A Distance Learning System for Teaching the Writing of Chinese Characters over the Internet

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ABSTRACT

This paper proposes an intelligent tutoring system (ITS) for teaching students to write Chinese characters over the Internet. In the proposed system, students can use a pen (or drag the mouse) to write Chinese characters on a digital board using a browser such as Microsoft Internet Explorer. For realizing the situation of student’s writing behavior, a neuron-based student model was designed to learn the writing style of each student. This system has been in development since 1996, and includes 2,734 Chinese characters (taught in primary schools). It has been used in elementary schools, and by thousands of students. Educational research reveals that over 82% of primary school students had some problems in using the correct stroke orders when writing Chinese characters, and the improvement exhibited by an experimental group was significant \( F = 25.331, p < .005 \).

Keywords: intelligent tutoring system (ITS); Internet; Chinese characters; neuron-based student model; stroke orders

INTRODUCTION

Around 4,000 Chinese characters are commonly written, and they have a wide variety of shapes and stroke orders. Each Chinese character is like a picture, and each stroke has a special shape, direction and position. Chinese characters can be written more easily if the correct stroke order is used (Bjorksten, 1994; Lam et al., 2001; Law et al., 1998; McNaughton & Ying, 2000; Yao et al., 1997). Additionally, the written characters are then more understandable and beautiful. Accordingly, the correct stroke orders of the characters should be learned before Chinese characters are written. Primary schools in Taiwan therefore teach correct stroke order of each Chinese character (as defined by the Ministry of Education, Taiwan, ROC, 1996). However, a teacher cannot verify the correctness of the stroke orders of characters written by every student in a class of 30. Therefore, an intelligent tutoring sys-
system (ITS) (Anderson, 1988) is required to help students learn the correct stroke orders of Chinese characters.

CAI (computer-assisted instruction) has been developed over the last two decades. Several good systems, such as the declarative model SCHOLAR (Carbonell, 1970; Carbonell & Collins, 1974), the black-box model SOPHIE-I (Brown & Burton, 1978), the qualitative model SOPHIE-III (Brown, Burton & de Kleer, 1982), the glass-box expert model GUIDON (Clancey, Barnett & Cohen, 1982), the procedural knowledge model BUGGY (Brown & VanLehn, 1980) and the neuron-based ITS (Sun, Huang & Wang, 1997) have been proposed. Most CAI systems are run only on personal computers. Users cannot operate the CAI system on the Internet, and researchers therefore have not been able to collect much data on the use of the CAI system. Therefore, “designing a CAI system on the Internet” has become extremely important in the field of distance learning. Moreover, “applying artificial intelligence to the CAI systems” is also critical for designing an effective learning system. These two issues were considered in the design of the proposed ITS, which combines the newly developed AI technique “neural network” (Lippmann, 1987; Sun & Fu, 1992; Sun & Fu, 1993) with the WWW programming techniques “Active X control” and “ODBC” (Denning, 1997; Microsoft, 1997) so it can provide an effective environment for learning the stroke orders of Chinese characters on the Internet. Similar CAI systems have recently been proposed (Lam, 2001). However, they can only be run on local PCs, and not on the Internet; also, they only “click” the strokes of the Chinese character and cannot detect if a stroke is made in the wrong direction. (The rules about the directions of strokes are not included.) The “click” operation is very different from actual writing behavior. The proposed system includes all writing rules and checks that are followed as students write each stroke of a Chinese character.

The next section introduces the system architecture of the proposed ITS. We then clarify the pertinent artificial intelligence techniques and present experimental results and conclusions.

**SYSTEM ARCHITECTURE**

The proposed ITS includes seven major parts—the user interface, the student model, the intelligent tutoring module, the instruction/test module, the explanatory module, the data- and rule-base module and the multimedia animated cartoon engine (as depicted in Figure 1). Figure 2 presents the architecture of the proposed ITS executed on the Internet.

Each Chinese character displayed on the user interface is specified by the pixel-locations on the screen (represents by X and Y coordinates). Each stroke is recorded as two to six (X,Y) positions, according to the complexity of the stroke. The first position refers to the initial part of the stroke, the final position to the final part of the stroke; the others are the intermediate turn-positions in the stroke (Figure 3). For example, the stroke “” in the lower-right part of the Chinese character “” (Figure 3) is recorded as (123, 183), (198, 178) and (175, 228), referring to the first, the intermediate and the final positions, respectively.

Therefore, the stroke order of a Chinese character can be recorded as a sequence of (X,Y) positions. Additionally, the “direction” of each stroke must also be considered. Eight directions are defined to represent each stroke in a Chinese character (Figure 4).
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