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Searching Halal Food Information from Distributed Databases: An Architecture of a Barcode Scanning Application using Smartphones

Mohd. Nur Faiz Abd Razak and Norliza Katuk
School of Computing, University Utara Malaysia, Kedah, Malaysia

Abstract: This study presents the architecture of a mobile application that accesses information from external databases. The application is intended for users in Malaysia to search halal information of food products by scanning the product barcode using their smartphone camera. Currently, the users use a mobile application provided by the Halal authority for this purpose. The application performs text-based searching according to the product names supplied by the users. The major limitation of the application is the accuracy of the user's searching key words due to input errors. This limitation can be improved by automatically scanning of product barcode using smartphone camera. Unfortunately, the product barcode information is not available in the Halal authority's database. Hence, the barcode information must be obtained from external databases and a link should be made to the Halal authority database. In designing the architecture, the Attribute-Driven Design method was adapted. The features of the other existing applications in the world were studied to identify the attributes that could improve the current application. The output of this method is the architectural design of the application that shows the components and communication flow between them.

Key words: Product barcode, halal food, information seeking, mobile computing, design, application

INTRODUCTION

The advances in Information and Communication Technology (ICT) has made smartphones affordable for many users around the world. Further, it also promotes a new paradigm called "mobile computing" where users use mobile devices instead of wired desktop computers to perform various tasks (Sarrab *et al*., 2013; Sanchez *et al*., 2014; Shahzad *et al*., 2013). Smartphones also come with interesting features such as touch screen, Global Positioning Systems (GPS) and digital camera. The digital camera performs an additional function rather than just taking photos and videos. Current research reported that the camera could be used as a scanning device for product barcode (Son and Shin, 2015; Seo and Park, 2016; Hoonlor *et al*., 2015). It is a cheaper solution for consumers who would like to access information about food products from the supermarket shelves instantly.

Many mobile applications have been developed to help consumers to access information by scanning the product barcode. Consumers look for information on the ingredients to suit their diet needs. For example, diabetic consumers look for the ingredients to know the sugar content. In spite the health need, consumers are also restricted to religious diets such as Muslim and Hindu. Muslim consumers consume "halal" food where the ingredients of the food must be of the permissible items and prepared in a clean environment.

In Malaysia, information on the halal status of food products is mainly provided by a special government agency named Department of Islamic Development Malaysia (JAKIM). Users can search the information directly from the portal or download the mobile native application and install it on their smartphones.

The application provided by JAKIM (http://www.halal.gov.my) requires users to type the product name for searching its halal status. It performs text-based searching according to the product names supplied by the users. The major limitation of the application is the accuracy of the user's searching key words. Some users are unable to provide the correct spelling of the product names which return incorrect or null results from the database.

Recent development shows that the use of smartphone camera for scanning barcode can provide higher accuracy despite giving faster results (Bodnar and Nyul, 2013). However, the product barcode information is no longer being collected by JAKIM since, 2011 as many local manufacturers do not have the barcode for their products due to expensive fees for obtaining the barcode. Hence, the barcode information must be obtained from external databases and a connection should be made to the existing JAKIM database. It will allow users to use their smartphone camera to scan the product barcode and obtain the halal information about the product instantly.

Corresponding Author: Norliza Katuk, School of Computing, University Utara Malaysia, Kedah, Malaysia

This study presents the architecture of a mobile application that allows users in Malaysia to search halal information of food products by scanning the product barcode using their smartphone camera. The study focuses on the components and architecture of the application, particularly the distributed databases for obtaining barcode information for verifying the halal status of the food product.

Literature review: Mobile applications (or simply apps) are the most important application software run on a smartphone. Users download a variety of mobile applications with various functions and purposes including communication, networking, entertainment, banking and self-wellbeing. Generally, mobile applications appeared in two forms mobile web and mobile native applications. Mobile web applications allow users to access the application through the smartphone's web browser. On the other hand, the mobile native applications are downloaded and installed in the device storage. Users simply touch the icon and the application will run immediately. Both types of approach have its advantages. The mobile web is platform-independent where the applications can run regardless the operating systems used by the devices (e.g., IOS Android and Window). Meanwhile, the native mobile applications provide faster access to the data and content compared to the mobile web applications.

In the context of searching information about food ingredients, there are many mobile applications ready for users to download. They include a mobile application provided by JAKIM for Muslim in Malaysia. The native mobile application has a few other functions. However, the one that provides halal information on a food product is called as "Direktori Halal" (Halal Directory; the application renders information in the Malay language). Figure 1 and 2 show the main menu of the application and the searching function for the "Direktori Halal", respectively. Figure 3 shows the example of the searching result. This application runs on an Android-based smartphone.

JAKIM's effort in providing halal information to the consumers in Malaysia is tremendous. It allows the Muslim to check the halal status of the food products using their smartphones. Consumers need to identify the product name by looking at the product cover. Then, they must type the product name in the searching textbox and press the "Carian" button. Depending on the accuracy of the product name, the application will list the product in the result. If the consumers supplied the product name that is similar as stored in the database, only one result of product name would be rendered. Otherwise, a list of the product will be displayed. Consumers must filter and

Fig. 1: The main menu for the JAKIM application

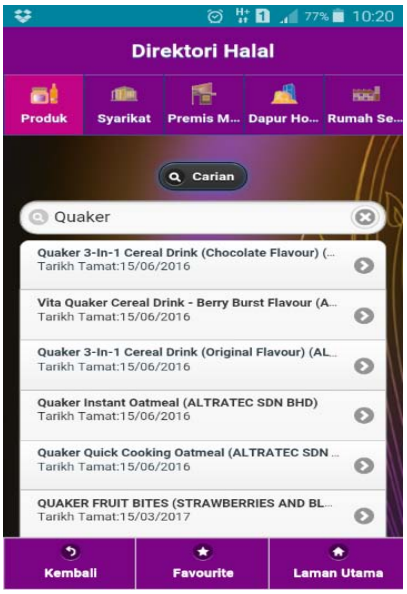

Fig. 2: Searching menu in the "Direktori Halal"

choose the product that matches their searching. Then, they have to press the button to view the validity of the halal certificate.

The searching task is simple and it returns faster result. However, when the consumers did not supply the correct product name, the searching will provide incorrect results. We performed a simple searching task based on a randomly selected product. The description and the output are explained in Table 1. A random product that is commonly consumed by Malaysian consumers was

Fig. 3: Example of the searching result

chosen and known to be Halal-certified by JAKIM. We checked the product name and its spelling from the manufacture's website. Then, we use the JAKIM app to search for the halal status of the product. We used three different ways of spelling the product name that possibly being chosen by the consumers. The searching result returned an alert message (No information in the list) if the consumers supplied the incorrect product name (as the first and second attempts stated in Table 1).

In reality, the consumers may provide different spellings of the product name based on what they see on the cover. If they supplied the incorrect spelling of the product name, the JAKIM application will return the result stating that the product name was not on the list. Users may think that the product is not Halal-certified by JAKIM and decided not to consumed it. In the same case, if the halal logo is printed on the product cover, the consumers may assume that the manufacturer used a fake halal logo.

The above scenario suggests that a little improvement to the input mechanism of the app is needed. Using the smartphone's soft keyboard, the users may subject to text-entry errors (Nicolau and Jorge, 2012) such as wrongly spell the product name or use an incorrect combination of the product name (a spelling that includes the brand as well). Hence, an automated mechanism that minimizes user's input is required. It can be materialized by using the smartphone camera as a barcode scanning device for searching the halal status of the food product.

Table 1: Searching tasks using "Direktori Halal"

Features	Description
Photo of the product (Downloaded from http://www.nestle.com.my/brands/milk/everyday	
Product name as in the manufacturer website	Every day
The key word for the first attempt of searching	Nestle every day
The result of the first attempt of searching	"Maklumat Tiada Dalam Senarai" (No information in the list)
The key word for the second attempt of searching	Every day (as the spelling in the product cover)
The result of the first attempt of searching	"Maklumat Tiada Dalam Senarai" (No information in the list)
The key word for the third attempt of searching	Every day
The result of the third attempt of searching	List of 19 products (The result appeared in number 13 of the list)

As stated in the earlier part of this study, implementation of this mechanism requires the developers to address the issue on the unavailable barcode database. Hence, the next section describes the method that we applied to model the improve version of JAKIM Direktori Halal.

MATERIALS AND METHODS

We perform the Attribute-Driven Design method (Bachmann and Bass, 2001; Nord and Tomayko, 2006); a software architecture-centric method for designing the software architecture. It has three stages decomposition of the system functions, identification of possible physical network configurations and allocation of the functional units to processors. All these three activities were conducted by analyzing the existing applications including the one provided by JAKIM and other applications that use smartphone cameras as an imaging device. The output or this method is the architectural design of the application with improved quality attributes.

RESULTS AND DISCUSSION

This study describes the architecture of the barcode scanning application for searching halal information of

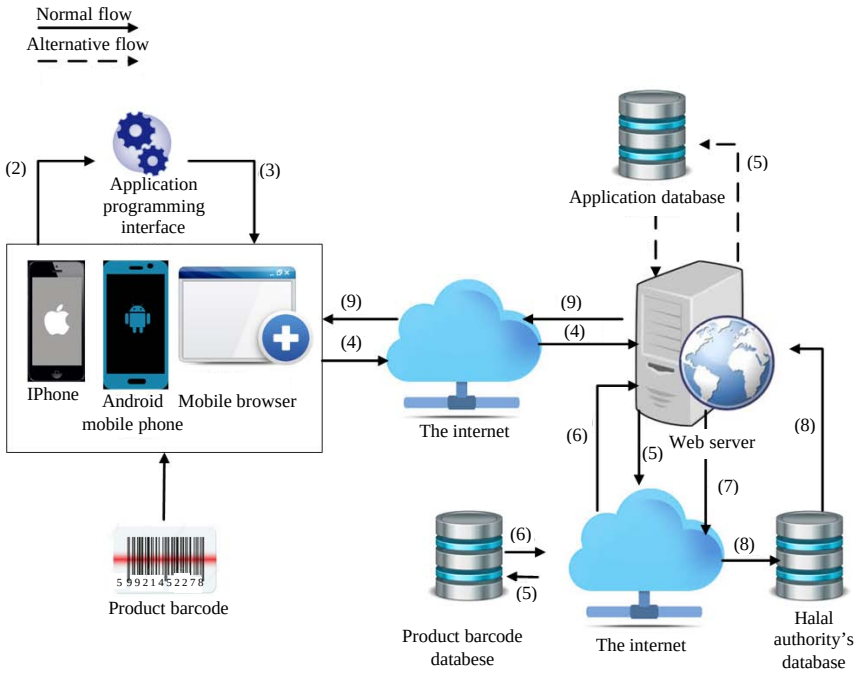

Fig. 4: The architecture of the proposed application

food product at the supermarket shelves. Figure 4 illustrates the components and their flow of interactions. As described earlier, the main attribute of the architecture is the communication between the server and other external databases to obtain different information about food products.

From Fig. 4, the main components of the architecture are smartphones, barcode API, web server, application database, product barcode database and Halal authority's database. A smartphone is a client machine that is used by the consumers or users to interact with the system. The smartphone could either run the Android or IOS. Computer tablet is also considered as a client. The smartphone should use the Application Programming Interface (API) to allow the system to detect and scan the product barcode and convert the image to barcode data. The web server hosts the websites and the copy of the mobile app for users to download it. The web server also holds a database that stores product information and user's profile. The admin can store a complete record of product at the local database. There are two external databases that the web server will contact. The product database is a global and common database that stores product information such as name, manufacturer, brand, barcode. The other database belongs to the Halal Authority that contains halal information about a particular product. From the network architectural perspective, the proposed app has the multi-tier client-server architecture.

The communication of the components in the architecture is numbered in the following order (Fig. 4): a user uses the app and scans the product barcode; The app in the smartphone device will call the API; The API convert the barcode image into the product code; The app in the smartphone sends the product code to the server through the network.

The server will check the local database if the code is already stored (represented by dotted line). If not, the server will contact the product database and send the product code to get the product name, brand and manufacturer; If the product is already stored in the database, then it returns the product name to the server (represented by the dotted line). If the server communicates with the product barcode database, it will return the product name, brand and manufacturer.

The server will contact the Halal authority database and query for the halal information of the product; The Halal authority database will return the halal information about the product if the information is available. Otherwise, it simply returns a simple message notifying the users that the product name is not in the database. The server returns the searching results to the smartphones.

In terms of functionality, a use case diagram in Fig. 5 shows the actors and the use cases. The users can scan product barcodes and set their language preferences. The app also has an additional actor that is the admin of the

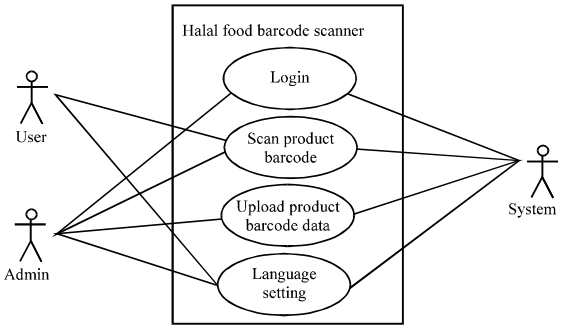

Fig. 5: The use case diagram for the proposed application

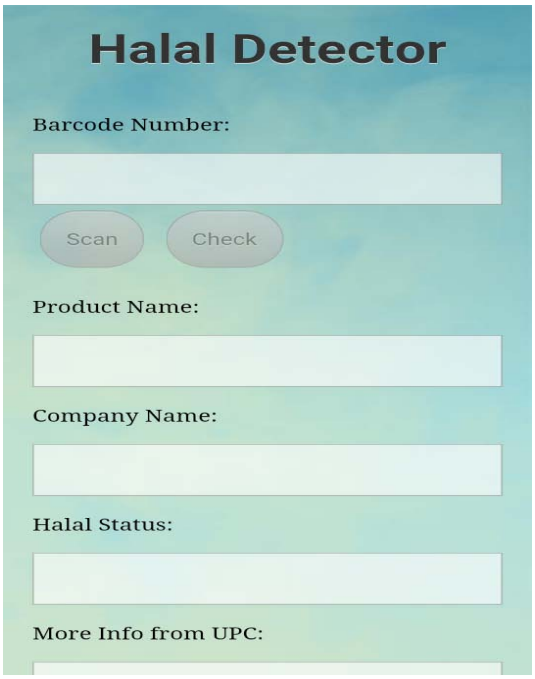

Fig. 6: The main interface for Halal detector

system. The admin can login to the system, scan product barcode, upload product barcode data to the server and set the language preference.

A prototype of the app was also developed to demonstrate the attributes that we proposed in the architecture. Figure 6 shows the screenshot of the mobile app for searching halal information of the food product called Halal detector. Users or consumers must download the app from the website and install it on the smartphone. Once users run the app, the smartphone camera will be activated and ready to scan food product barcode. When the barcode is detected, the app automatically scans and search the information from the databases. The result will be displayed in the text fields. The searching process for the app depends on the speed of the network and communication procedure with the external databases.

CONCLUSION

This study explains the architecture of a mobile application for searching halal information of food product from distributed databases using the product barcode. Muslim consumers in Malaysia search halal information about food product using an app that is provided by the Halal authority in the country. The searching process was done using product name, where it could lead to null results due to incorrect spelling. With the rapid growing of smartphones market, there is an opportunity to use them as a scanning device of the product barcode. Unfortunately, the Halal authority database did not provide information on the product barcode. Hence, the product barcode must be obtained from an external database. Therefore, we designed the architecture and presented the components of it and their communication flow. A prototype was also developed to demonstrate the functionality and the communication. Currently, we enhance the prototype for a full-blown app and conduct a usability study of it.

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