

An English-Chinese Learning System using J2ME and Java Servlets

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Abstract

Mobile phones offer a variety of interesting and exciting applications. A mobile phone can be a communication device, an entertainment device, and a learning device. J2ME is a popular platform for mobile phone applications. In this paper we present an English-Chinese learning system which is built using J2ME and Java servlets. The system allows users, especially, those who understand Chinese, to have fun playing while learning English on a mobile phone. The users can learn and play on the system anytime and anywhere.

The system comes with various features including an online dictionary and various games such as a hangman game, a word scramble game, a multi-player word guessing contest, and a crossword puzzle. Multiple choice questions for idioms and vocabularies are also available for both self-test and fun. Learning through playing is always an effective and inspiring way of learning. This paper describes the design, the implementation, and all technologies that need to construct such a system.

Keywords: J2ME, e-learning, Java servlet, Apache Tomcat server, Java gaming

1 Introduction

Wireless Internet becomes more and more accessible when mobile phones, wireless LAN, and 3G systems become more and more pervasive. The world-wide mobile phone users were reported to reach 2 billions in third quarter of 2005 [1]. With the deployment of 3G systems, higher data transfer rate is available. A variety of applications have been developed on mobile phones. A mobile phone can be a communication device, an entertainment device, and a learning device. The users can learn and play on mobile phones anytime and anywhere. In this paper, the development of an English-Chinese learning system that can run on mobile phones is introduced.

When people come across a word or a symbol that they do not understand, they usually tend to look it

up into a dictionary to get a clear understanding of its meaning. The traditional dictionary is a book of words listed in alphabetical order. A lot of time gets wasted on looking through the book to search for the meaning of the desired word. An online dictionary on the other hand not only saves the search time but also makes the process a lot easier and faster. While browsing through the online dictionary just needs to enter the word for which the meaning is to be found, within no time the meaning of the word is fetched.

Online word dictionaries, vocabulary games and crossword puzzles not only make things easier and efficient but also strengthen and enhance a person's vocabulary skills. These interactive games give them a chance to test themselves and widen their knowledge in a language. A digital learning system is not only challenging but also is the home of great fun.

Nowadays, Java 2 Platform, Micro Edition (J2ME) [<http://java.sun.com/j2me>] has become a platform for embedded consumer products such as PDAs, mobile phones, and other consumer appliances. "English-Chinese Learning System using J2ME and Java Servlets" presents a prototype system that allows users, especially, those who understand Chinese, to have fun playing while learning English on J2ME platform such as a J2ME-enabled mobile phone.

In this paper, the design and implementation of the system are described. The various aspects of the system are exploited. The online dictionary is one aspect of the system which allows users to enter a word and find its meaning in English and Chinese, its function such as noun, adjective, adverb, etc., its pronunciation, and sample sentences. A user is provided with the feature of listening to the audio pronunciation of the word. The system contains a hangman game, a word scramble game, a word guessing contest which is a multi-player hangman game, and a crossword puzzle. The hangman game and word scramble game are played between a player and the computing device. The multi-player word guessing contest allows multiple users to guess a word puzzle. The winner is credited by the winning points. The crossword puzzle gives the player hints about the word and the user has

to answer the past tense of the given word. Multiple choice questions for idioms and vocabularies are also available for both self-test and fun. The system is implemented using J2ME, Java servlets, MySQL DBMS, and Apache Tomcat server. The user can access the system through the J2ME interfaces or a browser. The request is sent to a Apache Tomcat server that holds Java servlets. The database access request is relayed from the Apache Tomcat server to MySQL DBMS.

The contributions of this paper are: 1) to introduce a new J2ME application; 2) to show a Chinese-English e-learning system that is fun, interactive, mobile, and wireless; 3) to present an online audio Chinese-English dictionary that can be accessed on a J2ME-enabled device; 4) to describe the design, the implementation, and all technologies that need to construct such a system; 5) to provide a template for a multilingual learning system.

This paper goes through the design and implementation of an English-Chinese learning system using J2ME and Java servlets and presents its user interfaces. The system is built for the mobile and wireless environment. The second section reviews current development platforms for mobile phone applications. The third section describes the system design and implementation. The fourth section presents the user interfaces. The final section concludes the research and describes the future work.

2 Development Platforms for Mobile Phone Applications

There are two inherent constraints imposed on mobile phone applications: the limited device resource and network connection. Usually, a mobile phone has limited computing ability, memory, and significantly smaller screen size. The mobile and wireless networks suffer from low bandwidth, high network latency, and mobility nature. Though fast advance of technologies made devices and network more powerful, device and network constraints are two major considerations while developing applications on mobile phones. To cope with the device resource constraint, the application code is made smaller and more suitable to the smaller screen. To deal with the network constraint several techniques such as data compression, timeout mechanism, movement and action prediction are used [4]. Specific protocols for mobile devices such as Session Initiation Protocol (SIP) [7] and Mobile IP [3] have also developed. Because of device and network constraints specific development platforms for mobile phone applications are required.

Currently, there are a number of platforms in which mobile applications can be developed. Seven platforms are introduced below: BREW, J2ME, Linux, .NET Compact Framework, Palm OS, Savaje,

and Symbian, This article is not focused on platform comparisons or intended to make the conclusion on which is the most suitable platform for mobile application development. The major features of each platform are mentioned. This would give developers a quick grasp on the platforms introduced and allow them more easily to make the choice based on their specific considerations.

Binary Runtime Environment of Wireless (BREW) [<http://brew.qualcomm.com/brew>] basically is a set of APIs that are specific for mobile phone applications. BREW applications can be written in C and C++. BREW also supports integration of Java applications, if a Java Virtual Machine (JVM) is available on the device. The developers can directly access the device so the code written could be more efficient. The BREW development tools, BREW SDK, can be downloaded without any charge for the developers but the fee will be imposed on the applications for the commercial use.

Linux has been a popular operating system since its appearance in 1991. Linux mobile phones were first introduced by Motorola in 2003. But the native application development tools were not available for third-party developers and they had to write applications on a JVM. Then in 2005 a group of telephony operators, device manufacturers, silicon and software vendors found The Linux Phone Standards Forum (LiPS) [<http://lipsforum.org>]. The goal of LiPS is to define a standardized software platform which allows applications and services to be deployed across all types of Linux telephony terminals. It is expected LiPS will produce development specifications in the near future.

The .NET Compact Framework was introduced in the Microsoft .NET initiative as a platform for developing applications for mobile devices, specifically for those running on Windows Mobile or Windows CE OS. Windows Mobile OS has been seen more and more on high-end mobile phones. The .NET developers will find the similar development environment for them. The disadvantage of .NET Compact Framework is it is only available on Microsoft's systems at this moment.

J2ME, a flavor of Java architecture, is aimed at low memory consumer devices. The biggest benefit of using J2ME for wireless device development is the ability to produce portable code that can run on multiple platforms. The disadvantage of J2ME is the lack of direct control over a lot of functionality of mobile phones. But more and more J2ME APIs are available.

Palm OS [<http://www.palmsource.com/palmos/>] is an operating system first introduced in 1996 for handheld devices. There are several developer tools available on Palm OS such as Palm OS Developer Suite, Palm OS SDK, Palm OS Simulator, and Palm Desktop SDK.

Savaje [<http://www.savaje.com/>] is a fully-featured native Java OS. It is first demonstrated on

an iPAQ. LG has announced to deliver mobile phone based on Java OS in 2006. Obviously, the advantage of SavaJe is that Java applications are running on a native environment instead on a JVM that is running on other operating system.

Symbian [http://www.symbian.com] was founded in June 1998 by several mobile phone manufacturers. Symbian OS is a powerful and complex operating system that is particularly designed for mobile phones. Symbian SDK is the tool used for developing applications on Symbian OS. SDKs for Symbian OS support development in both C++, Java, and Open Programming Language (OPL) that is an interpretive programming language specific for Symbian. SDKs are in practice built based on a particular User Interface (UI) platform for Symbian OS. So a developer needs to know which UI platform is associated with the targeting phone.

There is still high debate and competition on which development environment is most advantageous and possibly dominate the market [2, 8]. There is a variety of forums for different supporters. .NET Compact Framework is gaining popularity because of the growth of Windows Mobile OS and a large base of .NET developers. Although J2ME is not an operating system, J2ME is chosen in this research because it is the only cross-platform development environment for mobile and wireless devices. J2ME can be installed on most platforms mentioned above.

3 System Design and Implementation

The following softwares are used to develop the system:

- J2ME Wireless Toolkit - a set of tools for creating Java applications on mobile devices. Before using the Wireless Toolkit, Java Development Kit (JDK) needs to be installed.
- Apache Tomcat [http://tomcat.apache.org] - a Web/application server based on the Java servlet and JavaServer Pages (JSP) technologies.
- Java 2 Platform, Standard Edition (J2SE) Software Development Kit (SDK) - an integrated Java program development environment used to create Java servlets for Apache Tomcat.
- MySQL [http://www.mysql.com] - the database system used in the system design.
- Java Database Connectivity (JDBC) for MySQL - Java classes used to connect to the MySQL database system.

Java programs are usually called Java classes. J2ME Wireless Toolkit is used to develop the client-side classes. J2ME is composed of the Connected Limited Device Configuration (CLDC) and the Mobile Information Device Profile (MIDP). CLDC specifies the

basic set of application programming interfaces and a virtual machine for mobile devices [5]. MIDP is a profile that provides the solid Java runtime environment for mobile devices when combined with the CLDC [6]. Our system is based on J2ME-enabled devices with MIDP 1.0/2.0 and CLDC 1.0/1.1 support. J2SE is required for J2ME and used to develop the servlets to be deployed in Apache Tomcat. Apache Tomcat is the container to store all server-side programs. MySQL DBMS is used to store the data used in the system.

Figure 1 shows the general architecture of the system. The HyperText Transfer Protocol (HTTP) is used for the data transfer between the client and the server. It consists of the following components:

1. J2ME client - the user interface that facilitates access to the system on mobile phone.
2. Web page client - the page that allows access to the system from a Web browser.
3. Servlet container - the server used to store the servlets which response the requests from a J2ME client or a Web page client.
4. The DBMS which provides SQL processing and data storage management.

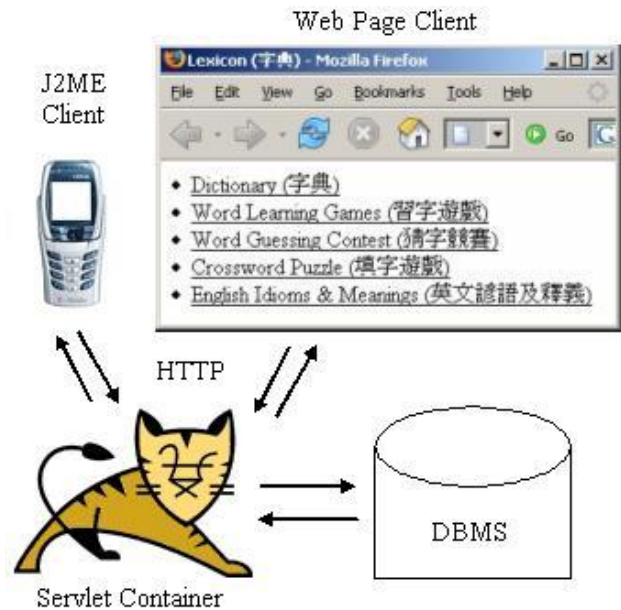


Figure 1. System Architecture

The tables in the database is described in Table 1. The data is stored in the 8-bit Unicode Transformation Format (UTF-8) that allows multilingual data to be stored in the same data field of a database table.

The system is built on client-side classes running on J2ME and server-side classes, namely Java servlets, running on Apache Tomcat. To run a Java class on J2ME-enabled devices, a special type of applet called MIDlet is required. The classes used to build the system are shown in Table 2.

Table Name	Attributes
dictionary	entry, function, meaning, and Chinese explanation of the word
idiom	idiom and its Chinese explanation
score	the name and score of players
sentence	entry, function, Chinese explanation, sample sentence, and Chinese explanation of the word

Table 1. Tables in the database

Client Classes	
Class name	Function
LexiconMidlet	the main MIDlet that initiates the system and presents the main menu
PuzzleClient	an interface for the word guessing contest
PuzzleMidlet	a MIDlet for the word guessing contest
Utility	supporting functions used in LexiconMidlet, PuzzleClient, and PuzzleMidlet
Server Classes	
Class name	Function
LexiconService	the main Java servlet that replies the requests from LexiconMidlet
PuzzleService	the Java servlet that replies the requests from PuzzleClient and PuzzleMidlet

Table 2. Classes

The details about creating MIDlets and servlets and the code optimization are not discussed in this paper. The interested readers can refer to related books for both topics. In this paper programming techniques such as multi-threading and media control are discussed.

When using an interactive system many tasks occur simultaneously. Multitasking can be achieved by using Java's multithreading capabilities. A thread is a path taken by a program during execution. An application is made faster, more interactive, and flexible by executing through multiple paths. In many cases the user interface is waiting for user's input and meanwhile needs to send the request to the server. Without using threads the client is blocked until the reply is returned. For each function that involves server requests a thread is created.

Threads also play an important role in a multi-player game. In the multi-player word guessing contest of the system a thread is running in the background to acquire the status of the game periodically. In order not to consume too much computability and network communication we set the period of update by using the `sleep` method in the `Thread` class. In our experiments two updates per second are enough. A special

flag called `running` is used to indicate if the thread should be stopped or not. When the contest is over, the `running` flag is set to be false so that the thread will not run forever. Similar techniques are used in gaming design because a callback J2ME or Java servlet is not really feasible.

Multimedia can provide a more effective and interesting learning environment. The online dictionary of the system allows the user to hear the pronunciation of a word. Playing multimedia can be accomplished by the `Player` class in J2ME. The typical code looks like:

```
Player player = Manager.createPlayer(url);
player.start();
```

The parameter of the `createPlayer` is the Universal Resource Locator (URL) of the media. Hence, the media can be any location on the Internet.

4 User Interfaces

To run the system, first start the Apache Tomcat server and then run the emulator from the J2ME Wireless Toolkit. The emulator opens up with the application option on the screen. The system contains two applications to be launched: the Lexicon and Word Guessing Contest. The Lexicon contains five options: Dictionary, Word Learning Games, Word Guessing Contest, Crossword Puzzle, and English Idioms as shown in Figure 2.



Figure 2. Main Menu of Lexicon Application


Dictionary that shows the button for the word and idiom of the day and the query interface to look up a word. When the user clicks the `Details` button, the word and idiom of the day is presented as shown in Figure 3. The users can click an audio icon  to hear the pronunciation of the word. When the user enters a word, the word is sent to the lexicon database on the server and the result is returned.



Figure 3. Word and Idiom of the Day

Word Learning Games that presents a menu of hangman game, word scramble game, and multiple choice quiz. After selecting the hangman game, the game is started. When the user makes the correct guess, the correct letter is exposed. When the user makes the wrong guess, the hangman diagram is advanced as shown in Figure 4. The user can guess the word character by character or solve the word at once. After nine wrong trials, a complete hangman diagram is presented. When the user click the word scramble game, the word is scrambled as a puzzle. The user needs to guess the correct word. In the multiple choice quiz the user is given Chinese or English word and needs to choose the correct English or Chinese translation that matches the meaning of the given word.



Figure 4. Hangman Game

Word Guessing Contest presents a menu of play, query score, and top 10 scores. When the play option is chosen, an interface to a word guessing contest of multiple players is shown. A player needs to input

her name first. Each player takes turn to guess the word. If a player guesses right, she can continue to guess. Otherwise, it is the turn for the next player. If a player tries a guess when it is not her turn, there is no effect on the game. The information about whose turn to play and the puzzle is updated periodically. A player can join and quit the game at any time. The score is accumulated for each correct guessing letter. When a player guesses the word correctly, the game is over and the winner is announced to every player. Then the score is presented to the winner, sent to the server, and stored in the database as shown in Figure 5. When a player quits the game in the middle of game, the game is over.

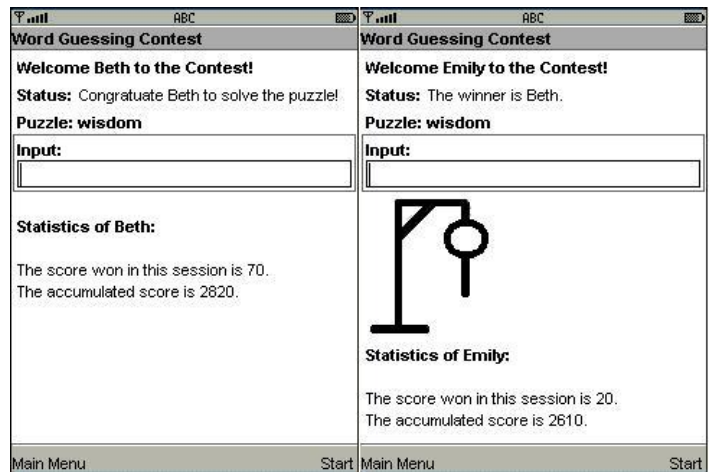


Figure 5. Word Guessing Contest

Crossword Puzzle portrays a crossword puzzle. The user needs to write the past tense of the verb words given as hints across and down as shown in Figure 6. The user can click the Verify button to check if the answer is correct or not. If the user fills out all blanks and answers correctly, a congratulation message is shown. Otherwise, the wrong guesses are cleared and the user keeps solving the puzzle.

English Idioms & Meanings depicts a multiple choice quiz. The user is given the Chinese translation and needs to choose the English idioms that matches appropriately as shown in Figure 7. If the user answers the question correctly, the score is accumulated. If the user's answer is incorrect, the correct answer is shown. The user can continue the quiz, the score is accumulated.

The application of Word Guessing Contest is an independent application that can be run without accessing it from the Dictionary application. The users who just want to play the word guessing contest can just download this application and play it. Because the server is a Web server, the system can be accessed through a Web page as shown in Figure 1.

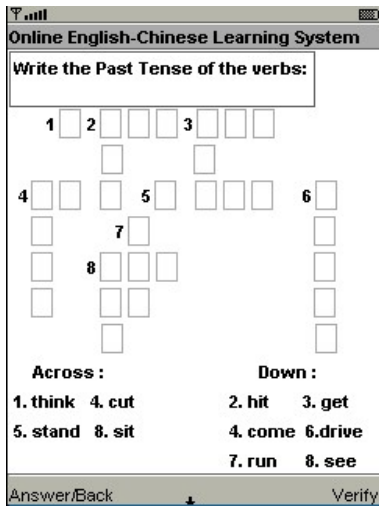


Figure 6. Crossword Puzzle

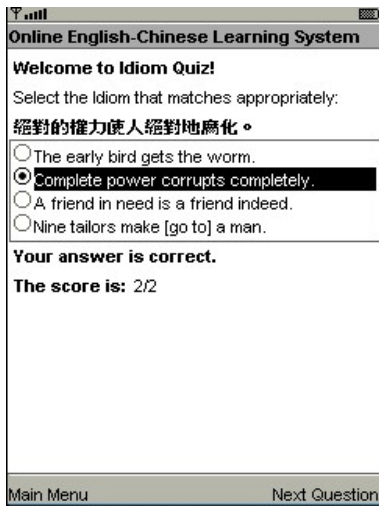


Figure 7. Multiple Choice Quiz

5 Conclusion and Future Work

In this paper we review the current development platforms for mobile phone applications and present the design and implementation of an English-Chinese learning system using J2ME and Java servlets. The system provides users with easy and efficient access to the dictionary. The various word games not only help users learn effectively but also gain great fun. A user can learn and play on the system anytime and anywhere.

The system is still evolving and the future work includes:

- Enhancing the content. Currently the database has a limited content. Nowadays, simplified Chinese has much more users than traditional Chinese. We can either develop or use some conversion program to convert between them. We can also cooperate with the content providers so

that the dictionary and idioms can be abundant in both simplified and traditional Chinese and moreover multilingual. More multimedia content can also be included.

- Creating more variety of games. For example, a crossword puzzle game can be dynamically constructed based on the data that is randomly selected from the database.
- Deploying and testing the system on a mobile phone. In this way we can gain the practical information about the bandwidth and latency so that we could tune performance of the system by adjusting code.
- Optimizing code. The purpose is to make code faster and smaller.
- Cooperating with a telecommunication company. This will make the system meet the demand of the industry and market.
- Using different technologies such as Web Services, ASP.NET, or PHP to implement the system.

References

- [1] GSM Association. GSM Subscriber Statistics. <http://www.gsmworld.com/news/statistics/index.shtml/>, 2006.
- [2] P. Coulton, O. Rashid, R. Edwards, and R. Thompson. Creating Entertainment Applications for Cellular Phones. *ACM Computers in Entertainment*, 3(3):1–12, 2005. Article 3B.
- [3] C. Perkins (Ed.). IP Mobility Support for IPv4. *IETF RFC 3344*, August 2002.
- [4] W. K. Kan and C. Y. Hong. Plotting Massively Multiplayer Online Game to Mobile: Constraints and Considerations on Networking. In *International Conference on Wireless Networks (ICWN 2005)*, pages 361–367, June 2005.
- [5] Java Community Process. *JSR-139 Connected, Limited Device Configuration Specification Version 1.1*. Sun Microsystems, 2003.
- [6] Java Community Process. *JSR-118 Mobile Information Device Profile 2.0*. Sun Microsystems, 2004.
- [7] J. Rosenberg, H. Schulzrinne, G. Camarillo, A. Johnston, J. Peterson, R. Sparks, M. Handley, and E. Schooler. SIP: Session Initiation Protocol. *IETF RFC 3261*, June 2002.
- [8] Pei Zheng and Lionel M. Ni. The Rise of the Smart Phone. *IEEE Distributed Systems Online*, 7(3), 2006. art. no. 0603-o3003.