AdTouch: A 2D-Barcode Mobile Advertising Service System

Siriphat Oumtrakul, Natharin Chanuntawaree, and Jerry Gao*

San Jose State University, San Jose, USA
Hsing Mei, Fu Jen Catholic University, Taiwan
Frank Zhang, Putara Inc., Fremont, USA
jerrygao@email.sjsu.edu

Abstract. The rapid increase of the number of mobile device users and the fast advance in mobile technologies and wireless networks created new opportunities in mobile advertising and marketing. Although barcodes have been used to support conventional electronic commerce and mobile commerce, there is a lack of research work on building 2D barcode based advertising systems and solutions to support full-cycle advertising services for mobile users, advertisers, and publishers. This paper reports a recent development of one advertising system (known as AdTouch) based on QR barcodes. Unlike the existing research in mobile advertising, this paper offers a set of comprehensive services for advertisers and publishers to market their printable 2D-barcode ads in different media, including barcode-based ad posting, distributing, detecting, and capturing using Android mobile devices. In addition, this paper presents the underlying business workflows, system architecture design, and technical solutions. Moreover, some application examples and case study results are presented.

Keywords: wireless advertising, mobile advertising, mobile commerce, mobile computing, 2D barcode based application.

1 Introduction

With the advance in wireless networking and mobile technology, the number of mobile device users is increasing rapidly. For example, in the United States, the number of mobile phones has increased from 169 million in 2004 (57% of population) to 276 million in 2009 (89% of population)[1]. This brings many opportunities and strong demands in mobile commerce and mobile advertising.

Barcode technology was developed to support electronic commerce and conventional supply chain. People started applying barcodes in mobile commerce applications as today's mobile devices have built-in quality camera with increasing memory capacity.

There are several types of mobile barcode applications. Based on our recent literature survey and product search, a popular 2D barcode application in Japan is to

[1] "Mobile Barcodes in Japan", retrieved from, http://www.i-nigma.com/SuccessStories.html

R.-S. Chang, T.-h. Kim, and S.-L. Peng (Eds.): SUComS 2011, CCIS 223, pp. 188–202, 2011.

store web address in product ad to assist the tracking and discovery of the product information by accessing barcode-embedded URL in advertisements. As of 2007, 2D barcodes are recognized by over 90% of Japanese mobile users, and over 50% of them use QR code. 2D barcode usage is becoming popular in European countries as well because barcodes frequently appear in diverse print media, such as poster, billboard, magazine, newspaper, promotional materials, product packaging, etc.

Although we begin to see more usage of 2D barcode in mobile commerce applications, there is a lack of published technical papers discussing its technical design, business workflows, and underlying architectures. The major technical contribution of this paper is the focus on how to build 2D barcode-based mobile advertising system. The paper presents different types of business workflows for barcode-based advertising to offer services to different user groups, including advertisers, publishers, and mobile users. Meanwhile, a new 2D barcode-based mobile advertising system, known as AdTouch, is presented, including its system architecture, functional components, as well as detailed techniques and implementations. Unlike other existing mobile advertising systems, AdTouch provides a comprehensive set of service functions for mobile advertising using 2D barcodes, with focus on services to publishers and advertisers.

The AdTouch system offers online advertising services for both advertisers and publishers to manage, schedule, publish, and deliver their 2D barcode-based advertisements. It also supports mobile device users on Android platform to access posted 2D barcode ads in diverse media, capture the barcodes, connect to the websites following the embedded URL, retrieve product details, and hence, potentially enable further mobile commerce transactions.

This paper is structured into the following sections. Section 2 provides some basic background, reviews the related research work in mobile advertising and m-commerce applications with 2D barcode. Section 3 presents the AdTouch system, including its business workflows, system architecture and components, as well as technical solutions. Section 4 presents some application examples, and Section 5 reports some case study results. Conclusion and potential future work are given in Section 6.

2 Background and Related Work

2.1 Background on 2D Barcode Technology

For decades, barcodes have been successfully used in commercial applications in many industries all around the world. The 2D barcode technology is used to contain (embed) thousands of characters. Unlike 1D barcodes (which contains a single number or serial code such as EAN, UPC, ISDN), 2D barcodes can store many types of information such as URL, product, vendor, sales, and promotional information. The embedded information in 2D barcodes can be decoded and displayed using barcode readers without internet connection.

With this capability, 2D barcode technology becomes one of the business solutions support e-commerce and business supply chains. Today, in the advertising industry, many companies use a 2D barcode in their ads to contain a URL of a merchant's website for mobile-commerce. Unlike traditional advertisements (that is not easy to support mobile accesses and M-Commerce), using 2D barcode technology in advertisements brings a new effective way to enable M-Commerce by providing a direct channel between merchants and mobile users.

QR Code Standard

QR code is one 2D barcode standard, which is widely used in different applications including advertising. Recently, it appears frequently in posted ads in magazines, newspapers, and posters. Based on its published specification (www.qrcode.com), a QR code is comprised of five patterns: finder pattern, timing pattern, formatting information, alignment pattern, and data cell. These patterns defined the structure of QR codes. To decode and retrieve information from 2D barcodes, image processing algorithms are needed. Its decoding process has five steps in [2]:

- *Pre-processing:* The step is to adopt the gray level histogram calculation.
- *Corner marks detection:* The marks on the three corners are detected using the finder pattern.
- *Fourth corner estimation:* The special algorithm is used to detect the fourth corner.
- *Inverse perspective transformation:* Bi-level code image is used to normalize size and shape of the barcode.
- *Scanning of code:* data cell inside the code is read.

QR Code (QR stands for Quick Response) was originally developed by Denso Wave (a division of Denso Corporation in Japan).

Length: can hold up to 7089 digits, 4296 characters, or 2953 bytes
Character set: ASCII
Error-detection: Yes
Type :matrix

Fig. 1. QR Code (http://www.denso-wave.com/qrcode/index-e.html)

QR Code is represented by a square area that consists of black and white square dots with a finder pattern located on three corners of the area. By 2007, QR codes are extensively used by over 50% of Japanese mobile users. It is also becoming popular in European countries. There, QR codes are mostly used in print media such as poster, billboard, magazine, newspaper, promotional materials, product packaging, and etc.

Table 1. QR Code Advantages

Advantages	Description
High Capacity Encoding of Data	QR Code is capable of handling all types of data, such as numeric and alphabetic characters, symbols, binary, and control codes. Numeric only has a maximum capacity of 7,089 characters. Alphanumeric only has a maximum capacity of 4,296 characters. Binary (8 bits) only has a maximum capacity of 2,953 bytes.
Small Footprint Size	QR Code carries information both horizontally and vertically and is capable of encoding the same amount of data in approximately one-tenth the space of a traditional 1D barcode.
Readable from any direction	QR Code accomplishes this task through position detection patterns located at the three corners of the symbol. These *position detection pattern* guarantees table high-speed reading, circumventing the negative effects of background interference.

2.2 Related Work in Mobile Commerce

With the significant increase of the mobile network, mobile users have become a focusing target by the advertising and marketing industry due to the major advantages of wireless advertising in mobile accessibility, personalization, and location awareness. These advantages critically increase the effectiveness of wireless advertising [3]. In fact, mobile advertising can deliver text message as well as rich content, such as pictures, audio, or video, to individual subscribers. According to Houston and Gassenheimer [6], mobile advertising enhances long-term relationship between end users and merchants/manufacturers. Experts believe that mobile advertising will play an important role in the advertising industry in the future [7].

There are several types of mobile advertisements. They include mobile web banners, mobile SMS, MMS, mobile web posters. Once a mobile ad has been delivered to viewers, on-going mobile user reactions and responses can be collected and provided back to merchants and manufacturers with ad tracking techniques. These tracked data can be used by the advertisers to analyze the performance of the posted ad. Some pioneering researches on mobile advertising have been reported in [1][3].

According to [1][3], there are two primary ad delivery methods in mobile advertising. They are known as push and pull methods. In the push approach, advertisers push and deliver mobile ads using systematic solutions to mobile devices directly with user permissions. In the pull approach, mobile users pull in mobile ads through clicking event or subscribed ad channels. In [5], Zoller, Housen, and Matthews classify mobile advertising into three types: a) permission-based advertising, b) incentive-based advertising, and c) location-based advertising. In the permission-based advertising, mobile users only receive the subscribed ads. In the incentive-based advertising, mobile users will be rewarded for receiving more promotions and providing their ad responses. In the location-based advertising, mobile ads are sent to mobile devices based on their location.

According to [4], the business workflow of mobile advertising process consists of three parties: a) publishers who manage and deliver an advertisement, b) advertisers who need to communicate advertisement to audience, and c) public mobile users who view the ads and may take responses to enable purchasing products from the posted ads. As discussed in [4], the process of mobile advertising includes six phases:

- *Ad space catalog*: The catalog, which is created and maintained by advertising publisher, contains the ad space basic information such as location, schedule, payment method, and current status.
- *Ad space trading*: The advertisers and publishers follow certain business steps and rules in order to initiate a business transaction.
- *Ad space schedule*: The advertisers and publishers make an agreement on when advertisement will be delivered.
- *Ad space fulfillment*: The publishers deliver the advertisement as committed.
- *Ad space measurement*: The publishers track and monitor the performance of the delivered advertisement.
- *Ad space payment*: After advertisement is delivered, the publishers collect payment from the advertisers based on the committed contract agreement.

Two other mobile advertising processes for publishers and ad service agencies are discussed in [1].

Personalization and mobility of mobile devices bring lots of business opportunities to mobile marketing and advertising. In the past years, lots of existing research work in different countries (Austria, Japan, Taiwan, and China) have shown the patterns of positive and negative attitudes (responses) of mobile consumers towards mobile advertising[11][12]. Informative and entertainment are the major factors that drive the mobile users to have positive attitudes (responses) and accept mobile advertising. In contrast, irritating is the most common negative attitudes (responses) of the mobile users thinking about mobile advertising, especially the ones that are sent without prior consent. Hence, it implies that permission-based mobile advertising might be a common approach in the future.

In wireless advertising, user privacy is always a major concern. There are a number of research papers addressing user privacy issue. For example, the MoMa project in [9] distinguishes public and private context information by requiring some personal information from users, such as profile information [9]. Another approach is to filter the ad information to separate the spam-messages from the real ads which are matched to pre-configured user interests and ad services [15]. A third approach given in [16] provides some ad search tools to allow mobile users to find the interested ads.

Recently, there are a number of papers discussed mobile advertising systems. One such advertising system is location based. In [10], the authors presented AdNext, A Visit-Pattern-Aware Mobile Advertising System for Urban Commercial Complexes. This system tracks the visited places by the mobile users, and uses a probability-based algorithm to predict the next places the same mobile users likely will visit. Based on the prediction, the system is able to provide the relevant ads relating to the predicted locations. According to [13], location-based context can be used in mobile advertising to increase the relevance of the advertisement delivered to the targeted consumers. Based on the research results given in [14], the closer to the physical location of promotional event where mobile consumers are, the more they respond to the received ad. Hence, location-based context can be effective for advertisers to create integrated mobile advertising strategies which suit the mobile users' interest at the right time and right place.

Unlike the research works addressed before, this paper presents a 2D barcode-based mobile advertising system, in which ads can be posted in diverse media (such as poster, newspaper, magazine, mobile page, and online page) with embedded 2D barcode. The barcode can be used to contain the related product information and shopping website URL address. As discussed in [8], 2D barcode-based advertising in mobile commerce offers three major benefits.

- An advertisement can be delivered in a small 2D barcode encoded with detailed product information for mobile users, including product supply-chain, product history information, and promotions and events associated.
- Capturing and decoding a 2D barcode in the posted ad, mobile users can easily discover the details about the product, and related information.
- Following URL in a 2D barcode, mobile users can easily browse to a merchant's website to conduct further m-commerce transactions, such as purchasing, payment, and delivery, as well as validation.

The authors in [8] presented our initial work in 2D barcode-based advertising. It focuses on how to develop 2D barcode-based advertising solution to support ad

posting and delivery in mobile content pages. In [8], the 2D barcode standard used is Data Matrix. In this paper, the presented AdTouch system can be considered as a major extension of the research work in [8]. Unlike [8], the AdTouch system developed and implemented a comprehensive solution to support 2D barcode advertising in diverse media, including posters, newspapers, magazines, and mobile pages. The major focus here is to support three different business workflows and to facilitate publishers and advertisers to generate, manage, deliver, and post 2D barcode based mobile ads. In addition, at the mobile client side, we used Android platform and technology instead of J2ME-based platform and mobile technology. Furthermore, QR barcodes are used instead of Data Matrix.

3 AdTouch System

This section presents our developed 2B barcode based advertising system for mobile commerce. It includes three parts: a) business workflows, b) system architecture and functional components, and c) used technology and implementation.

Business Workflows
Since the system supports different types of services to three types of users, three corresponding business workflows are designed and implemented.

- **Advertisement Business Workflow** - Figure 2 shows the business workflow for advertisers. Firstly, advertisers browse the advertisement catalog and book for advertisement spaces posted by publishers. Then, they provide a preferred advertising schedule and send a request to publishers for approval. Later, the advertisers provide the information for advertising payment contracts. Once an advertisement request has been approved by a selected publisher, the advertiser provides the detailed advertisement content and generates 2D barcode advertisement with a provided barcode generation function. Later, the advertisement will be sent to the publishers for printing and posting. After ad is posted, both advertisers and publishers are able to access ad performance information and reporting functions to track and evaluate the effectiveness of the posted ads.

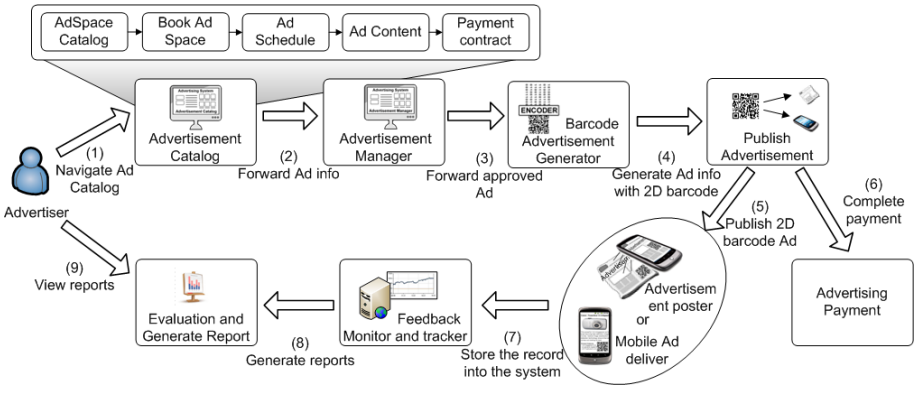

Fig. 2. The Advertisement Business Workflow

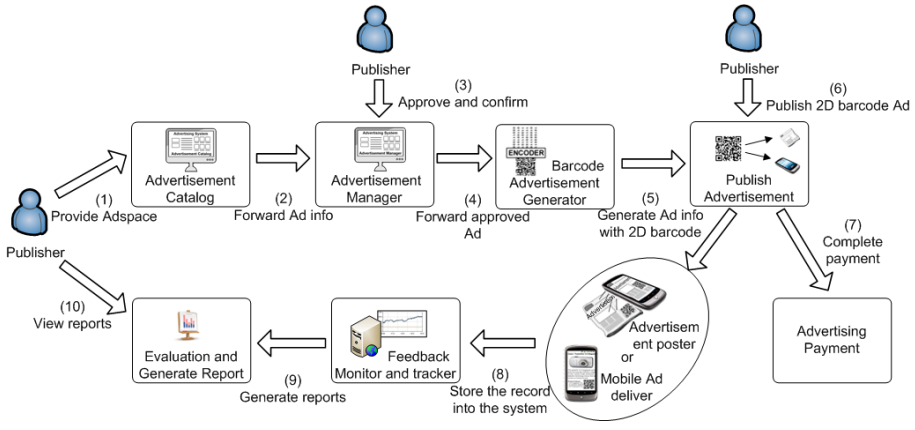

Fig. 3. The Publishing Workflow

- **Publishing Business Workflow -** Figure 3 shows the publishing workflow in which a publisher is able to access the provided online Ad Space Catalog to create, update, and delete their advertisement spaces. After advertisers check the advertisement space catalog and select ad spaces with their desired posting schedule using Ad Manager, they will need to send the request to publishers for approval. When publishers approve and confirm the posting schedule of an advertisement from the advertisers, publishers need to get the required ad information, generate and publish the corresponding 2D barcode with each confirmed advertisement. Then, publishers will post ads on publication media (such as magazines or posters), online or mobile advertisement spaces. Finally, when the ad is posted, publishers are able to access the advertisement performance report.

Mobile User Workflow to Access Mobile Ads

Figure 4 shows a workflow (or operation workflow) for mobile users. Mobile users can capture the posted 2D barcode in advertisement using the camera on their mobile devices. Then, they can view the decoded ad information from the captured 2D barcode, track the related product details, and connect to a mobile/online website from a merchant to conduct further M-Commerce transaction (such as shopping). The selected ad content and related merchant's URL can be stored for further retrievals for m-commerce. As shown in Figure 5, the AdTouch System supports four types of system users, including mobile users, advertisers, publishers, and system administrators.

AdTouch System Architecture and Components

As shown in Figure 6, the AdTouch system is structured as a three-tiered wireless internet application system below.

- ***The Client Tier*** - The client-tier is a presentation layer which supports the interactions between end users and different application servers in AdTouch. The online clients are developed to support publishers and advertisers to access different

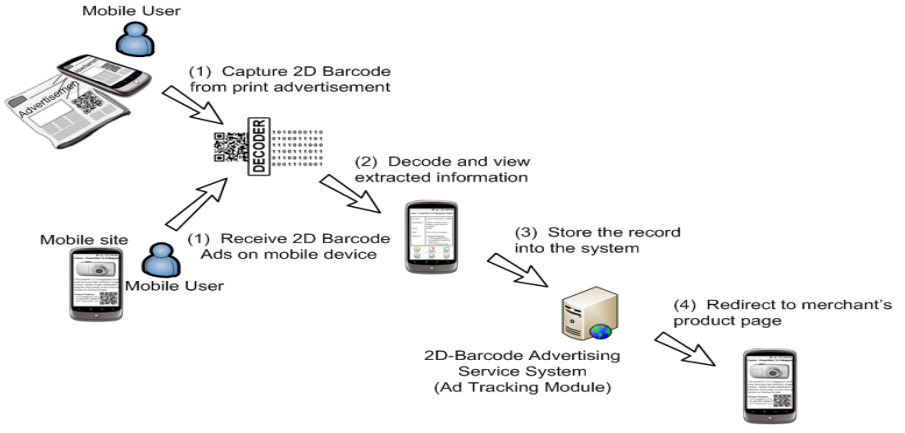

Fig. 4. Mobile User Workflow for Mobile Ads

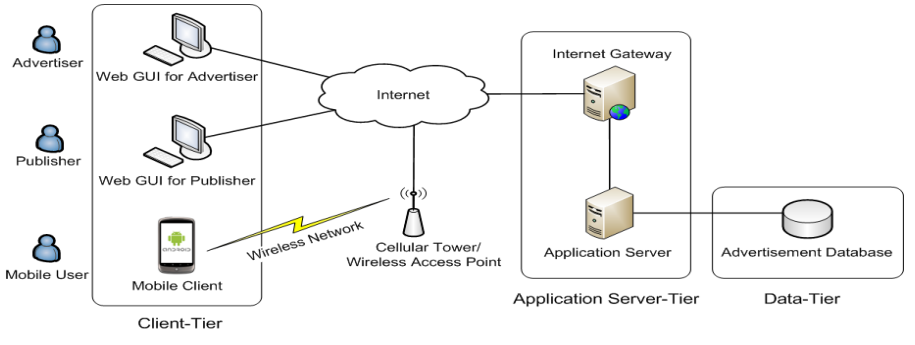

Fig. 5. The AdTouch System Architecture

types of service functions in the AdTouch system. Mobile client is implemented using Android platform, while online clients are developed as web applications.

- ***The Server Tier*** – The AdTouch server includes most of functional components. The application server is supported with middleware, such as web server and wireless server to interact with client software supporting mobile users at anytime and anywhere, as well as publishers and advertisers online.
- ***The Data Store Tier*** – This tier includes a database server (MySQL) and the database access program which manages the application database for mobile advertising, including ad-space catalog, advertisements and their posting schedule, as well as related barcodes and performance evaluation metrics.

AdTouch Application Server Architecture

Figure 6 shows the major functional components in the AdTouch application server. It is a web-based application server, which is developed based on Oracle's GlassFish application server (it is originally developed by Sun Micro System). The application server consists of the following major components:

- ***Advertisement Catalog –*** it offers an online accessible ad catalog for publishers and advertisers to list, select, search, and sort ad templates for ad spaces.
- ***Advertisement Manager –*** it controls and manages all of ads in the system to support advertisement posting, editing, deleting and retrieving. Moreover, advertisers can pick up an existing ad and preview it in a selected ad space.
- ***Advertisement Scheduler –*** it allows advertisers to schedule and manage ad posting schedule for their ads in each contracted ad space.
- ***Advertisement Space Manager –*** it controls the ad spaces in the system, such as adding, listing, editing, deleting, and retrieving ad spaces.
- ***Payment Contractor –*** it supports ad payment contracting and links to payment system to handle the payment process for advertising.
- ***User Profile Manager –*** it manages and controls the user profiles for all of existing users in the system, including advertisers, publishers, and mobile device users.
- ***2D Barcode Framework –*** It supports 2D barcode processing, such as: encoding, decoding, and displaying.
- ***AD Tracking Manager –*** It controls the tracking process so that the detailed steps of advertising process for each ad are tracked and monitored. In addition, all types of mobile users' reactions, behaviors, and responses can be tracked and stored in the AdTouch Server for ad performance evaluation later.
- ***AD Performance Evaluation*** - It provides different types of ad performance evaluation reports based on the stored tracking records about each ad space and its posted ads. This service function is very useful for both publishers and advertisers to understand the effectiveness of each ad space

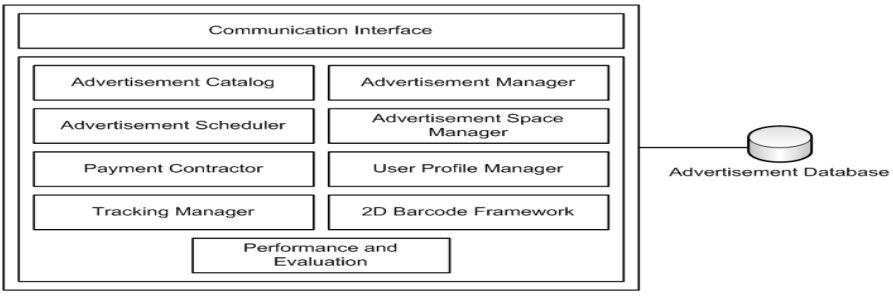

Fig. 6. The System Application Server Components

Mobile Client Architecture

AdTouch provides two kinds of user interfaces, a) online html-based user interfaces, this are particularly needed for the advertiser and the publisher, and b) android-based mobile user interface, which is primarily intended for the mobile users. Figure 7 shows the functional components in a mobile client. The following is a brief discussion of these components.

- ***Ads Web Viewer -*** This web viewer allows a user to view the ad contents.
- ***2D Barcode Framework (Detector/Decoder/Viewer) -*** This handles barcode decoding and content displaying.

- ***Ads Viewed Barcode Manager -*** This manages the viewed barcodes in a history file, so that mobile users can manage (retrieve and delete) stored barcodes in the history file as needed.
- ***Ads Detail viewer*** - This web viewer for detailed ad contents by retrieving 2D barcode data and provide means for following the embedded URL to merchant website.
- ***Print 2D Barcode Ads Retriever –*** This retrieves captured barcode information to mobile client user.
- ***Ads Tracker -*** This supports the ad tracking and performance reporting as a part of the application server.

In addition, it also includes some security functions, such as authentication and session management. To support 2D barcode capture function, we developed an abstract camera API stacked on top of the existing camera API given in the Android platform to increase the portability of the mobile client. Besides, the mobile client has a location-based service interface which connects to another location-based mobile ad system. Furthermore, a temporary storage is used on the mobile client side to keep certain ad tracking data and the storage of the temporary barcodes to support the viewer component. The mobile client architecture is shown in Figure 8.

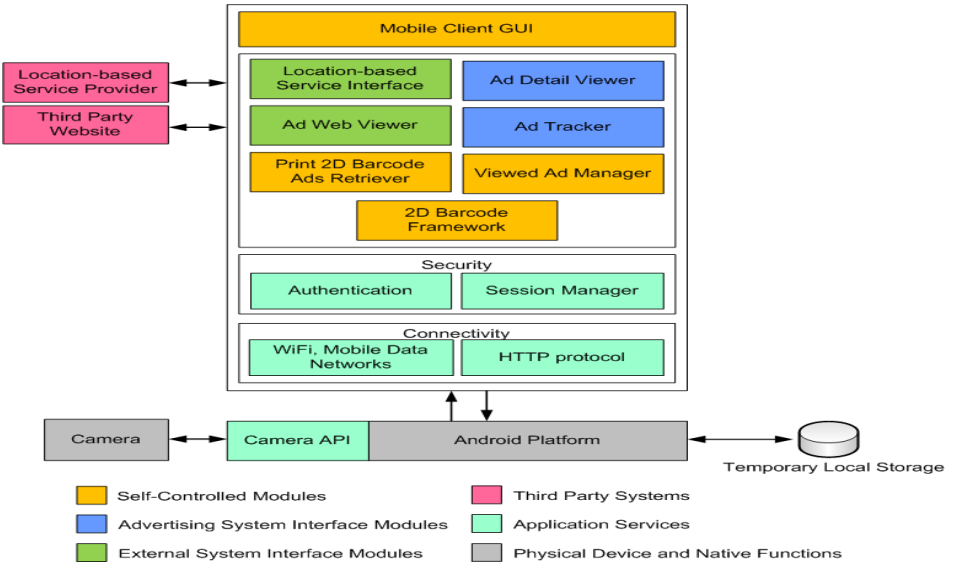

Fig. 7. Mobile Client Architecture in AdTouch

Implementation Solutions and Technology:

- ***Ad space formats and types:*** For publishers, AdTouch provides four types of ad spaces for different media, including poster, billboard, online page, and magazine. Meanwhile, certain types of ad space templates are provided for users to choose.

- ***Advertisement types:*** AdTouch currently supports different types of advertisements, including coupons, promotion ads, and product ads. Each advertisement includes 2 parts: a) a 2D barcode of the ad, and b) the detailed ad information. Whenever an ad is created or uploaded to the system, its corresponding barcode can be generated.
- ***Communication support:*** The communication between clients and the AdTouch server is supported by the RESTful protocol. The Spring Framework provides an easy way to connect third-party applications using the RESTful protocol. Moreover, it supports many data formats, such as JSON and XML, which allows the server to read/write and convert XML easily.
- ***Mobile client implementation:*** On the mobile client side, Java-based Spring Framework is used to build the mobile client using the Android device platform. Its advantage is to separate mobile client software into three parts: model, viewer and controller. In addition, a set of Android APIs are used, including Camera APIs, SQLite, GPS APIs, Zxing Barcode APIs. In order to avoid the dependency of Android-specific camera API, an abstract layer of the camera API was developed.
- ***Server implementation:*** The AdTouch server is developed using the MVC Spring Framework technology based on a Glassfish Application Server. JSP technology is used to present dynamic HTML pages, and Servlets are used to handle web users' requests. In addition, a MySQL database server is used to support data storage, persistence, and data access in the mobile advertising database.

4 System Application Scenarios

This section provides a scenario going through a completed scenario that accesses the primary functional operations in the system. The scenario starts with ad and ad-space creation until the ad has been published. Then, it is followed by mobile usage scenario in which a mobile user captures and accesses the published advertisement.

Step 1: A publisher creates user account and the related login access information.
Step 2: A publisher creates any ad space for advertiser to pick this ad space.
Step 3: An advertiser logins as a user.
Step 4: Advertiser enters a product's information and its ad.
Step 5: Advertiser picks an advertisement space.
Step 6: Once the ad space selected, publishers have to review and approve or decline it.
Step 7: After advertisement has been approved, contract is created.
Step 8: Advertisement is posted.

Due to paper size limitation, screen captures from some of the web client operations are provided in attached figures. Figure 8 shows the web client start screen. Figure 9 presents the ad space catalog screen. Figure 10 shows an ad with a QR barcode.

Fig. 8. Web Client Start Screen

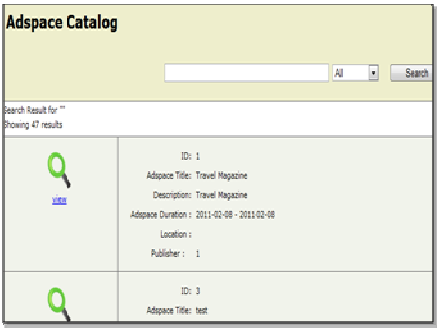

Fig. 9. Ad Space Catalog Screen

Fig. 10. Advertisement with a QR Code

The mobile user scenario is given below:

Step 1: A mobile user starts a mobile client.
Step 2: A mobile user captures the barcode in a posted advertisement.
Step 3: A mobile user views the ad contents by decoding the captured barcode in ads.
Step 4: Advertisers/publishers can track the responses of the ads in ad spaces.
Step 5: Advertisers/publishers are able to access and check ad tracking states.
Step 6: Advertisers/publishers access the different summary reports.

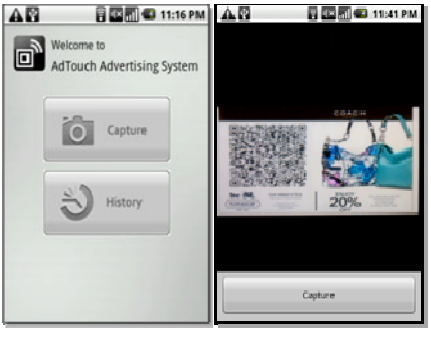

Fig. 11. Mobile Client Barcode Capturing Screens

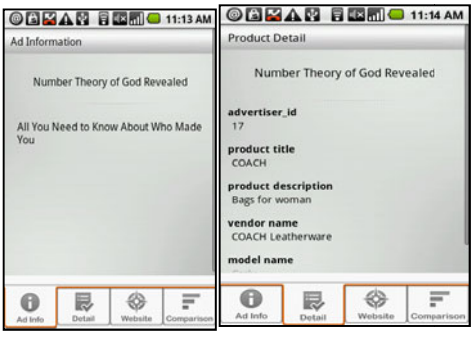

Fig. 13. Mobile Ad Detailed Screens

Due to the paper size limitation, only a few of the mobile client screens are presented here. Figure 11 presents the mobile client screens where a user is able to capture 2D barcodes in any posted ad and views it on a mobile device. Figure 12 shows the mobile screens that allows a mobile user to access the decoded ad contents. Figure 13 displays mobile tracking screens for advertisers, and Figure 14 shows the online tracking support.

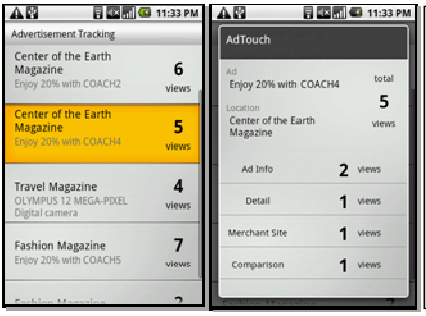

Fig. 13. Mobile Ad Tracker Screens

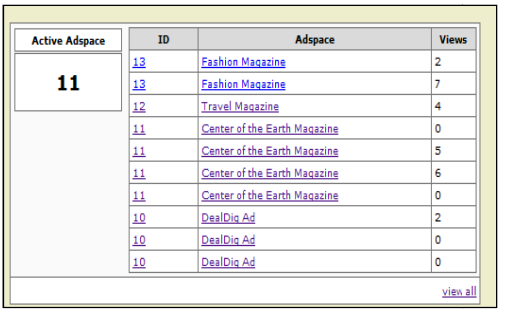

Fig. 14. Web Ad Tracker Screen

5 Performance and Benchmarks

Certain performance tests are conducted to measure the speed and response time of the AdTouch System from the mobile client side. We selected three scenarios from a mobile client to measure: (a) page querying, (b) ad status tracking and update, and (c) QR barcode decoding time. We performed the tests by collecting and tracking operation time for each task. For each scenario, we performed multiple tests and find the associated performance, such as the average user-oriented response time. For system validation, mobile clients are used to connect to the application database server in AdTouch over a wireless internet.

Page Loading Performance

In this test set, we measured the page loading time for mobile clients, including the pages in Ad Information, Product Detail, Merchant Site, and Location-Based Price Comparison. The detailed test results are given in Table 2.

Table 2. Page Loading Performance

Processing Time (msecs)	Test 1	Test 2	Test 3	Average
Ad Information Page	30	28	47	35
Product Detail Page	3630	1711	1292	2211
Merchant Site Page	30	24	31	28.3
Location-Based Price Comparison Page	2737	3124	3598	3153

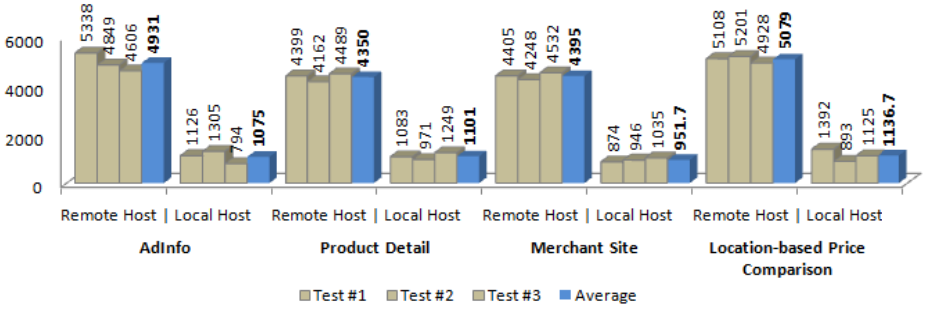

Fig. 15. User Response Performance

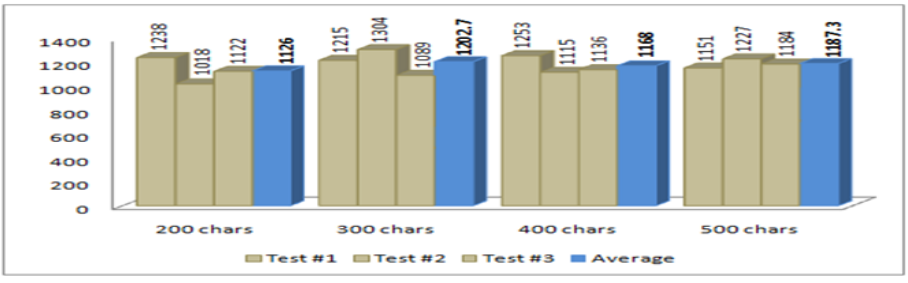

Fig. 16. QR Code Decoding Performance

Performance of Tracking Status Updating

When mobile users open a page in the mobile client, the system updates the advertisement status to the server. In this test set, we measured the performance of ad updating and tracking for a mobile client. This test set includes different mobile client pages, including Ad Info, Product Detail, Merchant Site, and Location-based Price Comparison. The detailed results are shown in Figure 15.

QR Barcode Decoding Performance

We also conducted some performance tests on QR code decoding feature. QR barcodes with different lengths of characters are tested. Figure 16 shows the detailed decoding performance data for QR barcodes. The average decoding time was approximately one second for each QR barcode. However, the current prototype has a limitation to support QR barcodes with more than 600 chars due to the limited memory sixe on the mobile device (T-Mobile G1).

6 Conclusion and Future Work

This paper presented a 2D-barcode based mobile advertising service system, known as AdTouch, which provides a direct channel among publishers, advertisers, mobile users, and merchants. All advertisements are created with accessible QR-based 2D barcodes for advertisers to allow mobile users to connect to merchants' websites anywhere and anytime.

This paper reports the developed business processes, system architecture, and design, as well as its implementation. For future research, we are working on the integration of other mobile-based advertising techniques and solutions, such as location-based and context-based methods. Meanwhile, we are developing mobile targeting techniques to enhance and improve the effectiveness of mobile advertising. Finally, we are building a new service-oriented advertising system in clouds.

References

1. Gao, J.Z., Shim, S., Su, X., Mei, H.: Engineering Wireless-Based Software Systems and Applications. Artech House Publishing, Boston (2006)
2. Ohbuchi, E., Hanaizumi, H., Hock, L.A.: Barcode Readers using the Camera Device in Mobile Phones. In: Proceedings of the International Conference on Cyberworlds, Washington D.C. (2004)

3. Yunos, H.M., Gao, J.Z., Shim, S.: Wireless Advertising's Challenges and Opportunities. IEEE Computer 36 (2003)
4. Gao, J.Z., Ji, A.: Smart Mobile AD: An Intelligent Mobile Advertising System. In: 3rd International Conference on Grid and Pervasive Computing (2008)
5. Chen, P.-T., et al.: Broadband Mobile Advertisement: What are the Right Ingredient and Attributes for Mobile 14 Subscribers. Management of Engineering &Technology (2009)
6. Houston, F.S., Gassenheimer, J.B.: Marketing and Exchange. Journal of Current Issues and Research in Advertising 51 (1987)
7. Dezoysa, S.: Mobile Advertising Needs to Get Persona. Telecommunications International (2002)
8. Gao, J.Z., et al.: A 2D-Barcode Based Mobile Advertising Solution. In: 21st International Conference on Software Engineering & Knowledge Engineering (SEKE), Boston, Massachusetts (2009)
9. Bulander, R., et al.: Advertising Via Mobile Terminals–Delivering Context Sensitive and Personalized Advertising While Guaranteeing Privacy. In: E-business and Telecommunication Networks. CCIS, vol. 3. Springer, Heidelberg (2007)
10. Kim, B., et al.: AdNext, A Visit-Pattern-Aware Mobile Advertising System for Urban Commercial Complexes. ACM HotMobile (2011)
11. Haghirian, P., et al.: Mobile Advertising in Different Stages of Development: A Cross-Country Comparison of Consumer Attitudes. In: Proceedings of the 41sth Hawaii International Conference on System Sciences (2008)
12. Tsang, M.M., et al.: Consumer Attitudes Toward Mobile Advertising: An Empirical Study. International Journal of Electronic Commerce 8(3) (2004)
13. Goh, K.Y., Chu, H., Soh, W.: Mobile Advertising: An Empirical Study of Advertising Response and Search Behavior. In: Proceedings of ICIS (2009)
14. Bruner II, G.C., Kumar, A.: Attitude Toward Location-based Advertising. Journal of Interactive Advertising (2007) retrieved from, http://jiad.org/article89
15. Kim, Y.S., et al.: Mobile Advertisement System using Data Push Scheduling based on User Preference. In: Wireless Telecommunications Symposium (2009)
16. Lovitskii, V., et al.: Mobile Search and Advertising. In: Second International Conference on Intelligent Information and Engineering Systems (2009)