Project Title
Mobile Discount Directory - Google Map's Mobile Application

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ABSTRACT

Digital map is useful and helpful media to display world’s geographical information. The mature development of the wireless network technology and the widespread of Global Positioning System (GPS) promote the growth of mobile map’s application and enhancement of the application performance. These features allow the mobile users search for the scenery spots, entertainments locations and restaurants information with the digital map. The innovative development attracts verities of map application derived.

This report studies several popular websites, which are related to the use of the digital map like openrice.com, navimap.com.hk and some newly launched mobile map’s applications. Learning from the advantages and addressing the limitations from these applications, this report presents a new mobile application — Mobile Discount Directory with the use of Global Positioning System to find discount, coupons and promotion information, which surround user’s current location.

Mobile Discount Directory supports several automatic functions like auto discount searching and systematic coupons clipping function. Mobile device users may bookmark their favorite shops and save their favorite coupons via the personalized services. Apart from these personalized and easy-to-use functions, the application also supports intelligent features like destination directing function and notification function. This application is well-balanced in functionality and battery consumption, together with a quick response time controlling. Using this application, mobile device users can present the digital coupons at the point of purchase or meals. It brings convenient to users and helps them consume intelligently.
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1 INTRODUCTION

In the age of information outbreak and technological advancements, location-awareness becomes a landmark in the modern communications network. Mobile phones and the Internet have transformed the communication methods and the lifestyle of people. Digital map is one of the very useful media to show spatial information. It is a tool which provides geographic location information for users. With the real-time Global Positioning System and digital map product, users can find their place and search for the geographical information conveniently.

1.1 Background

An increasing number of mobile phones promotes people to access the wireless connection anywhere. A study of the Internet use has been conducted with 1,461 residents between 18 and 74 in Hong Kong, by the Department of Media & Communication, (Zhu, 2009). They discovered a continuous increase in the adoption of wireless connection from 8% in 2006 to 22% in 2008, as shown in table 1.1a.

Fig 1.1a  Use of Wireless Connection to the Internet

Data Source: HK Inter Project 2000-2008 (Internet use in Hong Kong: 2008 annual survey report)
The studies also reported that the wireless connection was the second most popular method of accessing the Internet in 2008. (See Fig 1.1b)

**Fig 1.1b** Methods of Internet Connection (Multiple selections permitted)

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<th>Methods</th>
<th>2007</th>
<th>2008</th>
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<td>Broadband</td>
<td>76%</td>
<td>82%</td>
</tr>
<tr>
<td>Wireless (including WLAN, GPRS, WAP, EDGE, 3G and HSDPA)</td>
<td>20%</td>
<td>22%</td>
</tr>
<tr>
<td>Cable Modem</td>
<td>8%</td>
<td>14%</td>
</tr>
<tr>
<td>Telephone dialup</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Data Source: HK Inter Project 2000-2008 (Internet use in Hong Kong: 2008 annual survey report)

Some of the cyber users surf the Internet for fun, some for work, even some of them are for saving money! In recent years, there is an increasing number of websites available for Internet users to browse through the online advertisements, download and print the coupons or promotion leaflets.

The possible reason contributing to this phenomenon is likely to be more and more companies are trend to use Internet, which is a cost-effective and effective way to promote their products and services. As a consequence, the volume of the sales boots boost accordingly. Some examples like Openrice.com, getjetso.com and couponsuperstore.com are quite popular in Hong Kong. The consumers, then, search for the coupons in the Internet and share the information with friends via emails or text messages.
Scarborough Research analyzed the Internet coupons' usage and reported it had grown 83 Percent since 2005 (Romano, 2008). A number of studies about Internet coupons also show that online coupon campaigns had clear and valuable positive effects on consumer purchasing behavior (Romano, 2008). The research also reported that more than 8.6 million households get coupons via text message or email (Mongrian, 2008). BIGResearch examined the consumers’ consumption behaviors, the results showed that 35 percent of consumers are persuaded by coupons (Thornquist, 2009). Rather than the limits of a paper coupon, e-coupons are delivered across Internet and grant a channel for business cooperation to encourage consumers to consume in an efficient way. E-coupons do reach more consumers than the traditional offline counterparts.

1.2 Online Coupon Campaign

It is true that the existing websites providing the coupons or promotion details make people notice about the latest information. Users are likely to surf the internet for promotion leaflets and coupons that they are interested in. However, some information may not be useful to people if we are not able to extract suitable information from a list of promotion advertisements or coupons.

1.2.1 Limitation of Online Coupons Searching

Most of the coupon websites allow users to search for the coupons in particular districts. It is time-consuming for the Internet browsers to glance over all the coupons in certain districts and find out those can be used somewhere nearby. Some of the users may want to narrow down the searching criteria from a district to a street or a shopping mall which is close to their current place. Nevertheless, it seems that the online coupon websites failed to offer these kinds of service. An online coupon website named Coupon Super Store provides a list site for the users to select their preference. In fact, most of the online coupon websites provide the mobile version for mobile users to browse through the website, but they seldom integrate the website with the Global Positioning System, which limit the way of searching coupons.
1.2.2 Lacking in Personalized Services

The ways of searching promotions or coupons are restricted to the user input, like “KFC”, “Pizza Hut” and “I.T. etc. This searching method hinders the effectiveness of coupons searching. Every time the Internet users want to find their favorite vendors’ promotions or coupons, they need to type in the keywords to do searching. Sometimes, they may miss out the sales or promotions in certain boutiques, restaurants or shopping malls, which are positioned closely to their current location. They may feel disappointed because of missing the chance to show the coupons and enjoy the discount at the point of consume.

1.2.3 Absence in Coupons Clipping Function

Many people browse through the coupons or promotions via the website or their mailbox for saving money when they go shopping or dinner. Nevertheless, the online websites rarely provide the bookmark service. Although some of the online coupon websites provide a channel for users to save the promotion leaflets or print out the coupons, Internet users still miss a service to organize their coupons. A lack of coupons clipping services brings inconvenience to the consumers. What they need is a well-organized page or application to clip their coupons and access to the coupons at the point of purchase or meals.

1.2.4 Lacking in Coupons’ Issue Date Reminder

Most of the online websites failed to provide a reminding service to inform the users about the coupons’ date of issue. Users may miss the chance to enjoy the privilege provided in the coupons.

To conclude, most of the online coupon websites are not providing comprehensive functions for internet users. Even some of the websites offer mobile version web page for mobile user to view the web information; they seldom integrate the mobile website with the Global Positioning System, which limit the way of searching coupons.
1.3 Approach to Solve the Problem

This report studies and examines some existing mobile applications and websites about coupons searching and promotion information. By combining and enhancing those applications, this report proposes an approach to search coupons and promotions. Based on the mobile users’ geographical location provided by Global Positioning System (GPS) and with the help of Geographical Information System (GIS), the mobile application provides the mobile phone clients a digital map, Google Maps API (Google Inc. 2005) to view their current position and the vendors’ promotions or coupon campaigns nearby with easy search option.

The Global Positioning System is a space-based navigation and time transfer system developed by the U.S. Department of Defense for military uses (Enge 1994). This technology was made available for civilians in the 1980s (Nalk 2009). The satellite-based Global Positioning System provides accurate location to mobile phone users worldwide. The aim of this report is to suggest a mobile application which adopts the Global Positioning System (GPS) and Geographical Information System (GIS) to facilitate map reading and location finding. With this intelligent application, users can browse through the coupons on the map in a convenient way.

Section 2 of the report studies the limitations of the existing mobile applications and the online coupon websites, and states the solutions to address them. Section 3 briefly outlines the structure of the application. Section 4 focuses on the design and implementation of the application and section 5 shows the results of the application and explains how it can be used. Following that, section 6 discusses the performance of the application. Finally, the last section summarizes the report.
2 LITERATURE REVIEW

Mobile map application provides human a convenient way to view the geographical information. In the temporary age, people typically keep their phone handy for answering calls, sharing information and checking location. It is no doubt that mobile map application is a prevalent and useful application for point of interest to do research. This section reviews some technical related terminologies and studies on some related researches.

2.1 Technical Review

2.1.1 Mobile Computing

Mobile computing was born in the early 1990's with the advent of full-function laptop computers and wireless LANs (Garlan, 2002). Mobile Computing is a general term used to describe technologies that enable end-users to access network services anyplace, anytime, and anywhere. Information access via a mobile device is plagued by lower available bandwidth, unpredictable network quality, and poor security (Stevenson, 2002). Unlike their wired counterparts, design of software for mobile devices must consider resource limitation, battery power and display size. But still, mobile computing is a very active. Mobile computing supports mobile applications, which reduce duplication of data inputs and provide instant information just-in-time. It is becoming de-facto standard for any IT infrastructure in the current and future system designs.

2.1.2 Google Phone – Android

Android is a mobile operating system that uses a modified version of the Linux kernel (Linux, 1991 and Kroah-Hartman, 2010). Android allows developers to develop code in the Java language (Sun Microsystems, 1990), controlling the device via Google-developed Java libraries (Shankland, 2007). Android provides an open development platform and offers developers the ability to build innovative applications. Developers take the advantage of the device to access location information, run background services, set notifications to the status bar, etc. The application framework is designed for simply reuse of components. Android employs a set of C/C++ libraries used by various components of the Android system. These capabilities are exposed to developers through the Android application framework.
Fig 2.1.2a shows the major components of the Android operating system. In the applications' level, Android ships with a set of core applications like an email client, SMS program, maps, browser, etc. All the applications are written using the Java programming language (Sun Microsystems, 1990).

**Fig 2.1.2a  Android Architecture**

[Android Architecture Diagram]

Date Source: http://developer.android.com/guide/basics/what-is-android.html
2.1.3 Wireless / Mobile Application

The fundamental idea behind the wireless network is network connections without wires. In the simplest sense, there are needs from the end-users and together with the growth of technology supports wireless technology. Wired networks are for communication between fixed locations while wireless is for communication between devices; this means we are no longer dependable on the location (Clark, 2008). Wireless technologies cover a wide range, which allow users to establish wireless connections across long distances, unlike infrared light, which is optimized for a short-range wireless connection. Mobile computing applications reduce duplication of data inputs and provide instant information just-in-time. With mobile application, companies have more ways to restructure their business processes to realize greater efficiency.

2.1.4 Google Maps

Google Maps (Google Inc. 2005) is an application which supports basic web mapping service and technology. It is an open map provided by Google to organize world’s information in form of digital image. The main advantages of Google Maps are to make dynamic maps and provide an interactive interface to the user. User can drag the map to fit his/her satisfaction without waiting for a long time.

2.1.5 Google Mobile Maps

Google Maps for mobile was first launched in 2006 (Google Inc. 2006). It enables users to view interactive maps. Google Mobile Maps is an innovative mobile mapping and local search application used widely. It provides the feature like GPS positioning function to mobile phone which has built-in GPS function. Combining Google Mobile Maps and Google Maps API, they offer a number of utilities to manipulate digital maps. Users can add-on some contents on the map through a variety of services. This newly launched application allows programmers to create robust map applications on the mobile.

Although Google Maps for Mobile support varieties of functions, it supports a limited number of all cell phones, like Android, BlackBerry, Windows Mobile and iPhone. Its support is somewhat lacking in some of the mobile platform.
2.1.6 Studies of Global Positioning System (GPS)

Global Positioning System, formally known as the NAVSTAR – Navigation Satellite Timing and Ranging Global Positioning System (Dana 1999). It is one of the most significant advanced navigation and positioning technology developed recently.

How does GPS work? The GPS consists of three main components, which are GPS Ground control stations, GPS satellites and GPS receivers. The ground stations send control signals to the GPS satellites. As depicted in Figure 2.1.6a, the GPS satellites transmit radio signals and the GPS receivers receive these signals and use it to calculate its position.

Data Source: http://www.gps.gov/
2.1.6.1. Determining Position

Each GPS satellite transmits data which indicates its location and the current time. There are at least 24 operational GPS satellites all the time, see fig 2.1.6b. All of them synchronize operations so that these repeating signals are transmitted at the same time. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions. (Ferguson et al., 1997)

2.1.6.2. GPS Accuracy

The accuracy of the position determined with GPS depends on the type of receiver. In general, the hand-held GPS units have approximately 10-20 meter accuracy. Another type of the receiver, Differential GPS (DGPS) does obtain higher accuracy, but it needs an extra receiver fixed at a known location nearby (Ferguson et al., 1997).

2.1.6.3. Limitations

GPS receivers need a clear view of the sky, so they can be used in outdoor, and they often do not perform well within forested areas or near tall buildings. GPS operations very much depend on an accurate time reference, which is provided by atomic clocks at the U.S. Naval Observatory. Each GPS satellite has atomic clocks on board (Flandern, 1998).

2.1.7 Studies of Augmented Reality (AR)

Augmented Reality (AR) is an expression for a live direct or indirect view of a physical real-world environment, where the elements are augmented by virtual computer-generated imagery. Azuma (1997) mentioned the definitions of Augmented Reality are a combination of real and virtual, and it is interactive in real-time as well as registered in 3D. Currently there are two Augmented Reality browsers, which are available for Android users: Layar Reality Browser and Wikitude World Browser.
The Layar Reality Browser shows real-time digital information on top of reality in the camera screen of the mobile device. The Layar platform serves as an enabler for mobile location services. Any data with the geographical information can be turned in a content layer. See Fig 2.1.7a below.

![Fig 2.1.7a  Layar Reality Browser](http://www.svennerberg.com/2009/06/mobile-first-person-user-interfaces/)

Wikititude World Browser presents the user with data about the surroundings, nearby landmarks, and other points of interest by overlaying information on the real-time camera view of a smart-phone. The actual camera view is a mixture of information and the image view.

![Fig 2.1.7b  Layar Reality Browser](http://www.hksilicon.com/kb/articles/3503/1/Augmented-Reality/Page1.htm)
2.2 Research on Related Researches

2.2.1 Location Based Service (LBS)

Location information function is becoming an essential value-added service and being embedded in different mobile devices. Latest mobile services can be empowered with location-aware features, therefore, providing the users with a smooth environment to search and browse through any related information. Potential applications like shopping, entertainment and scenery spot can be found related to Location Based Service.

A commercial advertising feature about Location Based Services is presented by Sagiraju & Rudraraju (2008). This new idea is useful for the commercials to promote their services around their own location. So, when people are within the GPS enabled device, the advertised area will receive the advertisements automatically. LBS information is depicted in Fig 2.2.1a. It illustrates that LBS offers a two-way communication system between the user and the service provider. The user sends the information request, preferences and his position to the provider. The provider delivers the tailor-made information to the users.

Fig 2.2.1a Location Based Services (LBS) Information Flow
2.2.2 Location-based Reminder System

It was a common research topic on providing effective location awareness information for mobile users. A study on location-based reminders analyzed the reminders that people wanted to extend the life into all aspects of their personal lives. (Li et al. 2005). Luford et al. (2006) developed a functional location-based reminder application, called PlaceMail. Figure 2.2.2a shows tow subjects; whether the message delivered can help them remember to finish the task, and whether the message delivered was just right distance from the relevant place. The data from their study shows that of location-based information is delivered at a spot the users said is right, then the person is more likely complete the related task and to think the delivered the messages are useful.

Fig 2.2.2a A PlaceMail survey –
Individuals’ feedback when they received a message in a right location

Data Source: Everyday use of mobiles (Department of Computer Science, University of Minnesota)

Although delivering the message at the just right place is challenging, we can learn from the user’s behavior before sending him/her message. The application should deliver the message at right times, narrow the delivery radius for stationary users and deliver opportunistic reminders early, and task details late.
2.2.2.1. Deliver the message at right times

Scheduling every personal message is a tedious task. However, the user’s information such as selectable profile (college, workday, etc.) or the default time constraints (only weekdays after 6 pm) are many useful features. The application can learn from these features to help the user to manage the message.

2.2.2.2. Narrow the delivery radius for stationary users

If the user trends to spend a length amount of time at a place, then the application better not to send notification to the user. This is because if the recipient is not leaving soon, people could forget the message content and forget to do the task before going to the relevant place.

2.2.2.3. Deliver opportunistic reminders early, and task details late

There are two types of the message deliver subjects, one is an opportunistic reminder, and another is intending to go to the place. The former one is about the user wants to read the message early so s/he can maneuver through his arrangement and job orders. The later one is about that message is not useful to the user if s/he has no needs for the grocery list before arrival.
2.3 Information Push and Information Pull

On the present Internet, there are two ways in which information can flow from source to consumer: Information Pull, where a consumer or user takes (or is given) the initiative to get it; or Information Push, where a supplier takes (or is given) the initiative to deliver it (Hermans, 2000). Information Pull has been the most leading force in the information market (Hermans, 2000). This meant that browsers would take the initiative to visit a site to get information. However, information pull, in recent years, began to lose its appeal and power as it became too time-consuming and too lengthy.

Information push, arrived on the internet ten years ago was to offer a strong alternative to information pull, and the not-so user-friendly search engines. However, the information as received through information push like a mailing-list or mobile number list usually has a lot of noise such as spam or other irrelevant information.

In this Fig 2.3a, we see supplier-driven information push on the left side, and user-driven Information Pull on the right side. In the middle of the diagram is the tools and services that are used by both sides to find each other. The thin arrows pointing at the centre mean that there are many ways to find each other (Bartonlini, et al., 2009).

Fig 2.3a The current set-up of the online information chain
2.4 Review of Online Coupon Websites

The online coupon websites provide numerous functions to users. Browsers can get the latest coupons and promotion information from different vendors. Fig 2.4a depicted the functions provided in some of the coupon website in Hong Kong. From the figure below, it is clearly shown that some of the most popular coupon websites do not provide the coupon searching function with respect to the users’ current location. Also, these popular websites are neither likely to remind the users about the coupons’ issue date nor the latest information from the users’ favorite shops.

<table>
<thead>
<tr>
<th>Functions provided</th>
<th>Openrice.com</th>
<th>couponsuperstore.com</th>
<th>jetso.com</th>
<th>Mobile Discount Directory Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show discounts &amp; shop location in map</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Search discounts &amp; shops by districts</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Search discounts with respect to user’s current location</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Save the discounts in the user account</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Bookmark favorite shops &amp; discounts</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Remind users the bookmarked vendor have new coupons</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Remind coupons’ issue date</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Auto-retrieve nearby discounts</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Augmented Reality</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
2.4.1 Openrice.com

Openrice.com developed in 1999, is one of the famous websites providing restaurants’ information in Hong Kong, Macau and Shenzhen. It is a platform for members to write comments and rate the restaurant. Openrice.com also supports mobile version (a simplified web page for mobile users’ to access), but it does not use the GPS location detection nor auto-retrieve coupon function; while the Mobile Discount Directory Application proposed in this report supports these functions.

2.4.2 couponsuperstore.com

The Coupon Super Store, developed about 1 year ago provides a range of special offers on-line for mobile users to download directly from mobile devices. However, similar to openrice.com, it does not use the GPS location detection or auto-retrieve coupon function.

2.4.3 jetso.com

The getjetso.com provides a large variety of coupons, discounts and allows members to have the discussion. However, the web page is too slow for mobile users to access while they are using the wireless network or having outdoor activities.
3 AIMS AND OBJECTIVES

This section presents a mobile application for mobile device users to search for the discounts, coupons and promotion leaflets according to their location via wireless network.

3.1 Aims and Objectives

To assess the results of the above researches, the aim this project is to provide an intelligent mobile application to help people save money with the coupons and discount information provided. The application infrastructure will be designed in server and client modal. The coupons searching results will be presented in the geographic map on the mobile device from the server. On the server side, the system administrators can manage the users’ profile and verify the coupons information using the web interface.

In this project, it is aim to develop a mobile map application called Mobile Discount Directory (MDD) which combines the functions provided in some existing websites and the mobile applications. In additional to the basic function like searching coupons according to the user’s location, this application also employs some intelligent functions like coupons reminder function and favorite shop function. To achieve the results studied in the previous section and to enhance the application, this section lists out the proposed application requirements and user requirement.
3.2 Functional Requirements

Here specify functional requirements definition of the map interface, retrieve discount and personalized setting for the Mobile Discount Directory Application.

3.2.1 Map Interface Function Requirements

- The application should provide the zoom-in/out buttons for user to adjust the map zoom-level.

- The application should automatically receive the GPS information and display the user’s location on the map. If GPS receiver cannot detect the location due to location constrain, the application should provide manual positioning methods for user to set the location:
  - User may long press the map to set his/her current location.
  - User may press the search button and type the district or street name to indicate location.

- The application should show the user’s location information, like the street name, name, and the district inside a balloon on the map.

- The application should provide a map interface to display the discount information.

- The application should distinguish whether the discounts provider is the user’s favorite shop or not:
  - If yes, the star icon display on the map should be in yellow color
  - If no, the star icon display on the map should be in grey color
3.2.2 Retrieve Discount Function Requirements

- The application should retrieve all the coupons surrounding the GPS location detected or received.

- The application should retrieve and display the discount, coupon information from the servlet and display the information on the map.

- The discount, coupon information retrieved should be displayed on the map base on the provider’s location.

- The application should show the discount title and the provider inside a balloon over the map.

- The application should provide filter options for users to choose the information to be displayed on the map.
  - Show all the discounts
  - Show my favorite shops only
  - Show my saved coupons only
  - Choose the discount category (food, shopping, car park, etc.)

- If the coupon’s issue date is expired, the coupons should not be display on the map.

- The application should allow the user to click on the discount title and view the detail.
3.2.3 Personal Function Requirements

- The application should provide a button for user to add his/her favorite shop to the user’s favorite shops list. User may uncheck the bookmark button to remove shop from the favorite shop list.

- Whenever there are new discounts launched from the user’s favorite shop list, the application should notify the user via the mobile notification function.

- The application should provide a button for user to save his/her favorite discount to the user’s discounts list. User may uncheck the bookmark button to remove discounts from the saved discount list.

- The application should provide the reminder functions.
  - When the saved coupons’ deadline is approaching, the application should send notification to remind the user according to the users’ reminder preference.
  - The application should allow the members to choose the time interval to receive the reminders.
  - The application should keep checking the user’s location in 1 hour interval. If the user’s position changed, the application should send the location-based reminders to notify the users, there are discounts surround.

3.2.4 Advanced Function Requirements

- The application should calculate the straight line distance between the user’s current location and the shop location.
  - If there are branches with coupons available, the application should display the nearest one according to the distance function.

- The application should provide a list view of surrounding coupons. So users do not need to click the star one by one to view the discount.

- The application should provide Augmented Reality function to direct user go to the shop.
3.3 Non-Functional Requirements

This part specifies the non-functional requirements, which are mobile application performance and the interface design for the Mobile Discount Directory Application.

3.3.1 Interface Design Requirements

- The application should provide a user-friendly interface.
  - The button should be large enough for users to click.
  - The font size should be large enough and clear enough to read.
  - The application should limit the number of layers to at most 3. User clicks at most 3 times return button and back to the application main page.

- The star or my location icon should be sharp and large enough; the icon displayed should not have similar color with the map background.

- The menu title should be specific with one meaningful word to describe the menu function.

- The application should always allow the user to click the return button and back to previous. With the return function, novice is encouraged to try new operations.
3.3.2 Application Performance Requirements

- The application should provide well performance and response the client request in short time.
  - The application should refresh the map within 5 seconds when the user clicks the zoom-in/out button.
  - The application should pop up the menu bar within 5 seconds when user clicks on the menu button.

- The time-consuming task, like retrieve nearby discounts and display on the map, the notification function should be run in the background and a waiting / status bar should be display to indicate the functions are still loading. If the functions are running too slow:
  - The application should pop out a message box, telling the user that network is slow or no network, please try again later.

- The application should learn from the user’s preference and their habits to avoid sending them message or notification when they are at work or in school.
- The application should not keep running after the user closed the application, to avoid using the mobile memory continuously.
3.4 Users Requirements of mobile application

All the user requirements of the Mobile Discount Directory application from mobile client side, the server-administrative side is listed below.

3.4.1 Mobile Client Side

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digital Map Interpretation Function</td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Mobile user can zoom-in/out the map, drag to fit the digital map</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>User wants to re-center the map or re-scale map image.</td>
</tr>
<tr>
<td><strong>Expected Result</strong></td>
<td>User can modify the map scale, drag the digital map to adjust the map view</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Positioning Function</td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>The GPS device is employed as a location awareness tool to track the user’s current location and mark their position on the map.</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>User wants to know where they are.</td>
</tr>
<tr>
<td><strong>Expected Result</strong></td>
<td>If user’s mobile phone is connected to GPS receiver to read the GPS signal, then the application can transfer the GPS coordinates to the server. User can view his/her locate on their location. A marker will show on the map to indicate the user’s current location. When user walks along, the marker will be updating in real-time. If GPS receiver cannot detect the location due to location constrain, the application provides manual positioning methods to set the location:</td>
</tr>
<tr>
<td></td>
<td>• User may long press the map to set his/her current location.</td>
</tr>
<tr>
<td></td>
<td>• User may press the search button and type the district, street to indicate location.</td>
</tr>
</tbody>
</table>
3. **Data Manipulation and Display Function**

<table>
<thead>
<tr>
<th>Description</th>
<th>Discounts or Promotion details will be displayed on the map.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>User wants to view the coupons or promotion details surrounding his/her current location.</td>
</tr>
<tr>
<td>Expected Result</td>
<td>Mobile application sends the request to the server, collecting required information. Server replies the requests and the application display the information on the map. User can view the promotion information and click the “details” button to read more information.</td>
</tr>
</tbody>
</table>

4. **Bookmark Favorite Shop Function**

<table>
<thead>
<tr>
<th>Description</th>
<th>Favorite shops can be bookmarked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>User has a list of often visit vendors and s/he wants to bookmark it for convenient.</td>
</tr>
<tr>
<td>Expected Result</td>
<td>Mobile application allows the user to bookmark his/her favorite vendors and browses through a list of favorite vendor. If there are promotions of coupons launched from his/her bookmarked vendors, the application will notify the user. User can browse through his/her favorite vendors in a list view and see if there are coupons or promotions launched. User can remove the bookmark by uncheck the bookmark icon.</td>
</tr>
</tbody>
</table>
5. **Save Favorite Discount Function**

<table>
<thead>
<tr>
<th>Description</th>
<th>Favorite discount can be saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>User wants to save a number of discounts for convenient.</td>
</tr>
<tr>
<td>Expected Result</td>
<td>Mobile application allows user to save his/her favorite discounts and browses through a list of saved discounts. If there are promotions of coupons launched from his/her bookmarked vendors, the application will notify the user. User can browse through his/her favorite vendors in a list view and see if there are coupons or promotions launched. User can remove the bookmark by uncheck the bookmark icon.</td>
</tr>
</tbody>
</table>

6. **Coupon Reminder Function**

<table>
<thead>
<tr>
<th>Description</th>
<th>To remind the user about the coupon issue date.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>User may forget the coupons’ date of issue; they need a function that sends notification to remind him/her.</td>
</tr>
<tr>
<td>Expected Result</td>
<td>The application will alert the users about the saved coupons’ issue date.</td>
</tr>
</tbody>
</table>

7. **New Coupon Alert Function**

<table>
<thead>
<tr>
<th>Description</th>
<th>To alert the user his/her favorite shop has a new coupon launched.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>User wants to know his/her favorite shop’s promotion.</td>
</tr>
<tr>
<td>Expected Result</td>
<td>Mobile application sends notification message to remind the user about his/her favorite shops have new promotion.</td>
</tr>
</tbody>
</table>
### 3.4.2 Server Administration Website

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Manage Discounts or Promotion Information</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Administrator can manage the discounts/promotion information</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>Member or vendor supplies the discounts/promotion information and wait for the administrator’s approval.</td>
</tr>
<tr>
<td><strong>Expected Result</strong></td>
<td>After member or vendors supplied the information, the application will send email to notify the administrator. Administrator verifies the information and formats the data before appending to the database.</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Modify Promotion or Coupon Information</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Administrator can modify the coupons/promotion information</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>When there are changes in coupons’ or promotion information, admin can modify the information</td>
</tr>
<tr>
<td><strong>Expected Result</strong></td>
<td>Administrator can update or delete the information, so that user can obtain the latest information.</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Handle Mobile Clients Request</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Servlet handles the request from the mobile client</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>Mobile clients send the retrieve discounts request to the web server.</td>
</tr>
<tr>
<td><strong>Expected Result</strong></td>
<td>Servlet responses the request and returns the retrieve results to the mobile client.</td>
</tr>
</tbody>
</table>
4 SYSTEM DESIGN

What comes before implementation stage is system design. System design is a process which defines the system architecture, system components, system modules, interface design, and data to reach the specified requirements mentions in the previous section. This is a bridge between the system's theory and the development stage.

4.1 Methodology

Methodology is a collection of the software development models used in combination with one or more techniques. The word methodology means model together with techniques. The techniques of prototyping and object-oriented are methods to implement the waterfall, incremental, iterative and spiral models. These techniques may be mixed and matched on a project. Sometimes, parts of a technique may be used but not all area of that technique.

4.1.1 Object-Oriented Methodology

Object-oriented programming became popular in about 20 years ago. With the greater use of C++, and other new object-oriented programming languages (Purcell, 2007), developer starts considering the object-oriented methodology. To capture the full benefit of object-oriented features like classes, inheritance, methods, the Object-oriented Systems Development Life Cycle (SDLC) model was developed.

An important feature of Object-oriented (OO) systems is that software objects represent real-world objects. Objects are derived from Classes, and a class hierarchy that permits objects to inherit characteristics from parent classes. Although defining all the classes, methods, relationships, and properties is quite time-consuming, this design allows software object reuse, less coding, encapsulation of functionality, and many other benefits. However, if the class hierarchy is not well-designed, all the Object-oriented advantages fade away. This model which deals with Object-oriented SDLC is focusing on implementing real-world objects into abstract objects in the computer world and all the relationship between those objects (Purcell, 2007).
4.1.2 Rational Unified Process (RUP)

The IBM Rational Unified Process (RUP) is the system development process which is rigid and well-defined. It is employed to develop systems, which are based on object or component-based technologies (Ambler 2005). It provides a number of mechanisms, like comparatively short-term iterations together with well-defined goals and target points at the end of each phase (Kruchten 2004). One of the advantages of RUP is that it supports management visibility into the development life cycle.

Figure 4.2.1a depicts the RUP life cycle. It provides a general concept of how long each discipline is consumed in each phase. In this the four phases: inception, elaboration, construction and transition, each discipline gives an estimate of the comparative effort for the whole time. Usually a large part of Business Modeling occupies in Inception, although it keeps going through to early Transition. Deployment stage usually does not begin until Elaboration, and it does not step into peak until the middle of Construction.
4.1.3 Extreme Programming (XP)

Extreme programming (XP) is a relatively immature methodology in software engineering (Beck, 2000) and its development practices are becoming more popular. However, its value is still confused by hype and implicit. Extreme programming is based on identifying the needs of customers and focusing on developing and delivering what customers’ requirement in relatively short time. This methodology is a reverse of traditional approach in which developer and customer use plenty of time to document in detail.

4.1.4 Design with XP and RUP

To conclude, the design of the Mobile Discount Directory Application employs several design techniques: the object-oriented methodology, RUP and XP in the design. These techniques are mixed and matched in this project. RUP and XP are quite similar in two ways. Both of them are iterative methodologies, and they are designed at incremental delivery of solutions. In general, XP is active in a smaller and shorter life cycle project while RUP is active in a larger and big project. These two methodologies together with an object-oriented methodology act as complement to each other to fit this project design need. Combining these two design techniques help to achieve developer’s goals. RUP help to address small project needs while XP constructs a roadmap before the development stage starts.

This project design is developed with the skeleton of RUP and practice the use of XP. The shortened release cycles, simplified design and code refactoring are all integrated continuously during the project design and implementation.
4.2 High Level Design

This section provides a high level overview of how the functionality and the responsibilities of the application were partitioned.

4.2.1 Three Tiers System Architecture

The application adopted a three-tier client-server architecture, which includes the user interface, functional processing layer, data storage and access layer as different modules in each tier. The system architecture is shown in Fig. 4.3.1 a. The three tiers system architecture takes the advantages of system enhancement and migration in each tier. It allows any of the three tiers to be extended independently as requirements or software devices change. This architecture provides a flexible development environment for developing Mobile Discount Directory application.

Fig 4.2.1a The Three Tiers System Architecture

<table>
<thead>
<tr>
<th>Presentation Tier</th>
<th>Logic Tier</th>
<th>Data Tier</th>
</tr>
</thead>
<tbody>
<tr>
<td>• User Interface</td>
<td>• Server Side</td>
<td>• Coupons searching module</td>
</tr>
<tr>
<td>- Map rendering interface module</td>
<td>- Command processing module</td>
<td></td>
</tr>
<tr>
<td>- GPS connection module</td>
<td>- Data processing module</td>
<td>• Shop location query module</td>
</tr>
<tr>
<td>- User input module</td>
<td>• Admin Control</td>
<td>• Information storage and retrieveal</td>
</tr>
<tr>
<td>- GIS display module</td>
<td>- Information manipulation module</td>
<td></td>
</tr>
<tr>
<td>• Admin Interface</td>
<td>• Shop location query module</td>
<td></td>
</tr>
<tr>
<td>- Information management module</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>
4.2.1.1. **Presentation Tier**

From the Three Tiers System Architecture shown above, the Mobile map client application in Android phone uses the presentation tier as the user interface displays the geographical information like user’s location, retrieve, manipulate and display discounts and coupons information surround and convert the GPS signal the GPS receiver. This tier interacts with the user request and communicates with the Web Application Server. This tier is design to be developed by Eclipse. While the admin interface manages the discounts, coupons information and location information.

4.2.1.2. **Logic Tier**

This tier is designed to be developed my J2EE on GlassFish v3 Domain. The logic layer handles the data processing and replies to the request from the functions in the presentation layer like retrieve nearby promotion information, view my favorite shop list and promotions details, etc. Logic layer also supports the Administrator control and data management on the geographical information.

4.2.1.3. **Data Tier**

The SQL Server Management studio stores the promotion information for the Logic Tier to retrieve and pass to the presentation layer.
4.2.2 High Level System Architecture

The Mobile Discount Directory application is about Location Based Services (LBS) information between the mobile devices and the Internet server. Location Based Services are provided based on user's geographical location obtained from the positioning technology, Global Positioning System (GPS). LBS allows users to use the services to search for food and beverage discount, coupon, retail stores promotions and shopping malls activities, etc. based on their geographic information. Those services are provided in response to the user manual input of his / her current geographical position obtained from the mobile devices with the GPS.

The figure illustrates a two-way communication system in between the mobile device and the Internet. When the users send the service request to the server with the searching criteria, the information needs and geographic information, the server performs searching and extracting data from the database and then delivers the tailored information to the users. In finding the location, Global Positioning System plays an important role.

Fig 4.2.2a High Level System Architecture of the LBS Information Flow.
4.3 Entity-Relationship Data Model

The entity-relationship (E-R) data model perceives the real world that consists of a set of basic objects called entities and of relationships among them. Fig 4.2.3a shown below illustrates the data objects related to the Mobile Discount Directory application and their relationship in the database.

The item is an entity set which contains item information and is owned by shop(s). Event function, boutique discounts and restaurant “is a” item. The coordinate itself is a composite attribute whose component attributes are latitude and longitude. While the mobile user can save item(s) or bookmark shop(s).

**Fig 4.3 a  Entity Relationship Diagram**
4.4 Database Design

The database design of the Mobile Discount Directory application illustrates the data objects and the attributes contained in each table. After eliminating redundant data and ensuring data dependencies make sense, this database design conformed to the normalized database.

Normalization is similar to the concept of object-oriented schema. Normalized data schema removes all the redundant data and stores exactly one data at only one table. It also helps to draw the schema easier. The advantages of normalized database are to reduce the amount of space a database consumes and to ensure the data is stored logically. There are three basic forms of normalization: First Normal Form (1NF), Second Normal Form (2NF) and Third Normal Form (3NF).

First Normal Form (1NF) sets the very fundamental rules for database organization like eliminating duplicative columns from the same table; creating separate tables for each group of related data and recognizing each row with a unique column or set of columns (the primary key).

Second Normal Form (2NF) further addresses the concept of deleting duplicated data, which is to meet all the requirements of the first normal form. And to remove subsets of data that apply to multiple rows of a table and place them in separate tables and create relationships between these new tables and their predecessors throughout foreign keys.

Third Normal Form (3NF) goes one big step further: to meet all the requirements of the 2NF and remove columns that are not dependent upon the primary key. 3NF is the most preferable normal form in Relational database Management System (RDBMS). Normalization is the process of designing a data model to efficiently store data in a database. The rules of 3NF include making a separate table for each set of interrelated attributes, and give each table a primary key. If an attribute depends on some part of a multi-valued key, move it to a separate table. If attributes do not contribute to a description of the key, bring them to a separate table.
Fig 5.3.2 shows the database schema in Third Normal Form. There were no redundant data in each data. For example, the shop’s district name is stored in the districts' table instead of storing Kowloon in shop table.

The item table is a general class for all the restaurants’ coupons, shops’ promotions, sales, and event function. All these data have common attributes like the title, description, issue date, etc. And the shop is linked to the vendor by the vendor_id. When the user looks for the branch, the application will search the branch by shop’s vendor_id.

The item_cat table is to categorize the item type; see if the data is belongs to “promotion”, “sales” or “event function” etc. Each category is offered by an item_cat_id. This id is used to indicate the item category. So when there are changes in the category name or increase the type of category, amendments could be made on the item_cat table only.

The shop_mapping table and the item_mapping table are to map the data from the source webpage. This is to prevent duplicated data being added to the database.
4.5 Object-Oriented Analysis

Object-oriented analysis (OOA) presents at the problem with the conceptual model of the existing information that are being analyzed. Analysis models do not regard the implementation constraints such as persistence or how the system is to be developed. Analysis comes before the design, while implementation stage is developed during object-oriented design (OOD).

Fig 4.5a shows the abstract concept of Mobile Discount Directory application. Each point of interest (POI) has one to many shops. And each shop has one to many items. The item may be the restaurant discount, boutique discount and the event function organized by shopping malls. The item class is a general concept for the promotion item. The discount, promotion and event function are all inherited from item class. The advantage of inheritance is that it facilities the reuse of concepts and its identified structure related to other concepts.

Fig 4.5a  Object-Oriented Analysis
From the POI class, a list of shop — shoplist is created. When the mobile side sent the search coupon request based on the location, than the application will based on this relationship to handle the request, that is to search the shops located in that point. In the Shop class, a list of item is created. Each shop has a list of item for the application to query the shop’s promotion.

All of these discount and promotion share the attributes in item class like: item_name, item_description, itemTc, etc. The itemCategory is used to distinguish which category that the child belongs to. For example, the discount, coupons, promotion from openrice.com will be in restaurant category; while discounts provided by boutique will be under boutique category and event function will be under event category. And each category has some unique attributes that others do not possess.

RestaurantDiscount has different restaurant category like Japanese cuisine, Italian food or Chinese food, etc. Boutique discount have different category like leisure, man, woman, child etc. While the event function has guest and its start and end time.

After analyzing the abstract domain model, the next stage is object-oriented design which includes implementation stage.
4.6 Object-Oriented Design

An object-oriented program is to perform the interaction of encapsulated data. Object-oriented design is the way of defining the objects and their interactions. They are designed for problem solving which was identified and documented during object-oriented analysis stated in the previous sub-section.

Fig 4.6 is the Object-oriented design of the Mobile Discount Directory application. The class diagram shows there are mainly 5 user interface in the MDD application. And these UI are linked to the entities through the control classes.

The MobileDiscountDirectoryUI is the main UI, through this UI, the second layer and third layer can be contacted like mySavedItemUI, myFavoriteShopUI etc. Besides the UI class, there are three packages: myLocation, Services, Manager and Overlay. The myLocation package contains three classes: MyGeoCoder, MyLocationMapView, MyLocationPointOverlay. These three classes are all related to location so they are put under myLocation package. The MyGeoCoder class helps to reverse the district name, street name to the geographical point. The MyLocationMapView class is to show the user’s current location on the digital map. And MyLocationPointOverlay class is to show the district name and address information in the balloon.

The Manager package contains two classes where the manager contacts the servlet for information retrieval. Some of the services take long time to run the request, so the manager class will assign those services run in the background. These functions like notification and POI retrieve.

And the overlay class handles all the icon or information to be shown on top of the digital map. Functions like displaying stars and address balloon on the map.
4.7 Workflow Diagram — Modeling of Mobile Map Client

Figure 4.7a shown below is the workflow of the mobile map client. When the application is first launched, it will detect the user’s current position. If the area cannot receive GPS signal, then user can long press the screen to set his/her current location. After setting the user’s location, the application will retrieve the surrounding discount, coupons information and display the result on the map. User may click on a promotion to view the details. User can view his/her favorite shops or saved items in list view without setting his/her current location.

Fig 4.7a  Workflow Diagram — Modeling of Mobile Map Client
4.8 UML Diagram

4.8.1 Use Case Diagram

The use case diagram shows the functional behaviors of the application system. Figure 4.8.1a below shows the interaction between the mobile user and application system.

Fig 4.8.1a  Use case Diagram
4.9 Three Layer Hierarchical Structure

The MDD application is designed in three layer hierarchical structure. So, the mobile user will not get lost when using the application. The board shallow structure leads to higher speed, accuracy and performance. The advantages of the three layer hierarchy are to allow the user back to the main page within three return click.

Fig 4.9a shows the three layer hierarchical structure of the application design. The first layer is the main UI, which supports several operations like showing nearby POI, filtering option and refreshing user location. The second layer means that the application directs the user to a new page. User may view his / her favorite shop or saved item and select the coupons, discount to view the detail. The application brings the user to the 3 layer – the item detail page.

![Three Layer Hierarchical Structure Diagram](image)
4.10 User Interface Design

The Mobile Discount Directory application mainly provides three functions: searching nearby discounts; supporting personal services and sending coupon notification. This section presents the basic interface design of the application.

The application will load the digital map. User’s position and the related information will be searched and marked on the map automatically. Figure on the left shows the design of information searching and displaying. Orange star represents the users’ favorite shop while grey star is normal one.

A loading icon will be displayed on the top right hand corner to indicate that the mobile is searching information.

If the mobile cannot detect the users’ location, user can long press on the mobile screen to set the location or type in the street and district name.

Figure on the left shows that users can search the location by tying street or district name.
Figure on the left shows the menu bar contains four functions: refresh location, filter option, myShop and myDiscount.

If the users moved to another place where the mobile cannot detect the GPS signals, the user may press the Refresh Location button to update the location. Upon refreshing location, the application will search the nearby discounts automatically.

Figure on the left a balloon dialog pops up which is pointing at the star.

The balloon shows three things: the discount title, the discount provider’s and the shop image if available. If there is more than one shop or more than one discounts, the balloon will show a “…” symbol to indicate there are more information.

Figure on the left shows an interface design with a list view of the discount item with the discount provider. User may select one discount to view the discount details.
Figure on the left shows an interface design of the discount that the user select. In this page, user can save the coupon or bookmark the shop. User may uncheck the tick or star icon to remove the bookmark.

This page also shows the coupon image and allows the user to download coupon from webpage. At the bottom of this page, there are three icons: map, branch and AR. User can click the map to view the shop location and the user’s current location. The branch icon for user to view the branch and AR button to launch the Augmented Reality function.

Figure on the left shows the list view of the user’s favorite shop. The number inside the brackets “()” indicates the discount number that shop provided. And the distance shown on the right is the distance from the user’s location to the shop.

Figure on the left shows the list view of the user’s saved discount. The number inside the brackets “()” indicates the provider’s name. And the distance shown on the right is the distance from the user’s location to the shop.
5 IMPLEMENTATION AND TESTING

This section evaluates the programming tools used, describes the implementation technique and illustrates the testing of the application.

5.1 Programming Tools Evaluation

5.1.1 NetBeans IDE 6.8

NetBeans refers to both a platform framework for Java desktop applications, and an integrated development environment (IDE) for developing with Java, JavaScript, PHP, C++, etc.

In this project, Netbeans is used to develop the web services and web application. One of the reasons Netbeans is chosen because it is free. Besides, NetBeans IDE 6.8 (Sun Microsystems, 2009) fully supports J2EE6 which is this project web application implementation language. It is also highly integrated to our web application server — Glassfish v3 which can be used to debug easily and deployed the application efficiently.

5.1.2 GlassFish Enterprise Server v3

GlassFish Enterprise Server v3 (Sun Microsystems, 2006), is the compatible of the Java EE 6 Platform specification. GlassFish Enterprise Server v3 has high flexibility, extensibility, and ease of use. In this project, GlassFish v3 is used as the application server because it support J2EE v6 and it is lightweight and free. GlassFish Enterprise Server v3 has modular architecture which offers a lightweight runtime for this project.
5.1.3 Eclipse Galileo SR1

Eclipse is a multi-language software development environment comprising an integrated development environment (IDE) and an extensible plug-in system. Eclipse is open source application platforms which are collections of related functions pulled together to form the base for some domain logic or application. It changes the way the developer develops software because they encourage sharing, reuse and collaboration. Eclipse Galileo SR1 (IBM, 2009) supports several new features, which show three important trends in the Eclipse community: the expanding adoption of Eclipse in the enterprise, an innovation of Eclipse modeling technology and advancement of EclipseRT runtime technology (Yang, 2009).

In this project, Eclipse is used as the IDE for developing android application because it is highly integrated with android simulator. Eclipse is the official development environment of android application.

5.1.4 Microsoft SQL Server 2008

Microsoft SQL Server 2008 (Microsoft, 2008) is a relational model database server produced by Microsoft. It provides a consistent program model and common tools while offering high availability, and massive scale through distributed data services. Using Microsoft SQL Server 2008 make my application data query stable and minimal down-time.

After drawing the database diagram, setting primary key and linking the foreign keys, the database structures are nearly well-developed with tables ready for data storage. Huge code can be saved as there is no need to prepare SQL.
5.1.6 Apache Subversion

In this project, Software Configuration Management (SCM) is employed to control the changes and maintain the project quality. Apache Subversion is used for the SCM in this project. Apache Subversion (Apache Software, 2010) is widely used and cross-platform version control system. It is open source software distributed under Apache License. It helps to maintain current and historical versions of files such as source code, web pages, and documentation. In this project, Software Configuration Management (SCM) is employed to control the changes and maintain the project quality.

First of all, the SCM is responsible for the identification of individual software configuration items (SCIs) such as source code, database data. This project size is small and the duration is short, formal configuration management is not suggested but SCIs are be ensured for consistency. This makes sure the delivered codes will not be overridden. In configuration management, it will be mainly divided into version control, change control and release control (See Fig 5.1.6a). Subversion will remember the changes of files and can be reverted easily. It acts as time machines in the version control. The subversion server can detect the files changed and combine the changes when people are committing their modified codes.

**Fig 5.1.6a  Chart of Configuration Management**
5.2 Process Model

In this project, the developing process is mainly divided into four processes: design, develop, testing and debug (see Fig 5.2a below).

![Chart of Process Model](image)

What comes first is the Design stage. It is about Object-Oriented Analysis and Designs, as well as system analysis and prototype design of the Mobile Discount Directory application. With all these basic designs, relationships between classes, the database is developed and the class structure with object-oriented design is developed.

After developing the class structure and some basic functions like GPS location detection, information retrieval, the testing stage begins. The earlier the testing and debugging stages begin, the lower the cost. The test plan, test case specifications are prepared for testing. Right after the debugging stage, before adding advanced functions, code refactoring is scheduled to improve the code structure. With the procedure of code refactoring, the classes are easier to maintain while new features can be added and modified upon request.
5.3 Programming technique

5.3.1 Data Source Extraction

One of the discount data sets were extracted from a popular website: openrice.com. In order to save time for extracting all the latest discounts from openrice.com, HTMLUnit is employed to collect data. HTMLUnit is a "GUI-Less browser for Java programs" (2002-2010 Gargoyle Software Inc., 2002). With the property of modeling HTML documents and providing an API, HTMLUnit allows the programmer to call up pages, fill out forms, click links, etc. Its operation just likes what an internet user does in his/her usual browser. It has reasonably fine JavaScript support, which simulates two browsers: Firefox or Internet Explorer depending on the configuration adopted.

HtmlUnit is usually used for testing or to retrieve information from web sites. In this project, HtmlUnit is employed to work out a robot-like internet user to click each discount and extract data from each discount.

First of all, Firefox is set as the browser and two add-ons: XPath Checker and Firebug are added. With the XPath checker, the html structure of openrice.com can be examined and this website is ready for information retrieving. Fig 5.3.1a shows the coupon page from openrice.com and the usage of XPath Checker.

Fig 5.3.1a  Using XPath Checker to Examine the Page structure
Fig 5.3.1b shows the XPath Checker at openrice.com which checks the row structure of a table and the total number of coupons on each page. After examining the HTML structure of openrice.com, I developed two Java Classes with the HtmlUnit to pretend a user clicks all the coupons from the discount page and retrieve the information using the XPath of the HTML elements.

Fig 5.3.1b  XPath Checker for Coupon Retrieve

Fig 5.3.1c  XPath Checker for Coupon Retrieve
Another java class is developed to extract shop information. The java class first collects all the coupon information. With a list of coupon_id, HtmlUnit browses each coupon and collects the shop and the geographic location by the Firebug add-ons. HtmlUnit clicks on the map and get the longitude and latitude.

Fig 5.3.1d  Firebug for Shop Location Retrieve
5.3.2 Database Implementation

In this project, the database is not that huge. However, for easier maintain, faster query and cost saving, the design technique like normalization, indexing and mapping table are employed in the database design.

There are two mapping tables for mapping the data extracted from the webpage to the database. The item_mapping table is used to verify if the item has been added to the database or not. The shop_mapping table is to verify if the shop has been added to the database or not. These two tables help to prevent redundant data being added into the database.

![Database Scheme](image)

Fig 5.3.1d  Database Scheme
5.3.3 Web Service Implementation

5.3.3.1. Object Role Modeling (ORM)

In the web services, the Object Role Modeling (ORM) technique is implemented. ORM is a programming technique that performs the conversion of data between databases schema and object-oriented java class (Halpin & Morgan, 2008). ORM is a powerful approach for designing and querying database models. It is a fact-oriented method designed at the conceptual level to ease conceptual analysis. ORM is to realize the database data into java object. The database data are automatically fetched into the java object.

Object Role Modeling programming technique helps to reduce coding in this project. A host of services are provided by ORM tools which allow us to focus on the request and response implementation of the application instead of cycling Create Read Update Delete (CRUD) logic.

What is more, the changes to the object model are carried in a single place. One the object definitions are updated, the ORM will automatically make use of the updated configuration for retrievals and updates. The SQL Update, Delete and Insert statements can be dropped throughout different layers of the application that need modification. ORM also supports Cache management, where the entities are cached in memory, therefore sinking the load on the database.

5.3.3.2. JavaScript Object Notation (JSON)

JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is a text-based, human-readable format for representing simple data structures. In this project, JSON is used as a data interchange format between the server and mobile application, because it is easy to read and write and easy for machines to parse and generate. When compared with XML, JSON is more flexible and extendible. Extensibility helps lessen the combination between the producer and the consumer of the data. JSON is ease of creating the data on the server-side and ease of processing the data on the client side.
JSON are used to present the data in an object-oriented format for the mobile client to access. The JSON structure designed is similar to the database design. The results are searched based on a geographical point, a list of shopID or a list of itemID. When the servlet receives a geographical point, then the JSON will display a list of result based on the POI. The JSON shows 0 to many shops within 10km of the geographical point, and each shop has 0 to many coupons. Fig 5.3.3a shows below is the JSON editor used for the syntax check up.

Fig 5.3.3a  JSON Editor
5.3.4 Mobile Client Side Implementation

5.3.4.1. Offline compatible

To make the application running stably, the MDD application is implemented to be able to run in the offline environment. To achieve the offline compatible service, the data retrieved will be stored in the mobile phone’s database, just like the cache mechanism in the network environment. Once the information has been retrieved, those data will be updated and stored in the mobile phone database.

When the application sends the request to the servlet, the data will first be retrieved from the mobile database and then compare with those data obtained from the servlet. Offline compatible mobile application makes the services more stable, reliable and better performance.

5.3.4.2. Threading

All the services that have passed through the servlet are set to run in the background. Any of the requests have to be long waiting time are put to run in the background until the request is completed. Mobile function threading method is to separate the services run in the background and the human interaction. It helps to minimize the disturbance between the human and the mobile device interaction. User can still browse through the information.

5.3.4.3. Minimal Power Consumption

To avoid the application keep sending request to the server, the application will kill the detection of the user’s current location in 2 minutes. This is to prevent the application keeps finding the user’s location in the background and consuming the battery of the mobile device

5.3.4.4. Augmented Reality

There is a Direct Me! Function. This function adopts the concept of the Augmented Reality. What this function needs are the user’s current location and the destination point. With these two points and the compass in the mobile devices, the application can direct user to the destination.
How to make this? This is implemented based on the camera and the overlay added on the screen. With the users’ current point, destination point, the distance and the bearing from the user’s location to the destination, the application can calculate the bearing. The degree obtained will be added starting from the North point. Then an arrow will be displayed on the screen to direct the user go to the destination.

This is the item detail page, user may click the Direct Me button or the address to launch the Augmented Reality function.

The Direct Me! Function will show the street view with an arrow, The arrow points at the shop location and shows the distance between your location and the shop. This area shown in the screen is the road next to City University, so the arrow is pointing at the opposite side.

When the direction of the mobile phone changed, the arrow will change. Then the user can find the shop location easily.

This picture shows the arrow pointing at the Festival Walk.
5.3.4.5. Global System for Mobile Communications

For the notification function, the way of detecting the user’s location is somehow different to the way of detecting the user’s location for the nearby POI method. To retrieve the nearby POI, the user’s location detection should have high accuracy. But for the notification, which notifies the user about the nearby POI retrieved, the user’s location detection can be less accuracy. GSM localization is then used to detect the user’s current location. This is done by Multilateration based on the signal strength to nearby antenna masts. In this way, the user’s location is detected in a less accurate approach but at the sometime, it consumes less power and more efficient.

5.4 Difficulties, Solutions and Limitations

There are some difficulties faced during the stage of development and the suggested solutions are chose to handle the difficulties. And some of the limitations in the Mobile Discount Directory are listed as well.

5.4.1 Limitation of GPS

GPS receivers require a clear view of the sky, so they can be used in outdoor and they often do not work well within woody areas or near tall buildings. To handle the scenarios of indoor application usage or place cannot receive GPS signal, this application allows users to set the location manually.

5.4.2 Location Dependency

The MDD application is now supporting the restaurants and the discounts searching in HK only. Places beyond HK like Macau and Shenzhen are not supported in the current stage of development. However, the point of interest from these places can be added to the database for information retrieval.
5.4.3 Limitation Data Extraction

To extract the discounts data from online website, the HtmlUnit is tailor-made for a particular website. To do the data extraction from other websites, a new java class needed to be developed for data extraction. The way of data extraction is not that portable and not easy to maintain. Once the layout or structure design of the website is changed, the java class needed to be updated to fit the website.

5.4.4 Mobile Application Limitation

Mobile computing usage, however, faces a significant number of technical and environmental limitations.

5.4.4.1. Insufficient Bandwidth

Mobile internet connection is much slower than wired connection. The networks are usually available within range of commercial cell phone towers. To solve this problem, using higher speed wireless LANs may improve the quality but they have very limited range and cost is expensive.

Transmission interference is another problem in mobile computing. Since the medium is always a shared medium, there are noises and interferences coming from the transmitter itself or other transmitter. Weather, terrain and nearby transmitters can all interfere with signal reception. The quality is even much poor in reception in tunnels and rural areas. Offline compatible mentioned in the previous sub-section may be one of the possible solutions to handle the inadequate bandwidth problem.

5.4.4.2. Power Consumption Problem

Another problem is the power consumption problem. Mobile devices are usually small in size and power outlet or portable generator may not be available, but mobile devices totally rely on battery power. Some 24-hrs store provides quick charging service; user may use their services to maintain the necessary battery life.

To kill the location detection services after 2 minutes of trial is likely a reasonable method to save power.
5.5 Test Plan and Test Case

Test plan for the Mobile Discount Directory application and admin web server has been divided into unit test, integrated/system test, performance test, installation test. In the early stage of the development, bottom-up testing approach is used to test the functionality of each part. At that stage, unit testing and integrated testing are used to test the correctness of the part. After that, several parts will be integrated into larger modules. Finally, user acceptance test, performance and installation test will be adopted to ensure the application is user-friendly and highly accessible.

5.5.1 Unit Test

Unit testing is a software verification and validation technique. Unit test is to test an each part independently to make sure it works properly. A unit test is the minimum testable part of an application.

5.5.2 Integration/System Test

Functional test and user interface test will be employed on each life cycle. Functional modules will be started at bottom-up testing approach while user interface will be started at top-down testing approach.

5.5.3 User Acceptance Test

Acceptance testing involves testing on the acceptable level for the customer in the final phase. Mobile users can test on the whole application in different way.

5.5.4 Performance Test

Performance test is used to verify the transmission speed of using wireless network in the street, urban area or inside building. This is to check the performance of the application when numerous mobile clients request services to application server.

5.5.5 Installation Test

Installation test is to install Mobile Discount Directory Application to different kind of mobile devices with android platforms like HTC Magic, HTC Hero and Nexus One, to test if the interface layout, functions and performance works properly.
## 5.5.6 Test Cases and Results

### Test Type: Integrated Test / System test

#### 1. Digital map and GPS location detection

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>First time user launch the MDD application without GPS signal.</td>
<td>1. Display digital map 2. Show the zoom in/out control 3. Show the Kowloon area</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>1.2</td>
<td>Send operation request when launching the MDD application without GPS signal</td>
<td>1. Display digital map 2. Show the zoom in/out control 3. Show the previous location that the mobile detected</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>1.3</td>
<td>Send operation request when launching the MDD application with GPS signal</td>
<td>1. Display digital map 2. Show the zoom in/out control 3. Detect and show user’s current location.</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>1.4</td>
<td>User manually set GPS positioning</td>
<td>Detect user’s current location and show on the map</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>1.5</td>
<td>System automatic refresh user location (place receives GPS signal)</td>
<td>When user moves, system automatic detect GPS position</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>1.6</td>
<td>User refresh location (place cannot receive GPS signal)</td>
<td>When user moves, system auto detect GPS position</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>

### Test Type: Integrated Test / System test

#### 2. Retrieve, filter and browse nearby POI

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Mobile device retrieving GPS signal. Then application automatically retrieves nearby point of interest.</td>
<td>Retrieve and display all the coupons surrounding user’s current location, within 1km.</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>2.2</td>
<td>User clicks on the star to select the coupons launched by all the shops at that point.</td>
<td>An alert box pops up with all the coupons found on that point.</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>2.3</td>
<td>User selects a coupon and view the coupon details</td>
<td>Direct user to a new page with coupon information like item title, shop, date of issue, image, bookmark shop icon and save coupon icon.</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>2.4</td>
<td>User clicks the filter option show the coupons from my favorite shop only</td>
<td>Only coupons from my favorite shop will be displayed</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>2.5</td>
<td>User clicks the filter option to show my saved coupon only</td>
<td>Only coupons from my favorite shop will be displayed</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>
## Test Type: Integrated Test / System test

### 3. Add / remove favorite shop

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
</table>
| 3.1       | User clicks the star to add shop to his/her favorite shop item detail page | 1. Shop will be added to the favorite shop list and stored in the mobile  
2. Star color change from grey to yellow  
3. System show the feedback: shopABC is added to myFavoriteShopList | Same as expected. |
| 3.2       | User clicks the star to remove shop from his/her favorite shop item detail page | 1. Shop will be removed from the favorite shop list  
2. Star color change from yellow to grey  
3. System show the feedback: shopABC is removed from myFavoriteShopList | Same as expected. |

### 4. Save / remove saved item

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
</table>
| 4.1       | User clicks the tick to add item to his/her item list item detail page | 1. Item will be added to the saved item list and stored in the mobile  
2. Star color change from grey to green  
3. System show the feedback: itemABC is saved to myItemList | Same as expected. |
| 4.2       | User clicks the tick to remove item from his/her item list item detail page | 1. Item will be removed from the favorite shop list  
2. Star color change from green to grey  
3. System show the feedback: itemABC is removed from myItemList | Same as expected. |

### 5. Augmented Reality function

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>User click the Direct Me button to launches AR function in item detail page</td>
<td>The camera will be open and the screen will show the street view. A pointer will be displayed on the map and direct the user to user to the shop.</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>
### Test Type: Integrated Test / System test

#### 6. View my favorite shop

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>User launches the MDD application without any favorite shop.</td>
<td>1. The myShop button is hidden and not possible for clicking</td>
<td>Same as expected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The myShop button is possible for clicking</td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>User launches the MDD application with favorite shop(s).</td>
<td>1. The myShop button is possible for clicking</td>
<td>Same as expected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. User can click myShop button to view a list of favorite shop</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The favorite shops are listed out in the descending order of distance between the user’s location and the shop location.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. If the shop has a branch nearby, then the application will show the nearest one.</td>
<td></td>
</tr>
</tbody>
</table>

#### Test Type: Integrated Test / System test

#### 7. View my saved item

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>User launches the MDD application without any saved item.</td>
<td>1. The myItem button is hidden and not possible for clicking</td>
<td>Same as expected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The myItem button is possible for clicking</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>User launches the MDD application with saved item(s).</td>
<td>1. The myItem button is possible for clicking</td>
<td>Same as expected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. User can click myItem button to view a list of saved item</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The favorite items are listed out in the descending order of distance between the user’s location and the item’s shop location.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. If the shop has a branch nearby, then the application will show the nearest one.</td>
<td></td>
</tr>
</tbody>
</table>

#### Test Type: Integrated Test / System test

#### 8. Augmented Reality Function

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Steps:</th>
<th>Expected Results:</th>
<th>Actual Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>When user view the item detail, s/he can click the Direct Me button to launch the AR function.</td>
<td>The camera will be open and the screen will show the street view. A pointer will be displayed on the map and direct the user to follow that direction to the shop.</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>
### 9. Notification Function

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Steps</th>
<th>Expected Results</th>
<th>Actual Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>User will receive the notification of the nearby item when the location change</td>
<td>The GSM is used to detect the user location. If the user’s location changed, then the system will search the nearby item and notify the user.</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>

### 10. Location Balloon

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Steps</th>
<th>Expected Results</th>
<th>Actual Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>The application detects the GPS signal and shows the user’s location on the map.</td>
<td>The location balloon show the location information like, street name and districts</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>

### 11. POI Balloon

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Steps</th>
<th>Expected Results</th>
<th>Actual Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>User click on the location balloon to view all the nearby discount</td>
<td>A list box will be pop-up to show all the discount nearby</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>

### 12. Offline Compatible

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Steps</th>
<th>Expected Results</th>
<th>Actual Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.1</td>
<td>The application is running in the offline mode</td>
<td>If the user has used the application to search and browse the information before, then the application can still show those information</td>
<td>Same as expected.</td>
</tr>
<tr>
<td>12.2</td>
<td>User forget to close the application</td>
<td>The application will not keep detecting the users’ current location or searching the nearby information, the query will be killed after 2 minutes of retrieval.</td>
<td>Same as expected.</td>
</tr>
</tbody>
</table>
6  VISUALIZATION OF THE APPLICATION

This section illustrates the main functions of the Mobile Discount Directory application with the screen shots from the emulator.

6.1 Main Page

There are three ways to set the user’s current location on the map.

Method 1:
If the area cannot receive GPS signals, then the user can click the search button and type the street name / district to set the location.

Method 2:
If the area cannot receive GPS signals, user can long press the digital map on the screen to set the location.

Method 3:
If the area receives GPS signals, the application will detect the user’s current location and display the location information on the map.

If the user moves to a new location and the area cannot receive the GPS signals, then the user may click the Refresh Location button to get his/her current location.

If the mobile user does not have any favorite shop, the My Shops button will be hidden. And if the user has no Saved Coupons, then the My Coupons button will be hidden also.
By any method, method 1, 2 or 3, the application will show the location with a balloon on the digital map with the location information and automatically retrieve the nearby POI.

A loading icon will be displayed on the top-right-hand corner to indicate the application is searching nearby POI.

When the application finished searching, then the searching icon will be hidden and stars will be displayed on the map to indicate the discounts.

An information feedback with few words will be displayed for a while to notify the user.

User can click on the location balloon to view all the nearby POI in list view.

This design is to cooperate with the situation that some stars are located very close to each other, and user cannot click on it.
6.2 List View of myShop

User click My Shops button to view his/her favorite in a list view.

The Favorite shop list view shows all the favorite shops with the numbers of coupon launch currently and the straight line distance shows the distance from the user’s location to the shop. User may select one coupon from his/her favorite and view the detail.

6.3 List View of myItem

User click My Coupons button to view his/her saved coupons in a list view.

The saved coupons list view shows all the saved coupons with the owner of the coupon. The straight line distance shows the distance between user’s locations the nearest shop with those coupons.

User may select one and view the detail.
6.4 Item Detail Page

User may click the star, a balloon with the discount information, the shop name and location will be displayed. User click on the balloon to view the discounts at that point.

A box pops up to show the discount at that point. User selects a discount and click to view the detail.

In the discount detail page, there are 2 taps, one is “Coupon Detail” another is “Terms & Condition”.

In the “Coupon Detail”, user can browse through the discount information like the discount title, the shop name, the address, telephone number, the valid date, the link for download the coupon.

Last but not least, the Map View function and the Direct Me! Function.

This is the terms and conditions page where shows the coupon’s restriction.
When the user clicks the tick button, the coupon will be saved into the mobile database. User may uncheck the green tick to remove the coupon from the saved item list. Then the tick icon turns back to grey color.

When the user clicks the star button, the coupon will be saved into the mobile database. User may uncheck the yellow star to remove the shop from the favorite shop list. Then the star icon turns back to grey color.

User may click the dial button to give a phone call to the shop.
User may click the blue wordings “Click to Download Coupon” or the coupon image to download the coupons.

Click on the map view button will show a digital map with the user’s current location and the shop location.

If the shop is the user’s favorite shop, then the star will be in yellow.

The Direction Me! Function can direct the user to the shop.
6.5 Direct Me Function

The Direct Me! Function will show the street view with an arrow. The arrow points at the shop location and shows the distance between your location and the shop. This area shown in the screen is the road next to City University, so the arrow is pointing at the opposite side.

When the direction of the mobile phone changed, the arrow will change. Then the user can find the shop location easily.

6.6 Notification Function

In 1 hour interval, the system will automatically detect the user’s location. If it is same as the location retrieved last time, then the application will detect the location in every 2-hour interval.

When the user sees the notification, s/he may click on the message and then go to the application directly.

The application will retrieve the coupons mentioned in the message; user may view the coupon details.
### 6.7 Filter POI

User may click Show All, My Favorite Shop or My Saved Coupons.

When there are too many discounts on the map, user wants to filter the results, then he/she may click the Filter POI button to filter them.

The left picture shows the user click to filter My Favorite Shop only.

While the right one shows the user click to filter My Saved Coupons only.
7 DISCUSSION AND CONCLUSION

This section summarizes the achievements of the Mobile Discount Directory Application and evaluates the contribution of the project. Finally, some possible extensions of the application are suggested for improvement.

7.1 Achievement

Many people who have a habit of clipping paper coupons and searching digital coupons from websites might find the process is quite time-consuming and troublesome. A modern way of discount searching application is developed – Mobile Discount Directory, which may help to solve the problems. The application is developed based on the GPS and a pool of discounts which are extracted from discount websites.

7.1.1 Automatic Discount Searching

To tackle the limitations of the online coupons searching websites, the MDD application suggested a modern way of coupons searching services. Instead of initializing the search button by the user, this application promotes automatic coupons searching. With the GPS location detected, (either by GPS signal or manual location setting), the application can perform searching and displaying nearby discounts, which are within 1km from the user’s location. User may click on the star to view the discount and read the coupon's details. The automatic discount searching function may help user to search for discounts in a convenient way.

7.1.2 Providing “MyFavorite” Function

The MDD application provides several personal services like MyCoupon, MyShop function for the mobile user to save his/her favorite coupons or bookmark his/her favorite shops. Therefore, the mobile users can browse through the latest information from their favorite shop in advance. The distance from the user’s location to the shop will be shown on the list to indicate how far away the shop is. They can just go to the myShop list or myCoupon list to view the discount information. These two functions are specially developed for the old hands who just want to browse through their favorite shops or discounts only.
7.1.3 Systematic Coupons Clipping Services

Most of the coupon websites failed to provide the coupons clipping function. When the user finds that coupons useful, s/he needs to save the image or print the image for future use. This action is a bit time-consuming and not efficient enough. MDD application supports digital coupons saving function. By just one click, user can save the coupon to his/her mobile phone database. Whenever the user wants to use those coupons, s/he can click the MyCoupon button to view the coupons and present the coupons at the point of purchase or meals.

If the user has saved the McDonald coupons which are launched in Festival Walk, but in fact, the coupons can be issued at the branches in Mong Kok, Tsim Sha Tsui Central, etc. The MDD application will check if there is a branch where the coupons can be issued as well, then the application will suggest the nearest branch to the user, even if s/he bookmark the coupons from Festival walk McDonald. This function may help user consume in an effective way.

7.1.4 Reminding Coupons’ Issue Date

Apart from the personalized services, the MDD application also provides the coupon's deadline reminder function, mobile users might not miss out any chances of issuing his/her saved coupons before the deadline. Any out-of-date coupons will be removed from the coupons list, so that users will not be confused with a large amount of coupons. With this application, users, no longer needed to cut the coupons from magazines or newspaper but the MDD application will save the discounts for them.

7.1.5 Augmented Reality

The Direct Me! Function is developed to direct the user to the shop. This function is quite helpful to those mobile users who are not familiar with the roads and streets. This function adopts the concept of Augmented Reality. With user’s current location and the destination point, the application can calculate the direction of the shop. This function also makes use of the compass in the mobile devices to do directing. User may just simply follow the arrow to find the shop.
7.1.6 Auto-Notification Function

MDD application also supports location-based notification, when the user moves to another place, the application will send a notification message to the mobile users to remind him/her how many coupons are founded.

The automatic location detection service is launched every 1 hour. If the latest location detected is the same as the last detected location, then the application will check the user’s location in every 2 hours. This is to prevent consuming too much mobile battery and annoying the users if they are at work.

However, to achieve the effective and efficient notification reminder function, the way of detecting the user’s current location is not based on the GPS signal but the GSM location signal. Using GSM to detect one’s location might be more efficient although not very accurate. The location detected from GSM helps to search the nearby coupons and the application will notify the user.

7.1.7 Well-balanced in Functionality and Battery Consumption

To avoid the application keep sending request to the server, the application will kill the request in 2 minutes. Functions like detecting user’s current location and information retrieve are time-consuming if the sky is not clear or network is slow. To prevent the application keeps finding the user’s location in the background and consuming the battery of the mobile device, the request will be killed automatically.

The data retrieved from servlet will be stored in the mobile phone database, just like the cache mechanism in the network environment. Once the information has been retrieved, those data will be updated and stored in the mobile phone database. When the application sends the request to the servlet, the data will first be retrieved from the mobile database and then compare with those data obtained from the servlet.

This design is specially developed to make the application runs stably, and to be able to run in the offline environment. Offline compatible mobile application makes the services more stable, reliable and has better performance.
7.1.8 Extendable Data Source

The database design has a high degree of extensibility. Beyond restaurant coupons, the data source can be extended to boutique discount, cinema and movie information, hotel information, etc. The item is the generalized term for all kinds of location-based information. The database can be easily extended by adding the category table and new table for that information.

The location-based information can be even extending to Macau and Shenzhen. The application is highly flexible for extension.

7.1.9 Quick User Response Time without Interrupting User and Mobile Interaction

All the services that have passed through the servlet are set to run in the background. Any of the requests need long waiting time are kept running in the background until it is completed. Mobile function threading method is to separate the services run in the background and the human interaction. It help to minimize the disturbance between the human and the mobile device interaction. User can still browse through the information.

7.2 System Evaluation

7.2.1 Three Layer Hierarchical Structure

The MDD application is designed to have a three layer hierarchical structure. So, the mobile user will not get lost before accessing the main function. The board shallow structure leads to higher speed, accuracy and performance.

7.2.2 Aim of Consistence

To apply the design of similar command sequence for similar actions, the buttons of similar function are grouped together. It is much easier for the user to press and send a request to the Servlet. MDD application also applied the consistent terminology and layout. The menu or buttons are having 1-2 meaningful words for clear description. It is much easier for user to read and understand what the menu / button represents. And the icon used to represent the bookmark shop are similar the star that we see in the common browser.

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7.2.3 Offer Informative Feedback

MDD application always supports user feedback. Whenever the users add/remove the shop or save/remove the item or finished an action, the application always shows a short message to response to the user action. Fig 7.2.3a below show the system feedback after the user performed an action.

See Fig 7.2.3b, a loading icon is displayed on the top right hand corner to indicate that the application is running, and notice the user to wait for the reply.

Fig 7.2.3a Add coupon and shop

Fig 7.2.3b Loading coupons

7.2.4 Offer Error Prevention and Simple Error Handling

When the network is running too slow, the system will ask the user to try on later or stop the function.

7.2.5 Allow Users to be in Control

User can take the initiative to refresh his/her location base on his/her need. Although this application provides many auto functions, user can still choose not to receive that auto update and take the initiative to retrieve coupons.

7.2.6 Reduce Short-term Memory Load

Due to the limitations of human short-term memory, the MDD application is designed to have a simple display. And try to use the icon instead of words to users to recognize the actions.
# 7.3 User Evaluation

<table>
<thead>
<tr>
<th>User:</th>
<th>Date:</th>
<th>Rating:</th>
<th>Mobile Devices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiangfei</td>
<td>6 April, 2010</td>
<td>Excellent</td>
<td>HERO</td>
</tr>
</tbody>
</table>

**Comment:** This is a very useful tool as it retrieves the coupon information fast in combination with where I am. I used it several times when I have dinner with my friends last month. The app has almost no bugs and runs steadily on my phone, only crashed one time - compared to those lousy apps I downloaded from Android Market, this number is definitely low. There is one concern. However, that whether it uses too much memory of my phone and whether the app could release the memory properly when I shut down it or at other situations. But it still deserves a best rating considering its convenience.

Good job.

<table>
<thead>
<tr>
<th>User:</th>
<th>Date:</th>
<th>Marks:</th>
<th>Mobile Devices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mak Tze Kam</td>
<td>5 April, 2010</td>
<td>Very good</td>
<td>Magic</td>
</tr>
</tbody>
</table>

**Comment:** It gave me some help last weekend when my friends and I were searching for restaurants in Shatin. Thank you very much. I think it is very caring to include the Direct Me! Function.

<table>
<thead>
<tr>
<th>User:</th>
<th>Date:</th>
<th>Marks:</th>
<th>Mobile Devices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peggie Tai</td>
<td>5 April, 2010</td>
<td>Very good</td>
<td>HERO</td>
</tr>
</tbody>
</table>

**Comment:** When I am thinking of a place to settle down my friends for my wedding party briefing, I found Pacific Coffee coupons from your application. We just showed the digital coupons to the coffee maker to enjoy the coffee. This application works well inside shopping mall as well.
<table>
<thead>
<tr>
<th>User:</th>
<th>Kato Yeung</th>
<th>Date:</th>
<th>6 April, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marks:</td>
<td>Very Good</td>
<td>Mobile Devices:</td>
<td>Nexus One</td>
</tr>
<tr>
<td>Comment::</td>
<td>It runs very fast and it’s easy to use. The functions provided are very rich and good to help me search discounts. The Direct Me! Function does help in directing me to the shop.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>User:</th>
<th>Kate Law</th>
<th>Date:</th>
<th>6 April, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marks:</td>
<td>Very Good</td>
<td>Mobile Devices:</td>
<td>HERO</td>
</tr>
<tr>
<td>Comment::</td>
<td>I like eating very much! This application can help me find coupons a save money, very nice! However, a larger variety of coupons (clothes, cosmetic, and cinema) for searching are better. Thank you.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>User:</th>
<th>Timmy Leung</th>
<th>Date:</th>
<th>7 April, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marks:</td>
<td>Good</td>
<td>Mobile Devices:</td>
<td>HERO</td>
</tr>
<tr>
<td>Comment::</td>
<td>The application has many functions. I like the My Shop and My Coupon functions, these functions help me to find the discount faster.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7.4 Further Enhancements

The Mobile Discount Directory is now developed with some personalized services and supporting HK restaurant discounts. However, there is still room for improvement.

7.4.1 Expand Services Area

The MDD application is now supporting the restaurants and the discounts searching in HK only. Places beyond HK like Macau and Shenzhen are not supported in the current stage of development. However, the point of interest from these places can be added to the database for information retrieval.

7.4.2 Enlarge the Point of Interest

It could be extended to search shopping mall event function information, boutique sales and promotion, etc. One of the areas can be further developed is the branch searching function with the use of the hash table for faster query.

7.4.3 Use of Quick Response (QR) Code

More features can be included in MDD like the giving comments and rating to the restaurants, shops, shopping malls by using Quick Response (QR) code. For example, adding the QR code on the restaurant menu, boutique’s entrance door or information kiosk in shopping malls, user can use the mobile camera device to read the QR code and user can give comments and rate the shop or shopping mall.
APPENDIX

A. REFERENCES


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http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html


Retrieved March 14, 2010 from a website of Eclipse Foundation at
B. PROJECT PLAN

[Diagram with project timeline and task details]
## C. MONTHLY PROGRESS LOG

### Documentation 29 September 2009
- Project Plan
- Weekly Reports

### Background Study & Research
- Study Global Positioning System (GPS) Usage & Google API
- Study Geographic Information System (GIS) Applications & Projects

### Technical Study & Research
- Study Android programming language
- Import program to Mobile OS

### Interface Design
- Draw Paper prototype for the mobile application

### Documentation 31 October 2009
- Interim report (Introduction, Design Specification)
- Weekly log

### Interface Design
- Paper prototype
- Interface design

### Technical Study & Research
- Database installation
- Database design
- Data manipulation
- Google API registration and technical study
**Documentation**

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 24 November 2009   | - Interim report (Introduction, Literature Review, Aims & Objective and System Design)  
|                    | - Weekly log                                                        |
|                    | **Interface Design**                                               |
|                    | - Detailed Interface design                                        |
|                    | **Data manipulation**                                              |
|                    | - Data extraction from several online coupon websites               |
|                    | - Database design                                                   |

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 December 2009</td>
<td>- Weekly log</td>
</tr>
<tr>
<td></td>
<td><strong>Data manipulation</strong></td>
</tr>
<tr>
<td></td>
<td>- Data extraction from several online coupon websites</td>
</tr>
<tr>
<td></td>
<td><strong>Client mobile side</strong></td>
</tr>
<tr>
<td></td>
<td>- Get access to the database</td>
</tr>
<tr>
<td></td>
<td>- Interface &amp; functional development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 January 2009</td>
<td>- Weekly log, Monthly log</td>
</tr>
<tr>
<td></td>
<td><strong>Data manipulation</strong></td>
</tr>
<tr>
<td></td>
<td>- Database design</td>
</tr>
<tr>
<td></td>
<td>- Data extraction from several online coupon websites</td>
</tr>
<tr>
<td></td>
<td>- Data insertion into database</td>
</tr>
<tr>
<td></td>
<td><strong>Server side</strong></td>
</tr>
<tr>
<td></td>
<td>- Develop json for mobile side access that data</td>
</tr>
<tr>
<td></td>
<td><strong>Client mobile side</strong></td>
</tr>
<tr>
<td></td>
<td>- Interface functional development</td>
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<td>- Develop several auto functions</td>
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<td>- Exception handling</td>
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<td>- Port 80 and 8080 opened for public to access the data via json</td>
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<td>- User can search coupon everywhere</td>
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<td><strong>Documentation</strong></td>
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<td>• Weekly log</td>
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<td>• Monthly log</td>
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<tr>
<td>• Final report (Class diagram, Usecase diagram, bug report)</td>
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**Data manipulation**

• Database restructure

**Server side**

• Enhance JSON for mobile side access that data

**Client mobile side**

• OOA, OOD design
• Interface functional development & enhancement
• Develop several auto functions
• Exception handling
• User can search coupon everywhere

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<th><strong>Documentation</strong></th>
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<td>• Final report (Programming tools evaluation, implementation, testing, conclusion)</td>
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**Data manipulation**

• Database enhancement (indexing)

**Client mobile side**

• Interface functional enhancement
• AR function
• Exception handling
• Bug faxing
D. USER GUIDE

**Launch the MDD application**

After installing the Mobile Discount Directory Application, user can find the application icon in the menu list. User may click on the application to launch the application.

**First time user with digital map display**

If the mobile phone cannot receive the GPS signal and this is the first time that the user launches the application, the application will show the map of east Kowloon.

If the mobile phone cannot receive the GPS signal but the application have the last time location detected record, then the application will show that location

**Auto-detect location and retrieve nearby discount**

The application will auto-detect the user’s current location and retrieve the nearby POI.
Manual set location (Method 1)

If the mobile phone cannot receive the GPS signal, user may long press on the screen to set his/her location. A message box will pop-up and ask you to confirm set new location.

After setting the location, the application will search the nearby discounts automatically.

Manual set location (Method 2)

Besides long press on the screen to set location, user may click the search button and type the district name or street name to set the location. And then click OK button to continuous. After setting the location, the application will search the nearby discounts automatically.
**Location detected & retrieving POI**

After the location is detected, the application will retrieve the nearby POI, a loading icon on the top-right-hand corner indicates the application is retrieving information. But the mobile user interaction will not be disturbed, user can still zoom in/out the map, click the menu button etc.

**Retrieve POI finished**

After retrieving the POI, a short message with the number of discounts found will be displayed. If the user feels that the stars are too crowded, s/he may click on the location balloon to view a list of nearby POI.

**List view of nearby POI**

For example, the user may click on the discount from Little Sheep and go the item detail page.
**Click the star to view discount**

User may also find the coupons from the stars displaying on the digital map. The balloon shows the shop icon with the discounts.

If that location has more than one shop or more than one coupon, then the “… …” symbol will be shown to indicate there is more information.

**Select one discount**

When user click on the balloon, a message box pop up and ask the user to select one coupon.

**Item detail page**

Then the application directs the user to the detail page.

In this page, user can click on the tick button to save/remove the item to/from myCoupon list; User may click the star to add / remove shop to/from myShop list.

User may give a call to the shop, download the coupon from website.
| **Show your location and the shop location** | User can view his/her current location and the shop location |
| **Direct Me! function** | If the user does not know how to go to the shop, s/he may use the Direct Me! Function to give a hand. |
| **Menu with 2 hidden buttons** | In the main page, user can click the menu to refresh the location, to filter POI and view his/her favorite shop and coupons. If the user has no favorite shop, the My Shops Button will be hidden. Same as My Coupons |
Filter POI option

When there are too many discounts on the map, user want to filter the results, then he/she may click the Filter POI button to filter them.

Filter My Favorite Shops

If user clicks My Favorite Shops option, the map will show the user’s favorite shop only.

Show My Favorite Shops only

The map now only shows the user’s favorite shop.

Show My Saved Coupons only

If user clicks My Saved Coupons option, the map will show the user’s saved coupons only.

Show My Saved item only

The map now only shows the user’s saved coupons.
In one hour interval, the system will automatically detect the user’s location. If it is same as the location retrieved last time, then the application will detect the location in every 2 hours interval.

When user sees the notification, s/he may click on the message and then go to the application directly.

The application will retrieve the coupons mentioned in the message; user may view the coupon details.