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Automatic Expiry Date Notification System Interfaced with Smart Speaker

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ABSTRACT: *In the United States, 40% of the food supply is wasted in each year. One of the reasons for this food waste is that the consumer forgets the expiry date of the food after purchase and does not consume the food before it expires, and when he/she finds out that the food is expired, it is tossed out. In this paper, a novel cloud-based smart expiry system is proposed which sends an automatic notification to the customer's smartphone several days before the purchased food expires. The checkout operator app in the store generates a table containing product names with expiry dates and it is uploaded to the cloud. The customer scans a single Quick Response (QR) code printed on the purchase receipt with a smartphone. The table is then automatically downloaded from the cloud to the smartphone. The smartphone app also updates the customer's Google calendar with the expiry dates of the purchased items. The system is interfaced with Google Home smart speaker and can respond to customized verbal questions about expiring items. A prototype of the system is developed and tested.*

KEYWORDS: *Quick Response Code, Cloud Storage, Smart Speaker.*

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I. INTRODUCTION

American households waste 14% of their food purchases on an average and 15% of that includes products that never opened. According to [1][2], an average family of 4 tosses out $590 per year, making it a serious economic problem. One of the reasons for this food waste is that the consumer forgets the expiry date of the food after purchase and does not consume the food before it expires, and when he/she finds out that the food is expired, it is tossed out. It is also difficult to manually check the expiry dates of all the items stored in a refrigerator full of foods and keep in mind all the expiry dates. Also, consuming foods that have expired may cause serious health problems [3][4]. To solve this problem, we proposed a cloud-based smart-expiry system that sends an automatic notification to consumer's smartphones several days before the food expires in [5]. In the method proposed in [5], the consumer will just scan a single Quick Response (QR) code [6] – that is printed on the receipt, and he/she will be all set to receive the expiry date reminders and notifications. No manual entry of each of the product name or expiration date by the consumer into the phone is required. In this paper, the system is updated and now connected with Google Home [7]. The smartphone app automatically adds the expiry date reminders in the Google calendar. Google Home can respond to customized questions about expiring items by accessing the calendar data.

II. RELATED WORKS

Several apps have been recently developed to generate reminders for the expiry date. In the app in [8], the user needs to manually enter the product name, purchase date, expiration date, and it generates reminders several days before the expiration date. However, this manual entry of each purchased product's name and expiration date are tiresome, time-consuming, and not efficient. The app in [9] attempts to develop an easier way for entering the product information by only scanning the barcode of the product using the smartphone's camera. However, the table for converting the barcode to the product name is not available in the app, rather the table needs to be manually created by the user for all the products he/she uses, which is an overhead.

Samsung recently introduced the Family Hub refrigerator [10], which has 3 cameras to take images of items inside the refrigerator and a large display unit connected to the refrigerator. The user can manually set expiry dates of the items that are visible by the cameras using drag-drop reminder notes. This method involves manual entry and cannot be used in a fridge where many items are not visible by the front cameras. A concept of QR fridge magnets to keep track of food's expiration dates is reported in [11]. Each QR fridge magnet device is used to track one product's expiry date only and the device has a processor, display, and QR code scanner hardware. This idea involves purchasing of several QR fridge magnet devices, which is an overhead for the customer.

Compared with these related works, the proposed work seeks to provide the ease of entry of data just by scanning a single QR code on the receipt. The expiry dates are made accessible to Google Home, thus it can answer questions related to expiry dates – making a step forward for the smart home revolutions.

III. SYSTEM ARCHITECTURE

The proposed smart expiry system is shown in Fig. 1. The expiry date is generally written using the English language on a product. In the proposed method, the expiry date is written using bar code as shown in Fig. 1 (a) along with English. After the customer chooses the product and goes for check-out, the bar code for the product and also the barcode for the expiry date is scanned by the checkout operator, as shown in Fig. 1 (b), using a barcode reader as shown in Fig. 1 (c). This step is repeated for all the purchased products which have expiry dates. The app used by the checkout operator's desktop computer, as shown in Fig. 1 (d), decodes the barcodes, gets the product names from the store's barcode-to-product name conversion database, and creates a new table which contains the purchased product names and expiry dates. The table is then uploaded to a cloud, as shown in Fig. 1 (k), using the Internet. After the customer completes the payment, a receipt is printed using the receipt printer Fig. 1(e). The receipt, as shown in Fig. 1 (f), has conventional product names and prices along with a unique QR code.

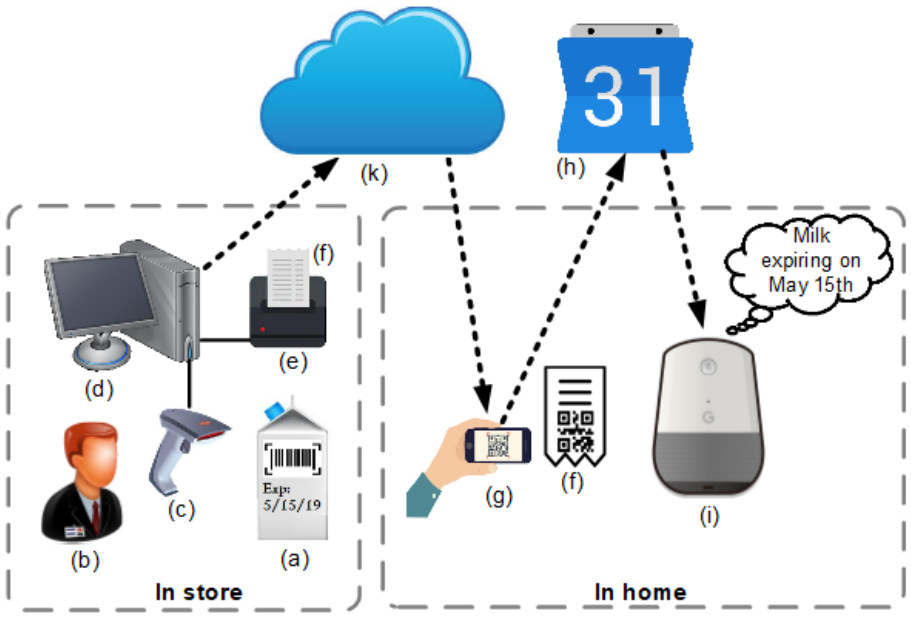


Figure 1: The proposed smart expiry system. In-store (Left), the checkout operator (b) scans product's expiry barcode (a) using a scanner (c); A table with the product names and expiry dates is created in the computer (d) and the table is uploaded in the cloud (k). The receipt (f), printed by a printer (e), contains a QR code to access the table in the cloud. In-home (Right), the customer scans the QR code with a smartphone (g) and the table is downloaded from cloud (k) to smartphone (g). The smartphone then adds the product names and expiry dates in the calendar (h) as events. Google Home (i) responds to voice commands and informs about the expiring items.

The customer, as shown in Fig. 1 (g), then scans the QR code with his or her smartphone using the proposed smart expiry app. The app decodes the QR code and gets access to the table that is stored in the cloud by the Internet and downloads the table from the cloud to the smartphone app to generate reminders and notifications. The smartphone app then updates the customer's Google calendar, as shown in Fig. 1 (h), with the expiry dates. When the customer asks a question using voice command to Google home, as shown in Fig. 1(i), it responds about the item names and expiry dates by accessing the calendar information. The main units of the system are briefly described below.

3.1 Checkout Operator Software

When a new customer comes, the software first generates a unique receipt number, referred to as *ReceiptNumber*. Then, a QR code image is generated in the software containing the *ReceiptNumber*. The checkout operator then scans the barcode of the product and also scans the expiry date of the product (if it has any) - one by one. When a product barcode is scanned, the app gets the product name and its unit price from the store's database and displays them in a list box. When an expiry date barcode is scanned, the preceding scanned product name and the expiry date is appended to a comma-separated value (CSV) file. The name of the file is set as *<ReceiptNumber>.csv*. This file contains the names and expiry dates of all the products that were purchased by the customer.

After the payment is processed, the <*ReceiptNumber*>.*csv* file is uploaded to the cloud storage using the Internet. The software prints a receipt along with the QR code containing the *ReceiptNumber*.

3.2 Cloud Storage

The Firebase cloud storage [12] platform is used to store the <*ReceiptNumber*>.*csv* files in the cloud. Firebase storage is a powerful, simple, and Exabyte scale object storage solution. Files can be uploaded, downloaded, and deleted using the Firebase software development kit (SDK) functions from the desktop, mobile, and web platforms. The Firebase SDKs add Google security to file uploads and downloads for Firebase apps. Firebase provides a declarative rules language that allows controlling the read, write, and delete access so that the storage is restricted to only authenticated users.

3.3 Smartphone App

The app is designed for the Android platform. The first screen of the app contains a list-view box. Each record in the list-view box shows the name of the item, days remaining to expire or how many days ago it expired, and the actual expiry date. The app contains a settings menu where days before notification, `DaysBeforeNotification`, and notification hour of the day, `NotificationHour`, can be set. The user can also choose notification properties such as sound, vibration, and light.

The user gets a receipt from the store where the smart expiry QR code is printed. The app contains a button on the first screen for scanning the QR code. When the button is pressed, the front camera is turned on for scanning the QR code. A QR code reader library is used in the app. It decodes the code and outputs the message contained in the QR code in a string. The string contains the *ReceiptNumber*. Then a *service*[15] is started for downloading the <*ReceiptNumber*>.*csv*file from the Firebase cloud. After the file is downloaded, the contents of the CSV file are read in a *list.*

Then, the product names and the expiry dates are parsed from each record in the list, and events are added in the calendar on those expiry dates at `NotificationHour` using Google calendar library. The title of the calendar events contains the product name concatenated with the word “expiring”. The list is then appended to the existing list that is already stored on the local phone. Then the list is sorted based on the number of remaining days to expire from the current date. Bubble sort is used for sorting the records. Then the list-view box on the front screen is updated with the contents of the updated list. Then the downloaded <*ReceiptNumber*>.*csv*file is deleted from the local phone and also from the cloud. The actions after the QR code is scanned is shown in the flowchart in Fig. 2

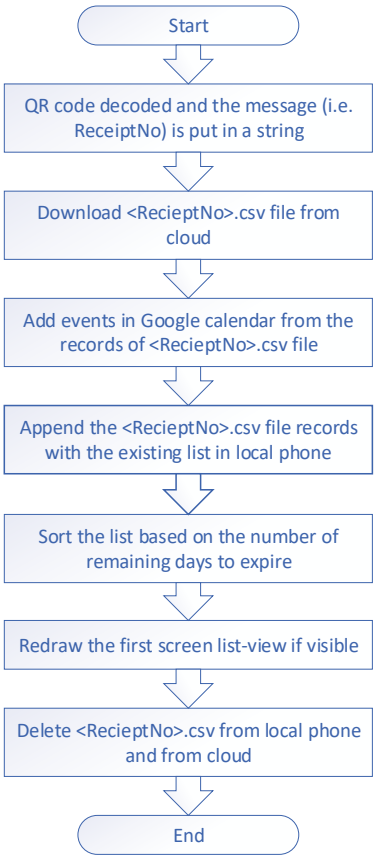


Figure 2: Flowchart showing the steps after the QR code is scanned

After booting the phone, a service [13] for generating smart expiry notifications is automatically started. The service checks the expiry dates every day at the `NotificationHour`, which is set by the user in the settings. For each item, the service calculates the days remaining, `DaysRemaining`, by calculating the date difference between the expiry date and the current date. If the`DaysRemaining`is smaller than or equal to `DaysBeforeNotification`, then notification for that item is generated. After an item is consumed, the consumer can remove the item from the app so that the app does not generate further notifications. This is done on the first screen by making a long-click on the record of the list-view box.

3.4 Google Home Smart Speaker

Google Home is a smart home speaker having integrated support for home automation. The user can ask questions to Google Home and it can answer them accordingly. Once the smartphone app has updated the calendar in the form of events, Google Home can read the calendar as it is linked with the user's phone calendar.

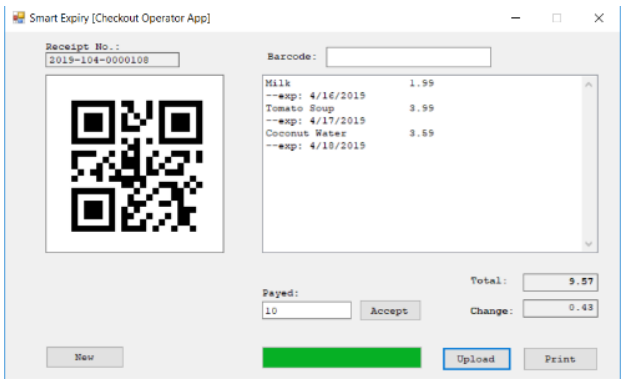
From the Google Home app, a custom routine [14] is created for this project. A routine is one or multiple actions grouped in order. A routine can be activated by saying a custom command or using a schedule. In this project, a routine is created that executes the question "what is in my calendar this week?"; whenever we say the custom command "smart expiry". The routine can also be scheduled to be executed automatically at a day and time in the week. One of the limitations of current Google Home is that it can say a maximum of 3 events from the calendar. It also says the expiring items along with the other home or work category events in the week. The specific command only to read a particular category of events from the calendar is not supported yet.

IV. RESULTS

A prototype of the proposed smart expiry system as shown in Fig. 1 is developed and tested successfully. In the proposed system, the expiry date is written using barcode along with English on the product as shown in Fig. 3. The desktop computer app for the checkout operator is developed for the Windows platform. The computer setup, a screenshot of the checkout operator app, and a receipt with smart expiry QR code are shown in Fig. 4.

Figure 3: The expiry date is written using barcode along with English.

(a)



(b)

```
*****************************
*       Smart Store         *
*****************************
Date: 4/14/2019
Receipt #: 2019-104-0000108

Milk                      1.99
--exp: 4/16/2019
Tomato Soup               3.99
--exp: 4/17/2019
Coconut Water             3.59
--exp: 4/18/2019
---------------------------
                Total:    9.57
                Payed:   10.00
               Change:    0.43
```

SmartExpiry QR Code

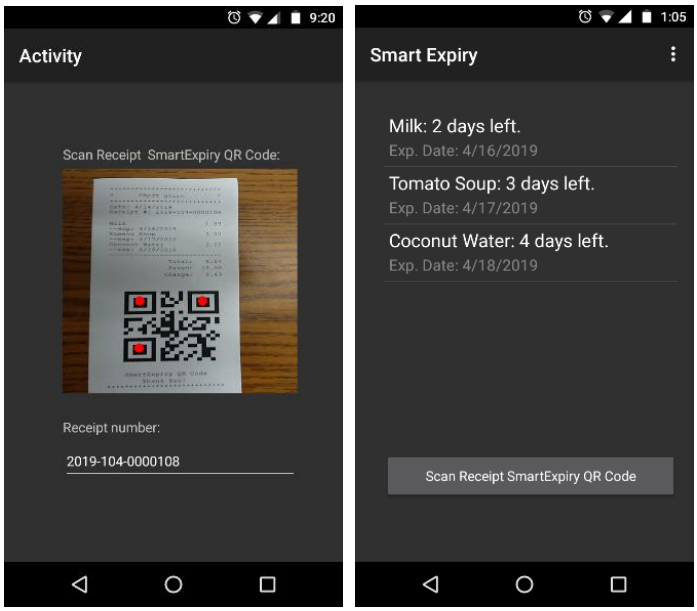
Thank You!

****

(c)

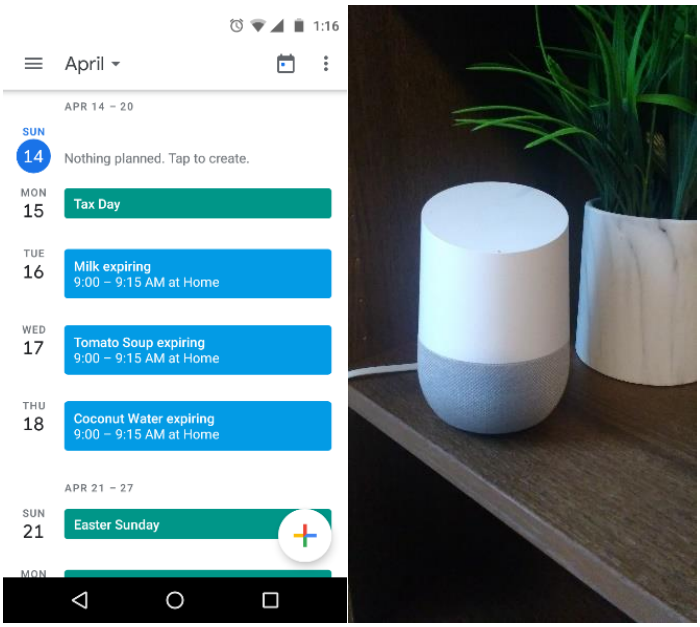
Figure 4: (a) Checkout operator computer with a barcode scanner and a receipt printer; (b) Screenshot of checkout operator app; (c) printed receipt with smart expiry QR code

The QR code in the receipt is scanned by the smartphone app by the customer as shown in Fig. 5(a). This action causes the expiry dates with product names to be downloaded from the cloud to the phone. A screenshot of the smartphone app is shown in Fig. 5(b) after the QR code has been scanned. Here, each row of the list-view box shows the name of the item, days remaining to expire or how many days ago it expired, and the actual expiry date. The app generates notifications for the soon-expiring items by calculating the date difference between the expiry date and the current date.



(a) (b)

Figure 5: Screenshot of the smartphone app: (a) Scanning of the QR code printed on the receipt. (b) List of items that are going to expire or already expired;



(a) (b)

Figure 6: (a) Screenshot of the Google calendar app showing the expiring items; (b) Google Home can tell the expiring item names and dates when the voice command is issued.

The smartphone app updates the customer calendar with the expiring item names and dates, as shown in Fig. 6(a). After the calendar is updated, Google Home, as shown in Fig. 6(b) can say the calendar events. For instance, when the custom command of "*OK Google, smart expiry*", is said on April 15th - it replied, "*there are 3 entries; tomorrow at 9 am, you have milk expiring; on Wednesday at 9 am, you have tomato soup expiring; Thursday at 9 am, you have coconut water expiring*".

V. CONCLUSION

In this paper, a state-of-the-art cloud-based, Google Home accessible smart expiry system is proposed. In the proposed system, the expiry dates are automatically downloaded to the customer's smartphone just by scanning a single QR code, and expiring items can be accessed using Google Home using voice command. Future work includes making the smartphone app for the iOS platform and interfacing with Amazon Echo.

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