Ajmeriya
Department of E&C, FoT, Dharmsinh Desai University, Nadiad, Gujarat, India

ABSTRACT

Development of technology has always been directly or indirectly focused towards reduction of human intervention in day to day life. Making the process of shopping faster, convenient and simpler is the requirement in consumer market every other day. This paper discusses an innovative system design which, to a great extent reduces shopping time and makes the experience better at retail shops and super markets. System discussed here is about designing smart trolleys employing Radio Frequency Identification technology, online payment gateway and servers. This technique will reduce the requirement of staff and equipment required during the process of billing up to large extent. Smart trolleys are using Raspberry Pi 3, keypad, display, Wi-Fi connectivity, sensors and printers for a better, faster, optimized and satisfactory service to the customers. This scheme also promotes the concept of Digital India and cashless economy.

Keywords: Digital India; Electronic Product Code; Raspberry Pi 3; Radio Frequency Identification; Smart Trolley; Super Market

I. INTRODUCTION

The primary aim of science and technology since earlier times has been to reduce human effort and human interference in the operations of daily life. Although a considerable amount of research work is focused on discovering new things, devising new and improvised methods, the hidden goal behind all these has been to ease what is called the 'life'. This ease also involves sustainability and improvisation of life. The aim of the proposed work is to develop a smart trolley for supermarket and retail shops which would detect the products placed in it and display the final total of all the products on a screen placed on it and also provide a facility for the customer to pay the bill through a payment gateway.

This would effectively remove the problem of long queues at the billing counters and there would be no longer a need of the counter staff as well. The system involves primarily an operation of trolley. So, the running cost would be very minimal, as the same trolley can be reused several times. The final total would require the prices of products which would be obtained by using an RFID (Radio Frequency Identification) reader in the trolley. The products containing the RFID tag would transmit the required data onto the RFID reader, which would connect it further to the interface board and server. The board would receive the product data from the server [1].

Section II is the system description. In this section, basic elements of the system are explained with a description of how the system would work. Section III contains the implementation of the system. The explanation of the merging of the basic elements of the system to form the whole system is done. Section IV highlights the advantages that the system has over the conventional practices. Section V states the challenges that the system would face. The future aspects are mentioned in Section VI.

II. SYSTEM

The main aspect of the discussed system is the use of RFID. Any RFID based products are one of the two types, either active or passive. As the name suggests, the active product doesn't need any external source for power and has its own battery, while passive one collects its power from the nearby sources. A passive RFID tag collects the energy from interrogating radio waves transmitted by an RFID reader and uses it to transmit back the information contained in it to RFID reader [2].

Figure 1 shows the system structure. Now, as soon as the customer would place a product containing an RFID tag in the trolley, RFID reader would detect it. RFID reader and tag would be linked with each other and the tag would transmit the information to the reader. Then, the reader would further link the received information with the interface board. The board would be connected to a server and it would send the product details to the board after receiving the required information. The screen interfaced with the board displays the details of the products and the final billing amount.

The reader and the tag would be connected as long as the respective product is in the trolley. Each sample of a particular product would have a unique EPC (Electronic Product Code), so the repetitive reading of same sample of product is not possible.

It is possible that multiple tags would be connected to an RFID reader. Two techniques are used to reduce the difficulty of the intake of information from multiple tags. First method is a slotted Aloha system in which the reader broadcasts an initialization command and a parameter that the tags individually use to pseudo-randomly delay their responses. The second method is adaptive binary tree protocol. In this protocol, the reader sends an initialization symbol and then transmits one bit of ID (Identification) data at a time. Eventually tags with matching bits respond, and eventually only one tag matches the complete ID string.

There would be an option of making payment displayed on the screen. After the required products are put in the trolley, the customer would select that option and the screen will display the list of various payment methods through which payment can be done. The customer can select one of these to make the payment [3].

Trolley will be equipped with RFID tag for its identity. When it gets out of the shopping area, trolley detection and cross check with server data related to payment will be done. In case of foul play it will trigger a warning bell.

If any customer is illicitly taking out a product without putting it in the trolley, the scanner at the exit will detect the presence of it and initiate an alarm.

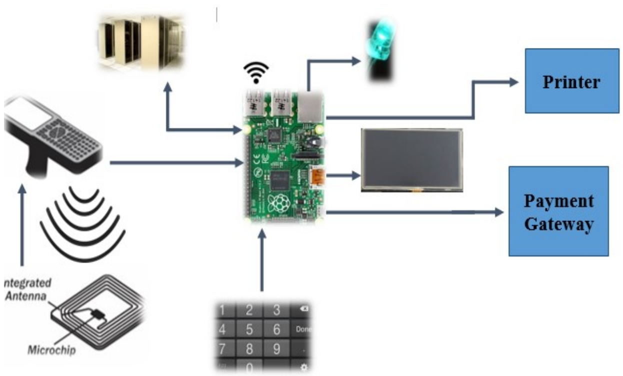

Figure 1. System Sructure

While payment process is going on, RFID connectivity would be stopped, to ensure smooth payment process. (As it might happen that customer may, by mistake, remove or add products from or to trolley respectively, while payment process is going on).

To avoid complex and ambiguous situations, RFID connectivity would be periodic and not continuous, for example, about 1 min or 30 sec. This will help the system to update the products in trolley in every 30 sec or 1 min.

The continuous connectivity is avoided because of the fact that customer may take out a product from the trolley after putting it in a trolley. In such cases, RFID reader would be in an ambiguity that which products are taken out from the trolley. It won't be able to send a proper message to the system. While periodic update process would ensure that RFID reader detects only those products that would be present at that particular moment in the trolley [4]. It would also save power that RFID components would consume.

EPCs of the latest products in the trolley would be stored in a memory. Any new update of data will overwrite the previous one. After the payment process is done, an LED (Light Emitting Diode) placed on the trolley would turn green which was red till the payment was not done.

The interface board would have a button for turning ON the RFID connectivity. After the customer is done with payment, while leaving the shopping area, the checkout personnel would press that button to turn ON the RFID connectivity. This would trigger another round of updating the products in the trolley. The system would compare the new updated data with the previous one for which payment was done. If any mismatch would be there, the system will set off an alarm to inform the security personnel. There is a possibility that after payment is done, the customer may add some products in the trolley, or replace the lower priced products with the higher ones. To catch and reduce such practices, this feature is included in the system. The button would be used for only turning ON RFID connectivity. Multiple pressing of the button would do nothing. It would not turn OFF the RFID connectivity. Figure 2 shows the flow of whole process explained above.

To save power at trolley, smart system would be employed which switches ON trolley. A magnetic pulse generator attached on the trolley will help the trolley activation process. As the wheel of trolley would move, it would cut the magnetic field generated and this would trigger the system. Figure 3 shows a simple diagram of such trolley.

The range of RFID reader would be increased up to some distance outside the trolley (few centimeters), as it may be possible that some products are above each other, and the topmost products would be outside the confined trolley space.

The payment would be done in an open place in the supermarket, where there are no products around to some distance, so that RFID reader does not detect products which are not in the trolley itself but in the shelves of the supermarket.

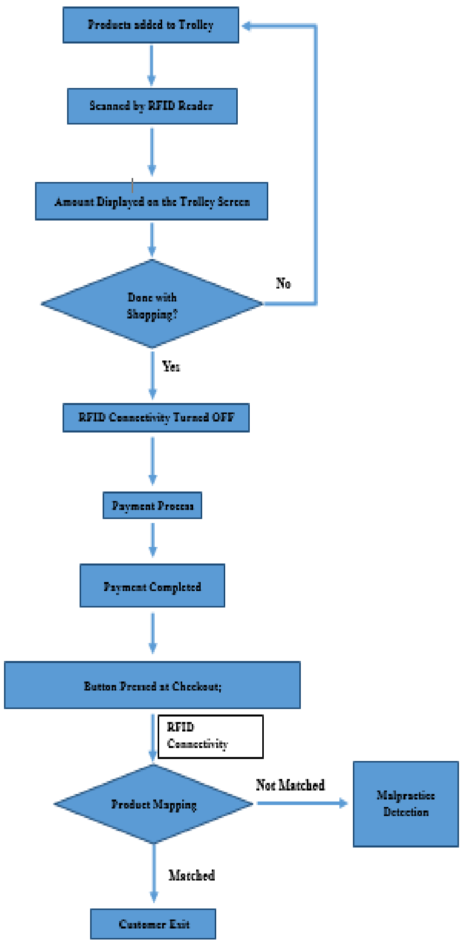

Figure 2. Flow Chart of Whole System

III. IMPLEMENTATION

The preferable interface board is Raspberry Pi 3 as it has large working memory and expandable memory up to 64 GB to store the data. It can be used to form a system with versatile electronic components [5]. It can be made to run in server mode. It has on-board Wi-Fi connectivity. The expansion with network devices is possible on it [6]. Figure 4 shows the operational flow of the system. When a customer would put an item in the trolley, RFID reader would scan the detectable volume around it after every 1 minute updating the items in the trolley. If the reader detects any products, it would fetch the EPC of that particular product. The reader would be connected with the interface board and the EPC would be received by the board.

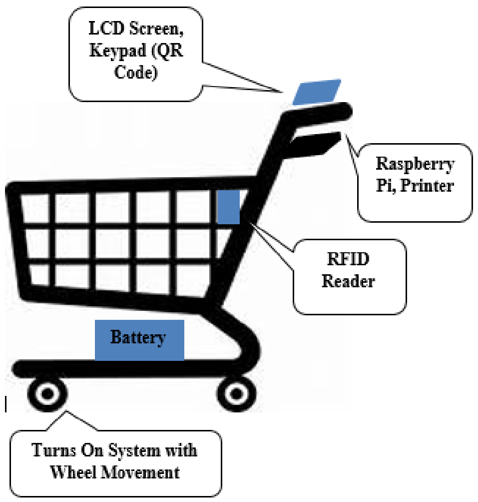

Figure 3. Diagram of Proposed Trolley

The EPCs which RFID reader would detect and send to Raspberry Pi 3 board would be temporarily stored in the memory of it and would be sent to the server at every 1 minute. The server would in turn, send back the details of the concerned product to the board and they would be stored in the memory of it. These details would be displayed on a screen. The EPCs in memory would be updated every 1 minute one by one, by the EPCs of updated list of products.

The updated EPCs would be stored in the memory for another 1 minute, to be replaced or updated by the present list after that 1 minute.

The data stored in the memory would help to compare the new updated data after the payment is done with the latest previous data before the payment is done, to avoid any illicit activities or attempts by the customer. The input pins of the interface board would be used to enter the necessary details for payment through a keypad. A printer can also be connected with Raspberry Pi 3 and a payment gateway can be connected to the board using on-board Wi-Fi connectivity [7].

If the payment option selected is a gateway whose application is already installed in the customer's cell phone, then he/she would directly make the payment through the application by scanning unique QR code of that supermarket on the trolley and enter the

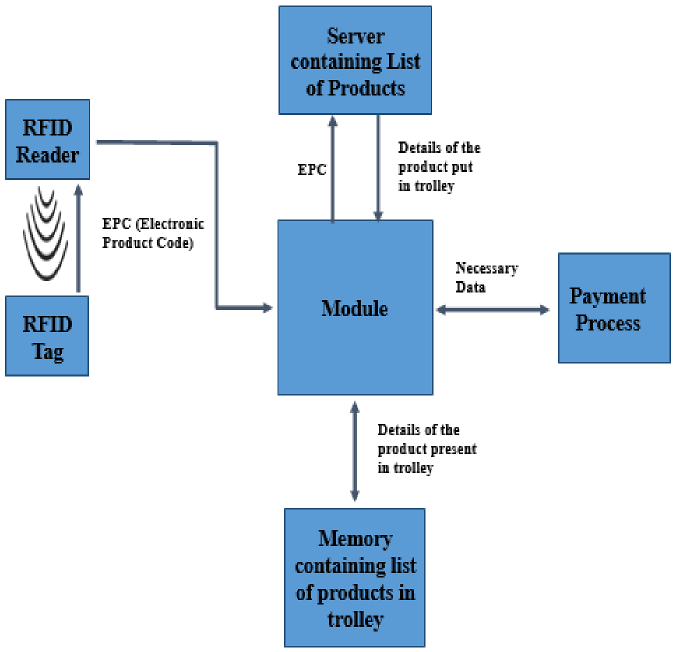

Figure 4. Operational Diagram

necessary details through cell phone itself. These details would also include the amount customer wants to pay. After the payment is done, the customer would input the Order ID provided by the payment gateway into Raspberry Pi 3. The board would then fetch the amount paid corresponding to that Order ID from the database of the payment gateway which had been used to make the payment and try to match it with the actual amount to be paid. If both are matched, then a LED attached with the board would turn green, which was red until this moment. Obviously for accessing the database of the concerned payment gateway, permission has to be taken from the company owning and managing that gateway.

If the payment option selected is a card (debit/credit), then the necessary details would be entered through a keypad connected with Raspberry Pi 3. A separate payment gateway would be connected with it and the payment can be done through that. Figure 5 shows flow of the whole payment process described above.

IV. ADVANTAGES

The system would reduce the check out and queue time of customer to a considerable extent. The present time spent at check out and queue both by a customer is from a minimum of 1 and half minutes to a maximum of 8 minutes. The system would reduce it to at most 1 minute. Also, the average time spent by a customer in a supermarket is around 40 minutes. The introduction of the discussed system would definitely decrease the time spent in a supermarket and as a result save the time of both supermarket staff and customer.

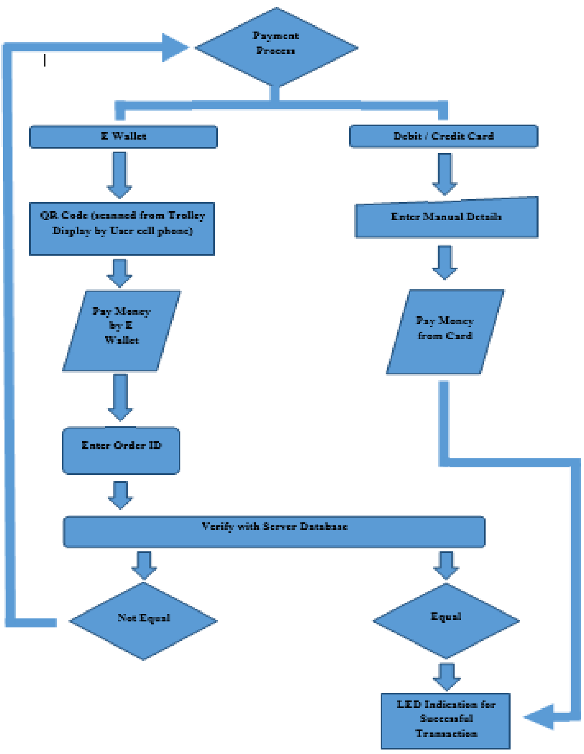

Figure 5. Flow of Payment System

The system would also be of a huge benefit for the 'quick shop' customers who are often in a hurry to get what they want quickly and check out.

The payment process is done by the customer only through smart trolley, thus at least reducing, if not eradicating the need of the check out staff and the equipments needed. This would reduce the overall running cost and maintenance of the supermarket. The work force and equipments required would be less.

The initial cost of the smart trolley would be a point to bother about, but that also would be less than the purchasing cost of equipments at the check-out of the supermarket [8]. The reliability and efficiency of the trolley would be higher, resulting in very less cost of maintaining the whole system.

The ease and speed with which the system would work, would obviously increase the customer's confidence and satisfaction for the super market. This would also encourage the supermarket to promote the system.

V. CHALLENGES

If system is not implemented properly and operated, then the time for shopping might increase instead of decreasing and also customer frustration may increase. The interface board should have proper internet connectivity. If a good connectivity is not there, the system might become lethargic and complex.

The security and privacy regarding consumer is a major issue while using RFID technology. The tags can be tracked wherever they are, with the condition that a reader is nearby at a required minimal distance [9]. There is a constant danger of consumer tracking and hacking of his/her personal information [10]. For at least reducing this disaster, if not stopped, manufacturing of precise and exclusive RFID readers and tags should be done; the result of which would be linking of tags with only those RFID readers which have been made to link with that type of tags only. The manufacturing of such 'specialised' RFID tags and readers is difficult.

VI. FUTURE ASPECTS

The attachment of RFID tags to all the products of the supermarket may take a good amount of time initially, but once implemented, the system will be time-saving, power-efficient, cost-effective, user-friendly and one of its own.

Each trolley would be having a unique ID with the help of a RFID tag attached to the trolley itself. Some RFID readers placed at certain places in the supermarket would help in tracing the path of a particular trolley and calculate how much time that trolley remained in a particular row of shelves. This would help in studying shopping patterns and preferences of customers.

VII. CONCLUSION

The design discussed opens new possibilities for smart shopping experience. It has got benefits of IoT (Internet of Things) concept like reduced human efforts, cashless shopping, improved security and faster operation. This article talks about feasibility, challenges and future aspects while migration to the stated smart system. The reduction of human resources in the supermarket thanks to the aspect of customer payment and checkout in the system is a major breakthrough as compared to the conventional practices. The security and privacy of the customers is a major issue for the system. However, taking appropriate precautionary steps and developing highly sophisticated RFID readers and tags can reduce that problem to a considerable extent. The tracking of trolley using RFID readers at various points in the supermarket provides statistics for analyzing the customer shopping preferences and patterns. Above all, for long term, the system takes customer satisfaction to a whole new level provided it is implemented and operated correctly. The scope of improvement in the system is very wide as it digitalizes the whole process of shopping.

REFERENCES

[1] Wamba, Samuel Fosso, et al. "Exploring the impact of RFID technology and the EPC network on mobile B2B eCommerce: A case study in the retail industry." International Journal of Production Economics 112.2 (2008): 614-629.

[2] Roberts, Chris M. "Radio frequency identification (RFID)." Computers & security 25.1 (2006): 18-26.

[3] Gulati, Ved Prakash, and Shilpa Srivastava. "The Empowered Internet Payment Gateway." International Conference on E-Governance. 2007.

[4] Clarke, Robert H., et al. "Radio frequency identification (RFID) performance: the effect of tag orientation and package contents." Packaging Technology and Science 19.1 (2006): 45-54.

[5] Maksimović, Mirjana, et al. "Raspberry Pi as Internet of things hardware: performances and constraints." design issues 3 (2014): 8.

[6] Upton, Eben, and Gareth Halfacree. Meet the Raspberry Pi. John Wiley & Sons, 2012.

[7] Shahazad, Ajeet Singh Karan Singh, M. H. Khan, and Manik Chandra. "A Review: Secure Payment System for Electronic Transaction." International Journal 2.3 (2012).

[8] Zhao, Cheah Wai, Jayanand Jegatheesan, and Son Chee Loon. "Exploring IOT Application

Using Raspberry Pi." International Journal of Computer Networks and Applications 2.1 (2015): 27-34.

[9] Juels, Ari. "RFID security and privacy: A research survey." IEEE journal on selected areas in communications 24.2 (2006): 381-394.

[10] Rieback, Melanie R., Bruno Crispo, and Andrew S. Tanenbaum. "Is your cat infected with a computer virus?." Pervasive Computing and Communications, 2006. PerCom 2006. Fourth Annual IEEE International Conference on. IEEE, 2006.