

A customizable wireless food ordering system with realtime customer feedback

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Abstract—The existence of wireless technology and the emergence of mobile devices enable a simple yet powerful infrastructure for business application. Some early efforts have been made to utilize both technologies in food ordering system implementations. However, the food ordering systems that have been proposed earlier exhibit limitations, primarily in cost effectiveness, allowing customizations and supporting real-time feedback to customers. In this paper, we discuss the design and implementation of a customizable wireless food ordering system with real-time customer feedback for a restaurant (CWOS-RTF). The CWOS-RTF enables restaurant owners to setup the system in wireless environment and update menu presentations easily. Smart phone has been integrated in the CWOS-RTF implementation to facilitate real-time communication between restaurant owners and customers. A preliminary testing suggests that the CWOS-RTF has the potential to eliminate the limitations of existing food ordering systems.

Keywords- smart phone; wireless food ordering system; mobile application

I. INTRODUCTION

Conventionally, information and communication technology (ICT) has been utilized to automate routine tasks in business transactions such as customer registration system, billing system, and inventory system. However, the evolution of wireless technology and the emergence of mobile devices have not only provided end users enjoyment in utilizing automated systems but also new ways to communicate information. In fact, the mobility and portability features of mobile devices have drawn researchers to establish a framework of mobile technology assessment in various e-commerce applications [1].

The convergence of wireless and mobile technologies can facilitate ubiquitous platform for implementing business applications such as food ordering system. Without any information and communication technology facilities, food ordering procedures require waiters to note orders from customers, bring orders to the kitchen, write receipts, and deliver the ordered menu. Although such routines look simple, the conventional food ordering system may significantly increase the work load of waiters or even prone to human errors in note making when the number of customers increases during peak hours. Some preliminary efforts have been made to

integrate mobile technology in automating the tasks of conventional food ordering system, such as in [2-4]. Essentially, the mobile device used in the existing food ordering systems was limited to personal digital assistants (PDAs). While PDAs are well-known for their portability features and capability to communicate with personal computers, there are some drawbacks to be addressed when they are used for food ordering tasks in restaurants. In brief, the PDA-based systems do not support ubiquitous communication, are exposed to health hazard, has lower hardware and GPU (graphical processing unit) capability and, are considerably more expensive for business to operate when a large quantity is needed. Furthermore, due to the hardware and GPU limitation, more intuitive interfaces, customization and real time communication cannot be easily done on PDA.

The rest of this paper is organized as follows. Section II reviews the existing PDA-based food ordering system, presents smart phone technology applications, and provides some background of food ordering system in a restaurant of our case study. The descriptions of CWOS-RTF architecture and system design are presented in Section III. Section IV presents the results and discussions of CWOS-RTF implementations. Finally, conclusions and future works are given in Section 5.

II. RELATED WORK

Some early efforts have been made to automate conventional food ordering processes using wireless technology, such as FIWOS [2], WOS [3], and iMenu[4]. Another PDA-based wireless food ordering system is by Color by the Bay (CBTB), Singapore. Using 8 access points, customers at CBTB can make order via a given PDA from participating restaurants or pot luck (multiple food hawkers under one management). These wireless food ordering systems enable customers or waiters to key in order using mobile devices, namely, personal digital assistants (PDAs). When a customer or waiter completes the ordering process, the order details will be sent to the server from the PDA. The PDAs used by a customer are to be collected by the waiters to be used by other customers. PDAs are preferable in the systems implementations because PDAs are small devices that make them easy to handle and portable [2-3, 5]. Besides that, with wireless technology, communication between PDAs and servers can be made

feasible and indeed, PDAs are capable to access information remotely [2-3, 6]. CBTB, iMenu, WOS and FIWOS are seen as solutions to solve the problems in taking orders using pen and paper, however, these PDAs based systems are prone to some limitations as follows:

- Restaurant owners have to prepare enough number of PDAs to accommodate the number of customers to be served especially during peak hours [7]. This may increase the restaurant expenditures. Furthermore, during peak hours, if PDAs are to be operated continuously, recharging the batteries would be a challenge [2].
- The PDAs are to be shared with public customers. Therefore, if a customer with infected disease, such as flu, uses a PDA, another customer may be exposed to similar health problem.
- Customers are required to be present physically to make order using the PDA-based system [7]. Thus, customers have no alternatives to make early order before coming to the restaurant. This implies that customers have to accommodate waiting time for food preparation.
- The PDAs based systems are not supporting real-time feedback between restaurant owners and customers. This is because the systems allow customers to send ordering details only using the PDA. Thus, customers are not provided with their order status feedback and billing details.
- The existing systems are not easily customized according to restaurant owners' needs. Technical knowledge is acquired for the restaurant owners to update or modify menu information.
- The screen design for the menu selection on the PDAs are limited to textual information and buttons only [8]. The lacked of images has made the user interface unattractive and uninformative.

Focusing on the described limitations, we proposed to implement a customizable wireless food ordering system with real-time customer feedback using smart phone (CWOS-RTF).

Smart phone is a result of converging two mobile technologies, namely cell phones and PDAs [9]. Smart phones are extremely popular and have revolutionized the use of mobile technology to support automation of routine tasks in wireless environment [9]. Indeed, smart phone technologies have been viewed as an essential device to support telemedicine services for various health problems, such as diabetes, blood coagulation, and urinary incontinence [10]. There are a substantial number of smart phone applications in existence for healthcare purposes, such as monitoring medicine intake [11], detecting heart failure [12], and confronting obesity challenges [13-15]. In [11], the system called Wedjat is used to issue reminders to patients, inform medicine intake directions, and record time of medicine in-take. Essentially, Wedjat combines telemonitoring techniques with real-time scheduling algorithms to allow ubiquitous services to patients using smart phone. PmEB in [15] helps users to track real-time

calorie balance. ChickClique [14] utilizes smart phone as a means to motivate exercises among female youngsters. TripleBeat [13] applies musical feedback to assist runners in achieving predefined exercise targets.

Besides these health related applications, smartphone's hardware and graphic capability has been leveraged to control electrical devices such as television, microwave, motion detector and video cameras in home automation and security application[16]. Moreover, machine vision is integrated into smartphone to recognize traffic signage in road safety[17], Disaster Alert System is yet another smartphone application that can provide effective counter measures in disaster situations [18]. Notice that hardware and graphic processing demand required by such application is readily available in smartphone.

Motivated by the usage of smart phone technology in healthcare and other applications, this paper presents a development of smart phone technology in a business application, namely food ordering system to be used in restaurants. To demonstrate the functionalities of the proposed system, we have chosen a restaurant near to our campus, namely City Corner Restaurant as our case study. Here we present some routine tasks of food ordering system at City Corner. Waiters of City Corner Restaurant take note on customer orders using pen and papers. Such conventional systems are prone to human errors. Orders can easily be misplaced or wrongly noted especially during busy dining hours. Receipts are also produced in written forms. Consequently, such records are more difficult to be kept and cause hassle whenever they need to be retrieved for future reference. Thus, the objectives of our proposed system are:

- To automate food ordering system at City Corner Restaurant that can eliminate or at least minimize the current problems in conventional system.
- To utilize wireless communication and smart phone technology in implementing the automated system.
- To facilitate more intuitive interfaces and customization for the restaurant owner to update the menu content on the customer devices.
- To enable real-time feedback between the restaurant owner and customers on the order status.

In the next section, we will present the description of the proposed system, CWOS-RTF.

III. THE CWOS-RTF SYSTEM

A. System Architecture

Figure 1 shows the system architecture of CWOS-RTF, which cover three main areas of the restaurant: the serving area, the restaurant owner's working desk (cashier table), and the kitchen. Conceptually, the CWOS-RTF are built on four main components:

- the mobile *application* on the smart phones *for customers* to make order

- the web-based *application* and server on the laptop for *restaurant owner* to keep track and respond to received customers' orders, and customize menu information.
- the *database* for restaurant owner to store order details, and updated menu information.
- The *wireless infrastructure* to support networked communications.

Essentially, the system architecture promotes portability, as the setting up can easily accommodate all kinds of restaurants, including the ones without Internet access. As the size of a restaurant increases, access point relays can always be added.

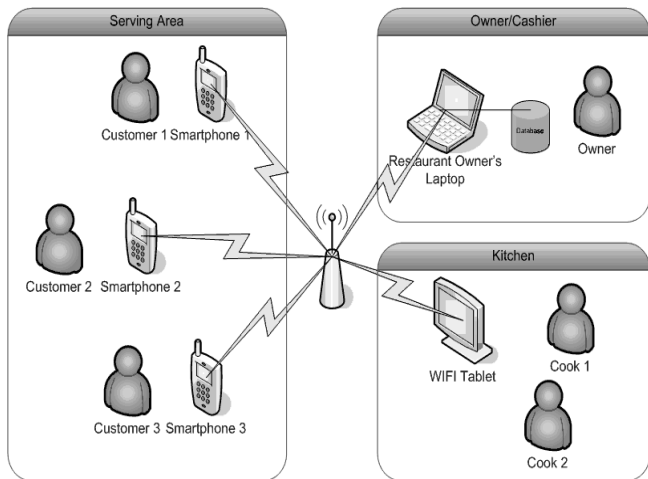


Figure 1. The system architecture of CWOS-RTF without Internet access

Alternatively, Figure 2 shows a setting up of the system that allows access to the server via Internet access. While Figure 1 limits the access of the system from the vicinity of the restaurant, Figure 2 provides the flexibility for the customers to make order prior to their arrival to the restaurant.

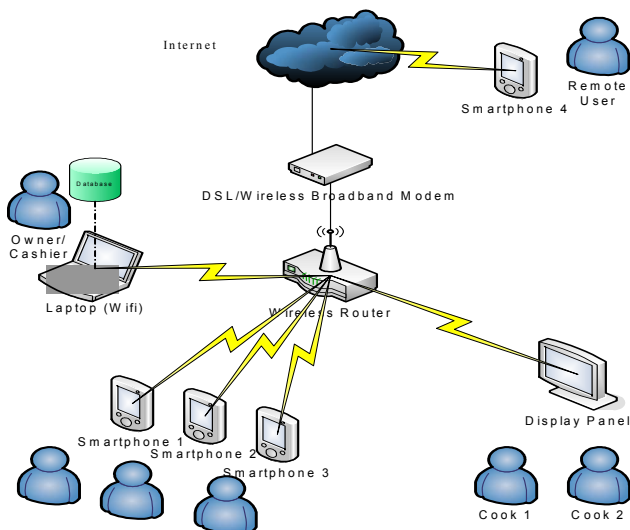


Figure 2. The system architecture of CWOS-RTF with Internet access

The system allows customers to order their food while they are still at their workplace, and decide to come once they are notified about completion of the order. Thus, customers can save time from waiting for the food to be prepared.

B. The System Design

In this section, we illustrate the system requirements using context diagram (CD) and entity relationship diagram (ERD). Due to space limitation, we only show the CD and ERD of CWOS-RTF without its detail data flow diagram (DFD). We have established CD of CWOS-RTF shown in Figure 3 to aid in determining the flow of the data throughout the system. Note that customer has to register prior to making order so that the system can assign identification number to the ordered menu. The CWOS-RTF will receive customer information and menu choices. The restaurant owner will receive the list of ordered menu from the system. The restaurant owner then can input feedback using the system to update the order status to the customer. Besides giving feedback to the customer, the restaurant owner can also use the system to update menu information and advertise promotion strategies.

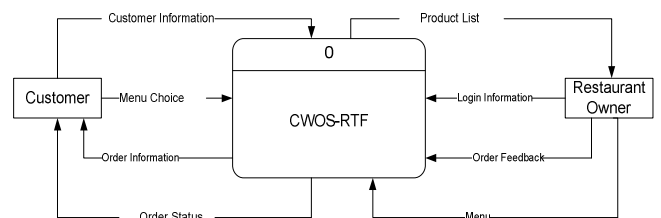


Figure 3. Context diagram of CWOS-RTF

Then we have also developed the ERD of CWOS-RTF as shown in Figure 4 to determine the entities of the system and their corresponding properties. The ERD is also useful to demonstrate relationships between the entities. In Figure 4, one customer is allowed to make order as many as they like. Each order is possibly consist of several menu selections. The restaurant owner may have to update the menu content. Each menu is grouped under category_id of food, cold drink, hot drink, and desserts.

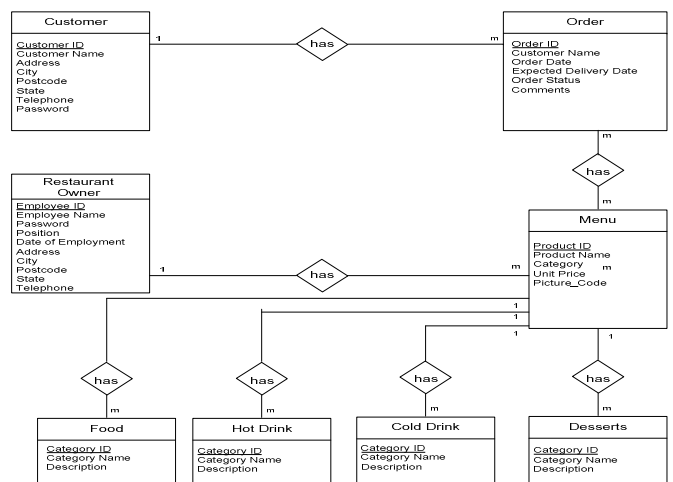


Figure 4. The ERD of CWOS-RTF

Once we have established CD, DFD, and ERD of CWOS-RTF, we designed the following components of the system:

- The sketch of user interface for the mobile application to aid customer to make order.
- The sketch of user interface to support feedback communication from restaurant owner to customer.

In the next section, we present the designed system with descriptions of the actual interfaces and flow of processes throughout the system.

IV. RESULTS AND DISCUSSION

A. User Interface for the Customer

The CWOS-RTF has been developed using both programming languages, ASP.Net and VB.Net. The database of the system has been designed using Microsoft Access 2008. This section presents the interfaces of the system according to sequence of ordering procedure specified for the CWOS-RTF. Figure 5 shows the login interface on smart phone of a customer. Upon log in, the customer can make selections from a list of menu images with labels as shown in Figure 6. Notice that a new layer of tabs for hot and cold drinks are shown when the drink tab is clicked. The user can freely navigate the choices of food, drink and dessert by using the tab and vertical scrolling.

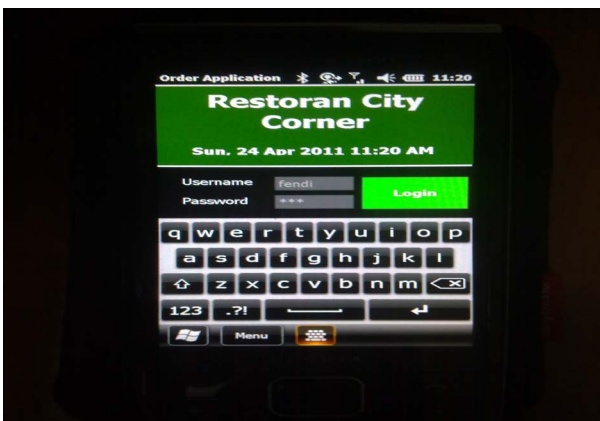


Figure 5. Customer login interface on smart phone



Figure 6. A list of menu images and labels on customer smart phone

The menu that has been selected will be listed together with its quantity and price as shown in Figure 7. The customer can still update the quantity for each menu that has been selected on this screen. The customer can also choose the item that they want to cancel. For each order, the customer can specify the required delivery date and time.

Once, the customer feel satisfied with the list in Figure 7, he or she can click Order Now button. The customer then can check the status of their order by clicking the Record button and a screen of the order details and order status will be shown like in Figure 8.



Figure 7. A list of menu that has been selected by a customer

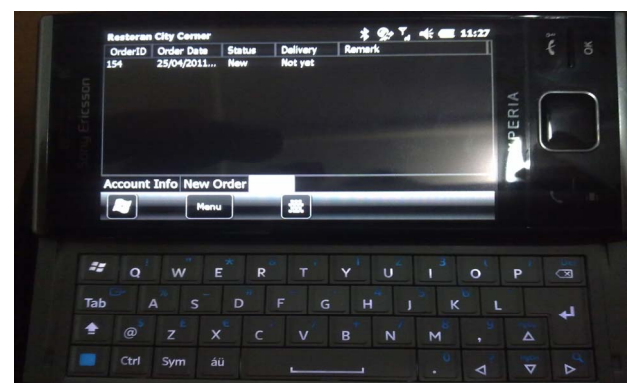


Figure 8. A screen to display feedback of the order status

B. User Interface for the Restaurant Owner

After the owner logs in, a screen with a set of functions, labeled on clickable tabs, will be displayed such as Customer, Product List, Add Product, and Orders. Customer tab is used to verify new customer that would like to make order and update existing customers' details such as changing of address and contact number. Product List tab is used to view existing menu in the list and delete any discontinued menu as shown in Figure 9.

Add Product tab is used to add new menu with its corresponding image, price, and product category as shown in Figure 10. Orders tab is used to view list of ordered menu sent by the customers, and to send feedback to the customers on their order status such as Accepted, Delivered, Not Yet as

shown in Figure 11. Figure 12 shows a receipt generated from the system to be sent to a customer's smart phone. The details of the transaction were kept in the database for future reference.

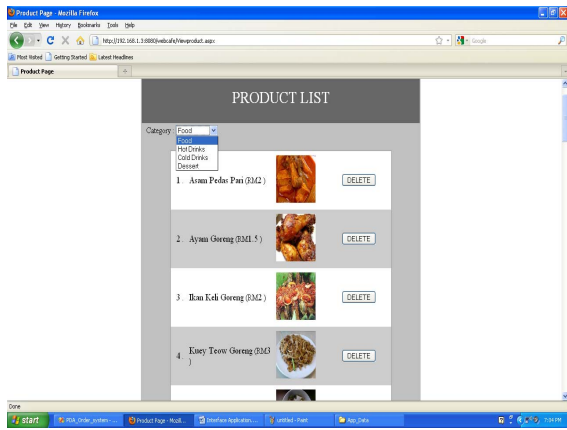


Figure 9. A product list screen that facilitates deletion of discontinuing menu.

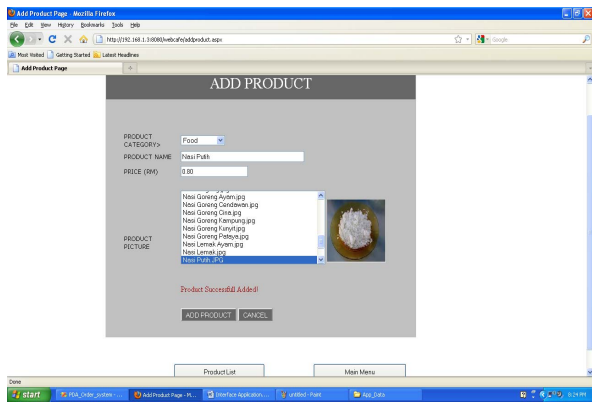


Figure 10. Add Product screen that allows insertion of new menu and its details

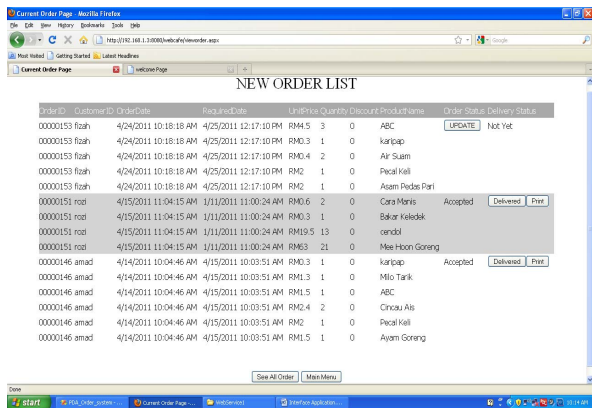


Figure 11. A list of order details sent by the customers

C. Database Queries

The database of the system is located at the restaurant owner's machine. As the restaurant business is relatively small compare to corporate organizations, thus we believe the current choice of database is suitable with the expected load. We have

established the database for storing order details, customer information, and menu information. Some queries are established within the system to allow the users to access requested information from the database.

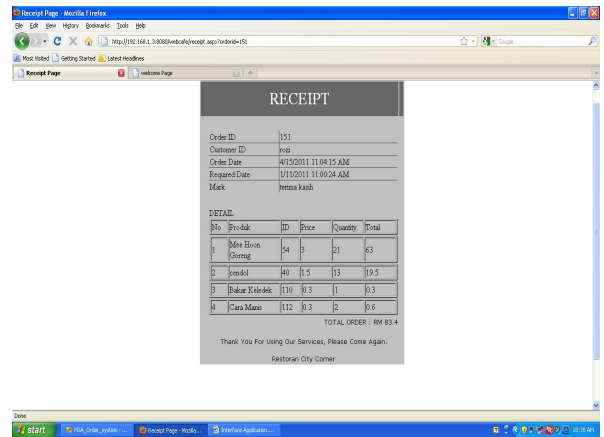


Figure 12. A screen of a customer receipt that is generated to be sent to customer's smart phone

D. System Testing

We have evaluated the performance of CWOS-RTF by running several system and user testing procedures. The functions tested in Table 1 were successful as the results produced meet our expectations.

Table 1. System requirement testing result

Test Module	Expected Result	Actual Result
Add data to the database	Input validation (eg. only integer value accepted)	Successful
	Ensuring all required information are filled before saving into the database	Successful
Delete data from the database	Delete only intended information.	Successful
Update entries in the database	Update only the intended entries.	Successful
Linking between interfaces	Information from one interface can be forwarded to the next interface.	Successful
Run mathematical calculations on input read from an interface	Able to execute mathematical calculation on input read from an interface	Successful
Report generation	Generate report on the smart phone as well as owner's computer, including receipts.	Successful
Performance	All interfaces are fully displayed within less than 3 seconds.	Successful

We have also tested the system with the customers of City Corner Restaurant which primarily consists of UTHM staff and students. Questionnaires which test on the following criteria were distributed (scaled from 1 as totally disagree to 5 as excellent):

- User-friendly interface design – easy to understand and interact with the system
- Easy to make order – anytime, anywhere
- Successful in sending order
- Simplify ordering process – save time as order can be made prior to arriving at the restaurant

There were 43 respondents involved in the evaluation phase of the system. About 91% of the respondents rated each item as Good (scale = 4) to Excellent (scale = 5). The percentage implies positive acceptance among the customers. We have also received positive feedback from the owner of City Corner Restaurant such as the system is sufficient to facilitate monitoring of customer order and updating menu information.

CWOS-RTF demonstrates the feasibility of using wireless communication and smart phone technology to meet food ordering system specifications. The menu information can easily be customized, prices of the menu item can be updated, and ordering status can be informed to customers in real-time manner. The system also facilitates receipts generation.

It appears that for food ordering system in restaurant, a low cost, medium range database system like MS Access is sufficient enough to accommodate storage and queries of data. The accessibility is fast enough from both, customers' applications as well as from restaurant owners' applications. Furthermore, the system architecture makes CWOS-RTF expandable by simply adding WIFI relay access point.

V. CONCLUSION

In this paper, we have presented a customizable wireless food ordering system with real-time feedback to customers. Instead of using PDAs to interface with customers, we leverage smart phones to provide necessary interfaces for customer to view and order menu. With private login system, customers can view and make order and receive updates in real-time and collect receipts right from the smart phone itself. It allows restaurant owners to manage orders from customers instantaneously whenever he or she logged in into the system. Our experience in developing CWOS-RTF shows the capabilities of wireless communication and smart phone technology in fulfilling and improving business management and service delivery.

In the next phase, we will run CWOS-RTF on more restaurants and customers to report on their acceptance. Although current interface (New Order List) can be used by the staff in the kitchen, the system can be further enhanced by adding inventory management module for the kitchen staff. Besides this, a module for remote delivery can be added for bigger customer coverage. Finally, the system can be extended to register and link multiple restaurants for more food and beverage varieties to the customers.

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