Augmented Calligraphy: Experimental Feedback Design for Writing Skill Development

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ABSTRACT
In this demonstration, we introduce the augmented calligraphy system that aims at supporting a calligraphy learner's self-training process by giving feedback. In order to write characters well, body posture is a very important factor. However, it is difficult to keep proper posture without any assistance. Therefore, the system monitors the learner's posture by a web camera and notifies them if the posture moves into a bad shape. Several types of multimodal feedback were implemented, since we are particularly interested in how feedback design can decrease cognitive load.

Author Keywords
Calligraphy, augmented reality, entertainment computing, tangible interaction, design guideline.

ACM Classification Keywords
H.5.1 Information Interfaces and Presentation: Multimedia Information Systems—*Artificial, augmented, and virtual realities*

General Terms
Design, Human Factors

INTRODUCTION
Japanese calligraphy is an effective way to improve the literacy skill of Chinese and Japanese characters. Nowadays its artistic aspect is often focused, but as a practice a learner can also develop the sense of writing (e.g., the layout of letters) by copying again and again from a copybook. For example, in Japanese elementary schools, Japanese calligraphy is a compulsory subject, and it is also still one of the most popular lessons for adults. However, such repetition practice could easily get boring, since the process is not attractive and informative enough to keep interests. Particularly a copybook neither intuitively demonstrates writing process, nor gives feedback/incentives for writing skill development. On the other hand, the concept of mixed reality is getting realized today. For example, these days AR (augmented reality) toys are commercialized in the market. Users can interact with a virtual character by capturing a matrix code with a web camera. The character is superimposed on the code and animated as preliminary programmed. Real and virtual environments are united into a hybrid world. Then digitally augmented features provide new user experience to consumers and assist players in gaming. For example, pervasive game is one domain in the mixed reality games [2]. The rapid progress of pervasive computing technologies would seamlessly integrate games into our daily lives.

Therefore, in this paper, we applied the AR technology to enhance the interactivity of calligraphy. We introduce the augmented calligraphy system, which aims at giving feedback to assist a user to improve their writing skill. Conventional copybooks instruct, for example, how to control the strength of a brushstroke with markers and texts. However, it is not intuitive particularly for beginners to do self-training. Making invisible information visible improves bodily experience, since immediate feedback to the brushstroke would be given in real-time. Eventually it leads the user to better understanding of the training. In this work, we also addressed the importance of cognitive load, since calligraphy particularly requires concentration. Thus feedback should not interfere writing task, with providing proper amount of information to allow a user to recognize invisible information (e.g., how the user bends forward). Mixed reality technologies are expected to appear in future products. Thus we believe that our experiments and findings can be also utilized in a variety of AR application domains [1].

Figure 1. Calligraphy with augmentation

AUGMENTED CALLIGRAPHY SYSTEM
In order to keep the original look-and-feel of calligraphy, we applied *augmented traditional games* concept to the system design [1]. The system uses rather ordinary calligraphy tools than virtual simulation, and learners can naturally fol-

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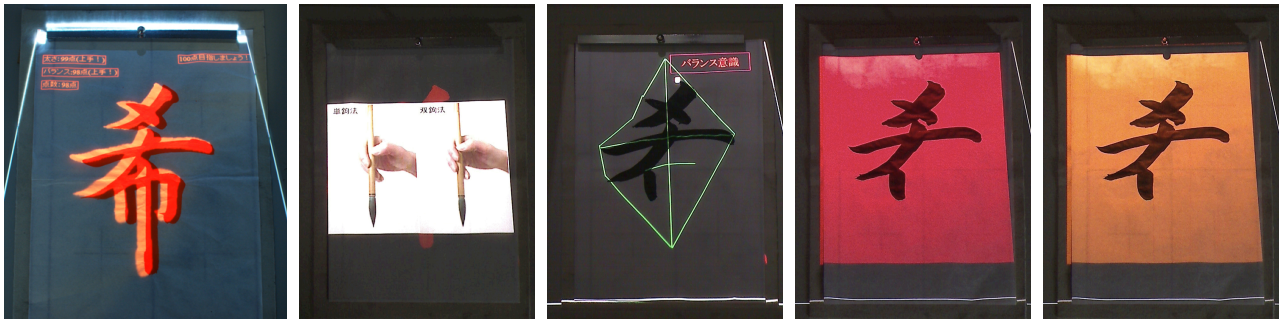

Figure 2. Examples of feedback and assistance information from the system

low its writing process without effortfully exposing themselves to the augmented environment (Figure 1). Users can also seamlessly turn on and off the augmentation support at any time. Figure 3 shows the augmented calligraphy system setup. The web camera on the top captures the image of characters written on paper, and their shape is recognized with OpenCV library. Another camera captures the shape of the user's posture from the side, and it detects how much the user bends forward while writing characters. Since a proper posture is important to do calligraphy well, the system gives warning feedback according to the calculated bending level.

Visual information such as feedback and guidance is given from the projector (Figure 2). For example, model characters are directly shown on the paper so that a learner can trace the line without switching their focus onto a copybook (Figure 2-(a)). Visual warning, such as "Keep a writing brush vertical to paper.", reminds a user of points and tips of the practice. For example, at the beginning of a practice, the system shows and emphasizes the correct pen holding style (Figure 2-(b)). Moreover it is also possible to visualize the balance of characters if necessary (Figure 2-(c)). This helps to recognize how the actual shape differs from the ideal one, since the balance of character is important point to perform good calligraphy. During the writing process, other advice remain on top of the paper, and lastly the user's score is shown (Figure 2-(a)). The score is calculated based on how the written character differs from the model ones.

Currently several feedbacks are supported with two modalities: visual and audio. The visual feedback supports both ambient and linguistic styles. The ambient style feedback changes the paper's color according to the user's posture. As shown in Figure 2-(d) and Figure 2-(e), the color changes from normal to yellow, and finally to red as the posture gets worse. In the linguistic feedback mode, a warning sentence is projected onto the paper and its size increases to draw more attention when the user's body bends forward. In the auditory feedback mode, a ring tone is played during writing process. Two parameters of the tone could be changed according to the posture: tempo and volume.

FUTURE WORK

In this project, we are particularly interested in feedback design, since it is tightly linked with the efficacy of self-training process. In order to prevent from interfering learners' concentration, timing, modality and the complexity of information should be sufficiently considered in a design process. Immediate feedback could be frequently provided to the user in a short period, and thus cognitive load to recognize and process the information could increase accordingly. In order to support an elaborated training process, enough cognitive resource should be allocated to the main task. As we introduced with the augmented calligraphy system, increasing the variety of multimodality is one approach to avoid conflicts in a cognitive activity. Since most of activities require visual attention, other types of modalities will allow the user to interpret given messages with different cognitive resource. We believe that immediate feedback should be ambient (i.e., non linguistic) information, and verbal description should be used particularly in the case that a system needs to draw players' attention (e.g., report a system error). In future work, we will conduct a user study with the system on this perspective, in order to identify a feedback design guideline that is applicable to other AR applications.

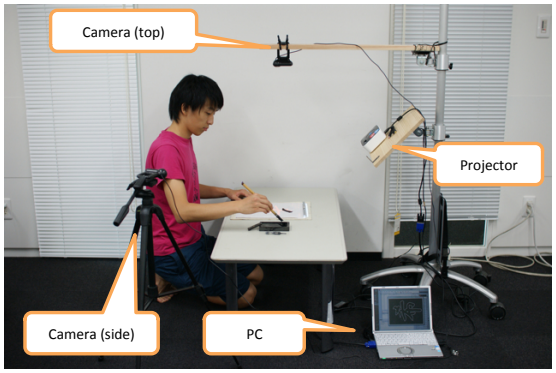

Figure 3. Augmented calligraphy system appearance

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