Exploring Chinese through Learning Objects and Interactive Interface on Mobile Devices

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***Abstract*—With its unprecedented economic growth, China has gradually developed its significant influence on the global stage in recent years. As a result, there are increasing interests to learn Chinese all over the world. Intrinsically, learning Chinese is challenging to most foreigners and Chinese students as well due to the complex structures of Chinese Characters, the writing of characters in correct stroke sequences, and their appropriate usage and pronunciation, etc. Even with the guidance of an experienced Chinese teacher, there is often insufficient time to practise the writing or pronunciation during classes. However, mobile devices such as the iPads or iPhones may open up numerous opportunities facilitated by the latest interface and sensing technologies for students to learn anytime and anywhere. Therefore in this project, we propose an extendible application based on learning objects which can fully utilized these features including the GPS, touch screen and camera of mobile devices to facilitate foreigners or Chinese students to learn Chinese more effectively. More importantly, we have designed an intelligent algorithm to help students in writing Chinese characters with correct stroke sequences. To demonstrate the feasibility of our proposal, a prototype of our proposed e-learning software is built on the iOS platform, and will be evaluated with a thorough plan. Furthermore, there are many interesting directions for further investigation of our proposal.**

***Index Terms*—Chinese characters; learning objects; mobile devices; e-learning systems; stroke sequences**

I. INTRODUCTION

There is a growing demand on learning Chinese due to the rapidly economic development and increasing political influence of China in the global stage in the past decade. To learn any language, we need to master the four basic skills including listening, speaking, reading and writing. Besides, writing Chinese characters with correct stroke sequences is conventionally important yet challenging due to the complicated structures and the diversity of Chinese characters. However, there are very few e-learning systems that can effectively handle the complex structure of Chinese characters, efficiently recognizes the strokes and their sequences, and ultimately analyzes on each user's behavior based on individual strokes written by him/her.

Nowadays, mobile devices are typically equipped with high-resolution touch screens, GPS sensors, digital cameras of reasonable quality, web browsers that can quickly access various web pages with very high-speed data access via Wi-Fi, 3G or 4G connectivity. Obviously, smartphones or tablets can provide a more potential mobile learning platform with great convenience for students to master the learning of Chinese characters or culture on their portable devices at their own pace anytime and anywhere. With the numerous powerful features including the high-resolution cameras, GPS sensors, high-speed Internet connectivity available on our mobile devices, there are many possible extensions in the next-generation e-learning systems for learning Chinese. Therefore in this project, we propose to develop an intelligent software integrated with learning objects and many useful features of mobile devices to help foreigners or Chinese students mastering the Chinese characters through their correct stroke sequences, basic meanings, pronunciation and usage of the concerned characters.

This paper is organized as follows. Section II details the system design of our proposed learning object based Chinese writing system on mobile devices such as the iPhone or Pad to enhance learners' experience for learning to write or speak Chinese. We give an empirical evaluation of our proposal on various criteria in Section III. Lastly, we summarize our work and shed lights on future directions in Section IV.

II. SYSTEM DESIGN AND FEATURES

Our proposed system is aimed to provide a sophisticated learning platform where students can learn the complete aspects of Chinese. In the system, students can learn the basic information of each Chinese character including its radical, stroke sequences, pronunciation, etc. They can also practice how to write the character in correct stroke sequences through an intelligent stroke recognition algorithm. To encourage collaboration in the learning process, an interesting feature for social networking is integrated into the system.

As clearly shown in Figure 1, all the above features are carefully categorized under the three basic functions for demonstration, practice, and evaluation of the proposed e-learning system.

In the demonstration part, our e-learning system will provide the basic information of each character to the students. There are altogether 6077 Chinese characters available in our

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system, including their radicals, spelling, pronunciations, stroke sequences, relevant phases and English translations. Moreover, a word net of Chinese characters was built in our proposed system [5]. Essentially, the word net is a lexical database of all the stored Chinese characters. We grouped the Chinese characters according to their radicals, spelling and numbers of strokes. Each character has its own cluster/set of related characters that will have a close relationship with the concerned character being placed in the center of the cluster.

Figure 1. The design of the system.

For the practice part, our proposed system will show the correct stroke sequences in writing each Chinese character through live animations for students to learn when their inputs are recognized as incorrect. The simplest yet highly efficient Wu-Bi method is used to check against each stroke of the involved Chinese character against its five basic strokes that includes : ***1***) heng 横(一), ***2***) shu 竖(丨), ***3***) pie 撇(丿), ***4***) dian 点(丶) and ***5***) zhe 折(乛). The code we employed in our e-learning system are basically the same as those of the official dictionaries (particularly the widely adopted dictionary as the Xinhua zidian 《新华字典》) that have been used to mark the stroke sequences of each Chinese character. For instance, the character "人" (pronunciation: rén, meaning: "person") in our e-learning system or similarly the online dictionary of the Xinhua Zidian, the stroke count and sequences of the character are stated as (Stroke count: 2; Stroke coding/seqeunces: ***3 4***) implying the total number of strokes is 2 with the first stroke as ***3***) pie 撇(丿) followed by ***4***) dian 点(丶). Furthermore, students can share their writing experience with other students during the practice. The actual process of writing for each individual learner can be reconstructed with the recorded touch positions and path through animations on the screen. Students can then learn from the success or failure made during the process of their own or peers' writings. Accordingly, they will have a more thorough understanding of their own strengths and weaknesses in writing through this specific feedback function.

In the evaluation part, the system will give a detailed analysis based on each individual's performance including the average rate of errors over all the Chinese characters the student has attempted, the particular basic structures or strokes that the student is more proficient or less familiar with.

Furthermore, according to the definition of the IEEE LOM standard, learning objects are described as "any entity, digital or non-digital, that may be used for learning, education or training". The following list of features is commonly associated with learning objects:

a) independence;

b) reusability;

c) interactivity;

d) ability to be aggregated;

e) ability to be tagged with metadata.

Clearly, the basic strokes of Chinese characters can perfectly match with the above features of learning objects. And the radicals as the classifying components to form various Chinese characters can be considered as learning objects at a higher level in the overall organization of knowledge structure. All the relevant Chinese phrases or sentences can then be implemented as ordered subsets of learning objects for a self-contained and re-usable e-learning system communicating with flexible and powerful mobile devices.

To fully utilize the sophisticated features of mobile devices nowadays, some interesting extensions are considered and implemented in our proposed system. An example is to firstly employ the GPS receiver of the mobile device together with the Google Maps database to return the Chinese address of the learner's current location. In case there is any signal reception problem with the GPS receiver, this can be aided with the use of the high-resolution camera to take picture of the street plate containing the Chinese street name as identified by an intelligent character recognition algorithm. The resulting Chinese address or at least the street name may capture some familiar and/or unfamiliar Chinese characters that can be looked up it in the local or online dictionary. In this way, the learners can expand their Chinese character sets in daily livings.

III. PROTYPE IMPLEMENTATION AND EVALUATION

The iPhone and iPod touch devices open up innovative mobile computing platforms for many potential applications to be developed. The Apple's desktop operating system, namely the OS X, provides a free integrated development environment (IDE) tool called the Xcode [10] that enables developers to design, implement and test a wide range of mobile applications with a rich library of application programming interfaces (APIs). In this project, we took full advantages of the iPhone's multi-touch interactive interface and fabulous on-board features using the Xcode IDE tool. To demonstrate the feasibility of our proposal, we implemented a prototype of our e-learning system based on the iOS mobile platform using the Objective-C programming language and the Xcode IDE tool.

To enable students with a thorough understanding of the associated structures for the involved Chinese characters, all

the Chinese character templates can be categorized according to the total number of strokes, the radical or pin-yin. As based on the selected categorization scheme, a tabular view of the related Chinese characters will be displayed as shown in Fig. 2.

Figure 2. The character list with a radical "亻" (dānrénpángr).

Each character will be implemented as a learning object that has some unique attributes including its pronunciation, related phrases, English translations and basic strokes. The interactive interface of each character will be divided into two parts. The upper part of the interface will be the input area containing the displayed template for student to practise. The lower part of the interface will be the control panel with the demonstration part to be triggered by one of the four underlying buttons. The interface is clearly shown in Figure 3 as below.

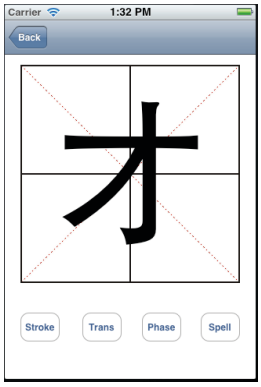

Figure 3. The user interface of the character object.

In the pratice part, we use a WuBi method (of five basic strokes) to check for the result of the inputted stroke sequence. The commonly used character standard for the stroke sequence of modern Chinese (现代汉语通用字笔顺规范) lists out the five basic strokes as: heng 横 (一), shu 竖(丨), pie 撇(丿), dian 点(丶) and zhe 折(乛). Each of the five strokes is given a distinct serial number: 1 for heng, 2 for shu, 3 for pie, 4 for dian and 5 for zhe [11]. Our intelligent stroke recognition algorithm tries to extract every single stroke from an individual's input on the touch screen of the iOS device when the learner is using the pratice mode. The algorithm will then compare the inputted stroke with the designated basic stroke(s) specified in the template of our e-learning system. The checking algorithm will iterate through each inputted stroke until any unknown stroke is identified or all the inputted strokes are matched with all those in the designated character template. Since the adopted character standard is official and commonly used, this checking method is clearly compatible with any available online dictionary of Chinese characters.

IV. Concluding Remarks

In this paper, we propose to develop an intelligent e-learning platform based on the concept of learning objects for foreigners or Chinese students to learn Chinese characters through the interactive interface such as the touch screen of mobile devices. To demonstrate the feasibility of our proposal, we implemented a prototype of our e-learning system using the Objective-C and the Xcode IDE tool for execution on iPhone/iPod touch devices.

Our prototype of the e-learning system can systematically categorize all the stored Chinese characters in its database according to three basic structures (radical, the total number of strokes, or pin-yin [i.e., the pronunciation]) to include Chinese characters of all the basic structures into each training exercise. All in all, there are many interesting directions for further investigation including the integration with existing online course materials, and a more thorough study on both the pedagogic and technological impacts of our proposed e-learning system.

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