

# Finger character learning system with visual feedback

Y Tabata<sup>1</sup>, T Kuroda<sup>2</sup>, Y Manabe<sup>3</sup> and K Chihara<sup>4</sup>

<sup>1,2,3,4</sup>Graduate School of Information Science, Nara Institute of Science and Technology,  
8916-5 Takayama, Ikoma, Nara, 630-0101, Japan

<sup>1</sup>[yoshi-t@is.aist-nara.ac.jp](mailto:yoshi-t@is.aist-nara.ac.jp), <sup>2</sup>[tomo@is.aist-nara.ac.jp](mailto:tomo@is.aist-nara.ac.jp), <sup>3</sup>[manabe@is.aist-nara.ac.jp](mailto:manabe@is.aist-nara.ac.jp),  
<sup>4</sup>[chihara@is.aist-nara.ac.jp](mailto:chihara@is.aist-nara.ac.jp)

<sup>1-4</sup><http://chihara.aist-nara.ac.jp/index.html>

## ABSTRACT

Many researches proposed many types of Computer Aided Education (CAE) systems for Japanese Sign Language (JSL). However, foregoing CAE systems for JSL have the problems that they cannot give the differences between targets and answers, and way to revise. The authors propose an innovative CAE system for JSL, which gives users visual information to revise their mistakes utilizing Computer Graphics (CG) animation. This paper presents finger character learning system with visual feedback as a prototype system of the proposed CAE system for JSL, a method to recognize finger characters and a way to give the visual information to revise.

## 1. INTRODUCTION

Recently, the hearing people had much opportunity to communicate with the hearing impaired. However, the hearing people cannot have sufficient communication with the hearing impaired. The main reason is the difference of mother tongue between the hearing people and the hearing impaired. Therefore, to learn the other language each other is essential for smooth communication.

Sign Language is one of the means of communication of the hearing impaired. The hearing impaired, especially the Deaf, always speaks sign languages in their daily life. When we, the hearing people, study sign languages by ourselves, we make use of textbooks in many cases. However, textbooks, which hold some pictures, do not teach us whether we learn the correct signs or not. Therefore, we may learn incorrect signs.

Many researches (Sagawa et al 2000; Terauchi et al 1999) have developed many types of Computer Aided Education (CAE) systems for Japanese Sign Language (JSL). However, foregoing systems for JSL have the same problems. These systems do not give users two important information; the differences between targets and user's answers and the way to revise the mistakes. Critical reason is that to obtain motions of JSL is quite difficult for PC.

To overcome these problems, the authors proposes an innovative CAE system for JSL, which gives its users visual feedback to revise their mistakes by means of Computer Graphics (CG) animation. As the authors developed finger character learning system with visual feedback as a prototype of the CAE system for JSL, this paper presents the concept of finger character learning system. This paper also presents a method to recognize finger character and a method to give the users visual feedback to revise mistakes.

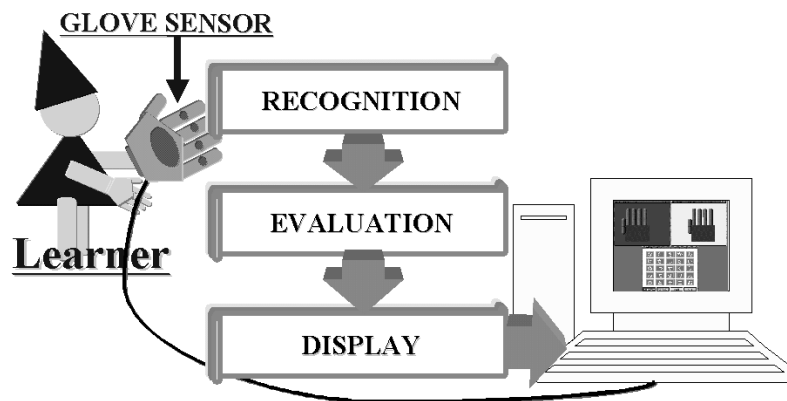
## 2. CONCEPTUAL DESIGN OF FINGER CHARACTER LEARNING SYSTEM

The finger character learning system consists of three components; recognition part, evaluation part and display part.

The recognition part recognizes given hand posture. The system makes use of a glove type motion sensor as input device to measure user's hand posture. This input device can obtain the many joints angle data. The recognition part utilizes Vector Quantization (VQ) technique to convert the given joints angle data into notation codes.

The evaluation part compares obtained code with target codes, and evaluates differences between these two codes to distinguish the mistakes of given signs.

The display part lets a user know whether his/her answer is correct or not. When the user made any mistakes, the system gives him/her the visual feedbacks to revise the mistakes via the display part. The visual feedbacks are given to the user by using color and CG animation. Fig.1 shows the conceptual design of finger character learning system.



**Figure 1.** The conceptual design of finger character learning system.

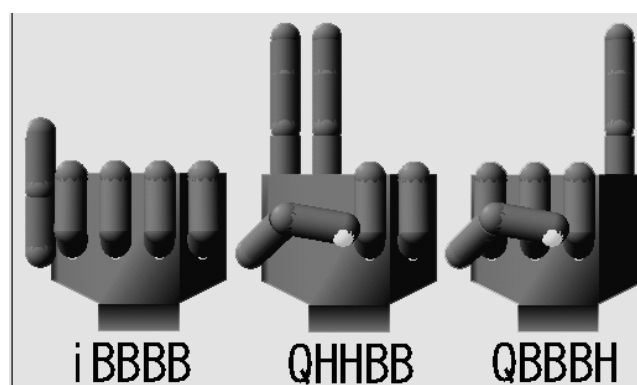
### 3. FINGER CHARACTER RECOGNITION

The system converts given joint data into notation code by means of VQ technique, compares obtained code with target code and recognizes the hand posture of finger character.

#### 3.1 Notation Code System

Most important process of this CAE system is to encode given hand posture of finger character. The foregoing notation code system for motion (Stokoe et al 1971; HamNosys; Kanda 1994, Kurokawa 1994) is divided into two groups, that is, the notation code for sign language and the notation code for whole gestures. However, as the notation code system for sign language tends to use non-alphabetical characters, a computer has difficulty to deal with. Therefore, the authors developed a new notation code system based on Kurokawa notation code system (Kurokawa et al 1992), which use the alphabets to note whole gestures.

A certain hand posture consists of each finger's posture, thumb's posture and their relations. Hence, the proposed notation code system denotes the hand posture as a combination of these factors. Each basic posture has the unique notation code in this system. The relations are denoted as the adduction and abduction between fingers and as contacts between each finger and thumb. Fig.2 shows the example of the proposed notation.



**Figure 2.** The example of the proposed notation.

#### 3.2 Vector Quantisation Technique

The system utilizes VQ technique and converts the given joints angle data into the proposed notation codes. Even hand posture that indicates same character given by single person is variant, not to speak of the one given by another person. The clustering techniques (Cui and Weng 1997; Starner et al 1998) including VQ allow these variations.

The system recognizes the given hand posture of finger character in the following procedure. First, the system prepares the represented quantized vectors in advance. Second, the system converts the obtained joint angle data into sets of vectors. Third, the system determines the best-matched represented quantized vector under the criterion of the shortest Euclid distances. At last, the notation code of selected represented quantized vector is used to denote the given posture. Fig.3 shows the process of notation conversion.

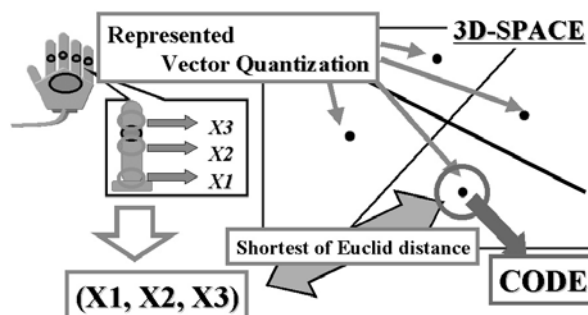


Figure 3. The notation code generation.

#### 4. VISUAL FEEDBACKS TO REVISE

The system teaches user's mistakes by means of color and animation. The system compares the obtained code with the target codes, and evaluates the differences. The differences are the user's mistakes. Fig.4 shows an example. In this example, the third digit is different.

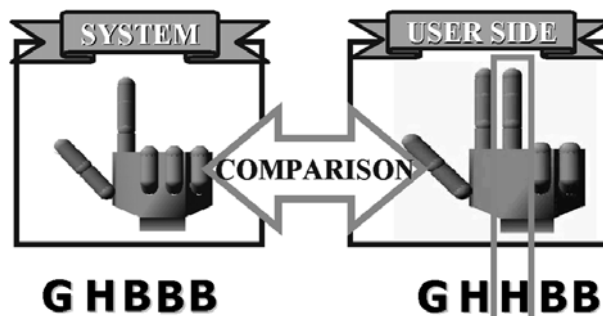


Figure 4. Example notations.

The system lets the user know the user's mistaken finger using striking color and gives way to revise the mistakes by CG animation. The system generates CG animation in the following manner. The system regards the obtained finger posture as the first key frame of CG animation and the target finger posture as the second key frame. The CG animation is produced as the interpolation between these two key frames. Fig.5 shows a snapshot of the system output that shows the mistake, and Fig.6 shows the animation.

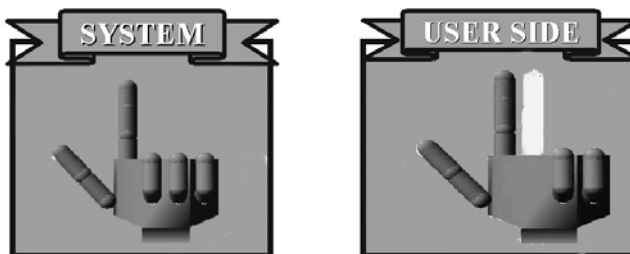


Figure 5. Visualising a mistake with color change.

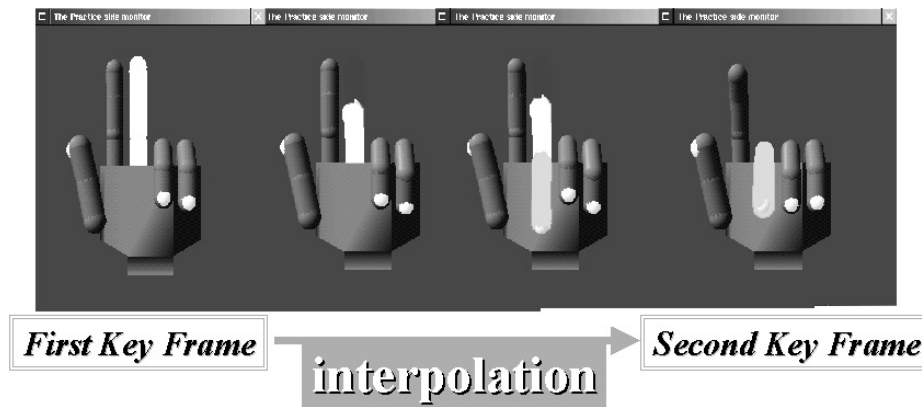


Figure 6. Visualizing a way to revise using CG animation.

## 5. EXPERIMENT

### 5.1 Experimental purpose

If the proposed concept has advantage in learning finger character, people can learn precise finger characters quickly via the system. Therefore, the authors developed the prototype finger character learning system with visual feedbacks and experimented about the effectiveness of the prototype system.

### 5.2 Prototyping

Fig.7 shows snapshots of the prototype system. The prototype system utilizes “Cyber Glove™”(Virtual Technologies 1994). Cyber Glove™ can obtain 18 joints angle of human hand and flexions of wrist.

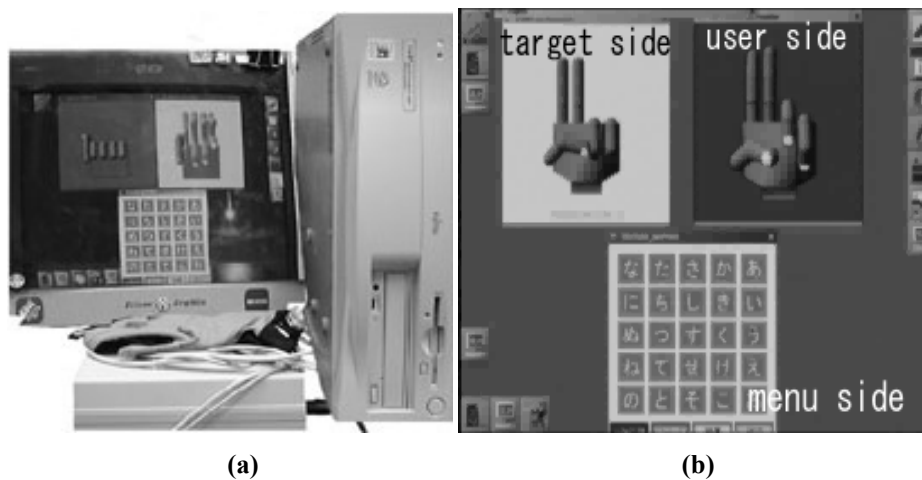


Figure 7. The prototype finger character learning system. (a) Overview. (b) Snapshot of the screen.

### 5.3 Experimental procedure

The prototype and a textbook were prepared in advance. The textbook has snapshots of target finger character. Ten subjects were divided into two groups. One group, named “book group”, studied finger character via the textbook, and the other group, named “system group”, studied finger character via the prototype. Each group studied finger character for ten minutes via given method and tried to show all target finger characters by themselves as shown in Fig.8. This procedure repeated three times. Fig.8 shows this experimental procedure.

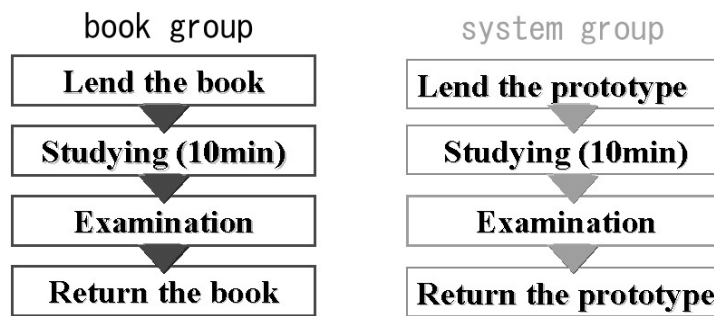


Figure 8. Experimental procedure

## 6. EXPERIMENTAL RESULT AND DISCUSSION

Fig.9 shows the result. The X-axis shows the number of iteration and the Y-axis shows mean accuracy of each group.

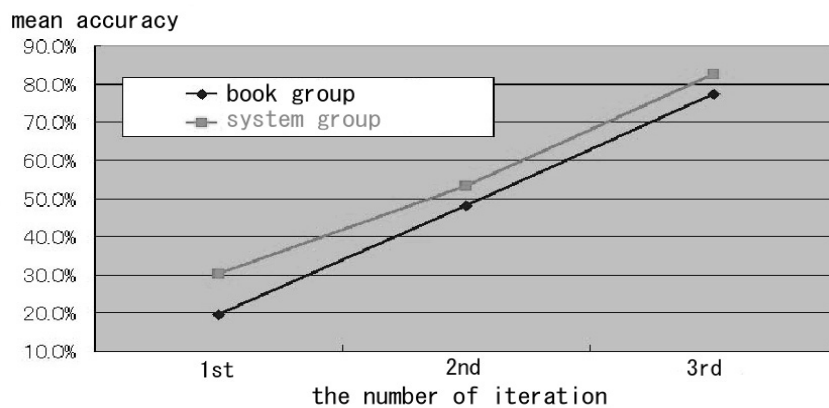
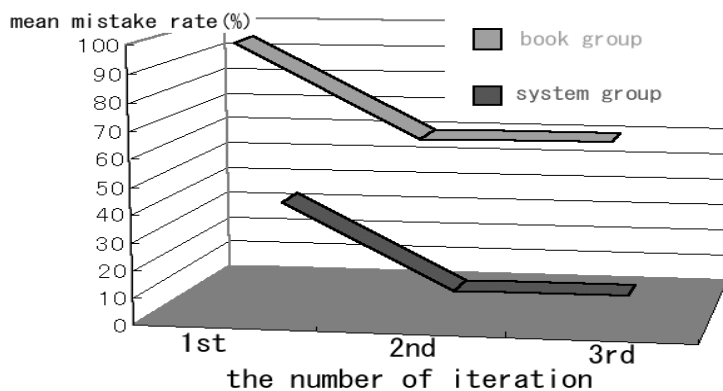
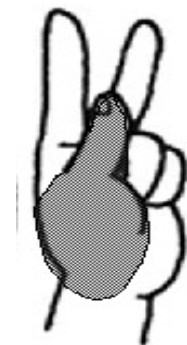


Figure 9. The experimental result

The authors examined about the accuracy rates of both groups. Testing statistical hypothesis under 5 % significant level resulted in the significances. The result shows the system group learned finger characters quicker than the book group under the conditions mentioned above. Therefore, the result proves the effectiveness of the prototype system.



(A)



(B)

Figure 10. A finger character of "KA". (A) Mean mistake rate of each group. (B) Hand posture

Detailed investigation of the result cleared that there were several characters that the book group could not learn throughout the examination. Finger character “KA”, shown in Fig.10, is one example of them.

The result in Fig.10 shows that error of book group was about double of error of system group and the error of book group hardly decreased in three times. Main reason of the result was the lack of contact of thumb's tip.

The typical characteristic of finger character “KA” is that thumb's tip contacts a center of middle finger. On the paper space, to express the contact information like this is difficult. Therefore, the book group can obtain wrong information about finger character “KA”. Moreover, subjects in the book group cannot notice their own mistakes and it seems that the book group could not revise the mistakes of finger character “KA”. On the other hand, if the system group mistakes the contact of thumb' tip, at first, the prototype system can let the system group's members know thumb's mistake by means of the striking color. Subsequently, the prototype system can teach the system group way to revise mistakes until the system group can learn precise finger character. Thus, the discussion may derive a conclusion that visual feedbacks enabled the error of system group to decrease noticeably as to finger character “KA”.

## 7. CONCLUSIONS

This paper presented finger character learning system with visual feedbacks, which was developed as a prototype of the CAE system for JSL. This paper described the conceptual design of the prototype system, the method to recognize finger character and way to revise user's mistakes by means of color and CG animation. The prototype system was experimented and the result proved the effectiveness of the prototype system.

**Acknowledgements:** This research is partly supported by Telecommunication Advancement Organization and International Communication Foundation.

## 8. REFERENCES

- A Koizumi, H Ando, H Sagawa, K Iwamura, M Takeuchi (2000), Sign Language Recognition and Its Applications, *Proc. 2000 RWC Symposium*, pp.143-146.
- M Terauchi, Y Nagashima (1999), JSL Self-Learning Support System on the Windows, *Proc. Human Interface Symposium '99*, pp.713-716, (Japanese).
- C Croneberg, D Casterline, W C Stokoe (1971), *A Dictionary of American Sign Language on Linguistic Principles*, Gallaudet University Press.
- HamNosys, <http://www.sign-lang.uni-hamburg.de/Projects/HamNoSys.html>.
- T Kanda (1994), *Sign Linguistics Lectures*, Fukumura Publishing Corporation, (Japanese).
- T Kurokawa (1992), Gesture Coding and a Gesture Dictionary for a Nonverbal Interface, *IEICE Transactions on Fundamentals of Electronics*, 75, pp.287-290.
- T Kurokawa (1994), *Nonverbal Interface*, Ohmsha Corporation, (Japanese).
- A Pentland, J Weaver, T Starner (1998), Real-Time American Sign Language Recognition Using Desk and Wearable Computer Based Video Perceptual, *M.I.T Media Laboratory Perceptual Computing Section Technical Report*, No.466.
- J Weng, Y Cui (1997), View-Based Hand Sign Recognition from Intensity Image Sequences, [http://www.dai.ed.ac.uk/CVonline/LOCAL\\_COPIES/CUI/pami\\_subnew.html](http://www.dai.ed.ac.uk/CVonline/LOCAL_COPIES/CUI/pami_subnew.html).
- Virtual Technologies (1994), *CyberGlove™ User's Manual*.