Chapter 3.13
Web-Based Handwriting Education with Animated Virtual Teacher

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ABSTRACT

This article introduces our Web-based handwriting education system developed with 3D computer graphics and pen computing technologies. Traditionally, in teaching handwriting, the teacher writes a character on the blackboard, and then students try to follow the teacher in order to write the same character. The teacher can check whether a student's handwriting is spatially correct by looking at its shape, but the teacher is not able to verify if the student is writing in the correct stroke order with the correct number of strokes. As a result, we design a Web-based handwriting education system. With our proposed system, students can stay at home to do the exercises for learning the handwriting of characters. A student's handwriting can be captured in digital format with the information in both temporal and spatial domain, and the results can be sent to the teacher for evaluation. In addition, we propose to animate a virtual teacher on the student's terminal for demonstrating the handwriting of the characters to give students a sense of presence.

INTRODUCTION

Studies in Hong Kong (Curriculum Development Council, 1996) have shown that children in the upper kindergarten are quite ready to write Chinese characters. Traditionally, in teaching handwriting, the teacher writes a character on the blackboard, and then students try to follow the teacher in order to write the same character. At home, students may be given homework for tracing the strokes of a character on a copybook or for copying a character for a few times as practice. With this

approach, the teacher only can check whether a student's handwriting is spatially correct by looking at its shape. The teacher is not able to verify if the student is writing in the correct stroke order with the correct number of strokes. As a result, we design a Web-based handwriting education system for teaching people writing characters. With our proposed system, students can stay at home to do the exercises for learning to write characters. A student's handwriting can be captured in digital format with the information in both temporal and spatial domains (coordinates and time stamps of the stroke samples and pen up/down events), and the results can be sent to the teacher for evaluation. In addition, we propose to animate a virtual teacher on the student's terminal for demonstrating the handwriting of the characters to give students a sense of presence.

One research issue of our system is the handwriting analysis. The objective of a handwriting analysis is to reduce the workload of the teacher by assisting in the automatic evaluation of the handwritings. Essentially, the idea is to make a reliable system that can analyze precisely a student's handwriting and then provide accurate feedback to the student about where a character is written incorrectly. This handwriting analysis problem is different from handwriting recognition. In handwriting recognition, it suffices to find criteria that are just enough to differentiate between the correct character from all other incorrect characters. In handwriting analysis, instead of looking for the most similar character from a set of characters, we need to find out whether and, more importantly, where the character is written incorrectly. We aim to train a person to write correctly instead of training the system to ignore mistakes.

Another research issue is the animation of the virtual teacher for writing. While it is possible to capture the 2D coordinates of the pen during handwriting and then to use those parameters to help to render the motion of the hand in the virtual environment, further parameters need to be determined in order to render the remaining part of the body, if we want to have a whole body model for the virtual teacher. This can be achieved by applying inverse kinematics to solve the unknown joint angles of the body.

This article is organized as follows. First, we describe some prior work on the related issues. Then, we introduce various components of our proposed system. The conclusion and future work are given next.

PRIOR WORK

Although pen-based devices have become more and more popular to the general public in recent years (Schomaker, 1998), there is no software that can analyze precisely a handwritten character. As a result, no accurate feedback can be provided about whether and where the character is written incorrectly by considering simultaneously the spatial and temporal information (coordinates and time stamps of the stroke samples and pen up/down events) captured with the input pen device.

In electronic ink processing, Lopresti, et al. (1993, 1994) reported their work on matching hand-drawn pictures, which they call pictograms. This approach has a drawback: it treats the same hand-drawings with different stroke orders as a poor match. In order to make the system less sensitive to the stroke order, Lopresti and Tomkins (1995, 1996) proposed to match the strings block by block. However, a poor match may still result if a stroke is drawn in reverse direction (i.e., when the start point and the end point of a stroke interchange). Under these approaches, string matching is performed for the alignment, based on the time sequence. As a result, it has the assumption that the strokes are drawn in the correct temporal order. This may not be the case for beginners who just start learning handwriting.

There has been some research about handwriting quality evaluation. Some of them target the English handwriting by evaluating the shape