ON-DEMAND EXPANSION OF AVATAR'S HAND FOR LEGIBLE SIGN ANIMATION

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Abstract: *In order to be accessible, information systems should interact with users in his/her mother tongue. Most of sign language interfaces, which handles mother tongue of the Deaf, provide information using computer graphics of signing avatar named sign animation. The legibility of given sign animation determines performance of information system itself. To be legible, a sign animation must visualize legible signs given by whole upper-body motion and legible finger characters given by hand posture in one shot. This paper proposes to expand avatar's hand while the avatar spells. The method increases legibility of sign animation without any visual mismatches.*

Keywords: *Sign Animation, Signing Avatar, and Legibility*
Abbreviations: *Avatar: Originally, incarnation of Hindu deity, especially Vishnu, in human or animal form. In this paper, a humanoid generated by computer graphics to visualize signs. Sign Animation: Computer generated animation of a stream of signs given by signing avatar.*

1. INTRODUCTION

Foregoing researches on human computer interaction emphasizes importance to make computer systems available for natural communication in user's mother tongue. Many researches have been working on natural speech recognition and generation. Now, several products are available in the market.

The mother tongue of the Deaf is sign language. As sign language has unique grammatical structure and vocabulary set, totally different from spoken/written language such as English, graphical interface cannot provide truly accessible interface for the Deaf. Therefore, an information system should handle sign language to make them accessible for the Deaf.

Moreover, a sign-available information system can be a good assistant for the Deaf. Main social barrier of the Deaf is communication barrier; the hearing impaired has no way to access phonetic languages and the non-deaf has difficulties to understand sign languages. Sign linguistic engineering or sign informatics, research to develop various information systems to mediate phonetic and sign language unifying knowledge of linguistics, information science and several other fields, are coming [1].

One of most important factor to decide performance of sign-available information systems is legibility of signs given by information systems. However, foregoing studies point out that signs given by the systems, regardless of visualization methods, are far less legible than signs given by real person.

This paper proposes a method to produce legible sign animation.

2. SIGN ANIMATION

A sign animation is a stream of sign given by computer graphics based virtual human called avatar. Because of capability to compose various sign sentences from small-size data set, most of foregoing systems utilize sign animation to show signs instead of video.

Sign animation can be classified into two types; notation-based animation and motion-based animation. Notation-based animation is sign animation produced from certain notation code [2]. Notation-based animation is suitable for the systems, which should produce sign sentences from other languages, such as computer aided sign education systems [3] and automatic interpretation systems between a certain sign language and a certain phonetic language [4]. Motion-based animation is sign animation produced from captured motion data by a certain motion capture system. Motion-based animation is suitable for the systems, which should visualize given sign as it is, such as sign language telephones [5].

3. ON-DEMAND EXPANSION OF AVATAR'S HAND

3.1 On-demand expansion

Most avatars used for sign animations are in shape of standard human body. However, in many foregoing researches, subjects claim that finger characters given by sign animations are illegible because size of avatar's hand is only a few percent of whole signing space [6], the space where signs are given. Watanabe et al. [7] utilizes avatar with 1.4 times bigger hand, as shown in Fig. 1, to increase legibility of finger characters. However, signs given by the avatar are less illegible, because irregular-sized hands break relationships between hands. Notation-based animation can avoid this relationship problem by editing motion parameters to fit them to the avatar. However, this problem is fatal for motion-based animation. Moreover, Kurokawa reports that subjects felt smashed by the avatars when the avatars stretched his hand.

Fig. 1. Avatar with big hand [6]

Kamei et al. [8] reports that view center of readers, especially sign experts, move from signer's face, the default position, to signer's strong hand, which gives finger characters. This fact indicates that a reader switches between, at least, two viewing modes, that is, a mode to looking whole signer's body motion, and a mode to watching into signer's hand, along contexts. Therefore, in order to be legible, a sign animation should have two different modes to show signs, and switches between these modes along contexts.

The authors propose to expand avatar's strong hand while the avatar spells. Thus, the proposed sign animation has "signing mode" to show signs via a standard avatar and "spelling mode" to show finger characters via an avatar with expanded hand.

Along Watanabe et al. [7] and several preliminary tests, the authors decided to expand avatar's strong hand 1.5 times. Developed signing avatar follows H-ANIM version 2.0 standard [9]. The authors added expanded strong hand under forearm node of humanoid tree. The sign animation switches visibility of regular and expanded hand along contexts. Fig. 2 shows a

snapshot of developed sign animation, showing Japanese finger character 'TO'.

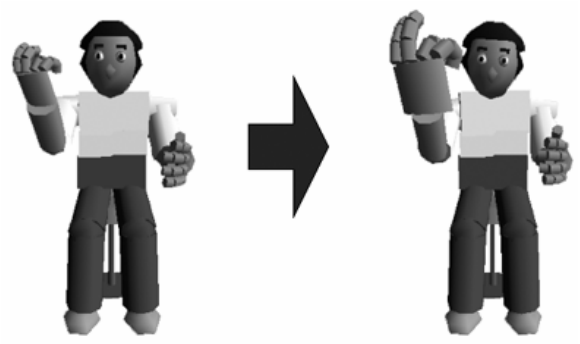

Fig. 2. On-demand expansion of avatar's hand

3.2 Finger character detection

The proposed sign animation requires a trigger to switch between the two modes. In notation-based animation, this trigger can be given as a part of notation codes. However, a certain mechanism to obtain the trigger is required in motion-based animation.

Kimura et al. [10] says that finger characters are given in limited region in front of shoulder of strong arm. This fact means that positions of strong hand may tell whether an avatar spells or not. The authors propose to switch into spelling mode while strong hand stays in the region named "spelling space".

In order to define the spelling space, the authors measured spelling spaces of three signers using the motion capture system for sign language developed by the authors [5] as shown in Fig. 3.

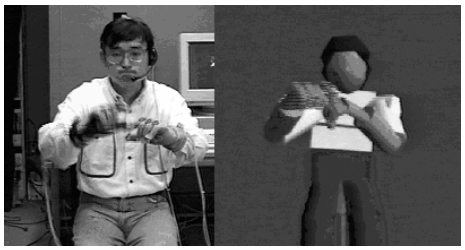

Fig. 3. Motion-capture system for sign language

The obtained data is normalized by signers' height. The result shows the spelling space is coincided among signers. The result shows the spelling space is inside a sphere, whose center is 40cm to the front from shoulder of strong arm, and whose diameter is 40cm, when signer is 170cm tall, as shown in Fig. 4.

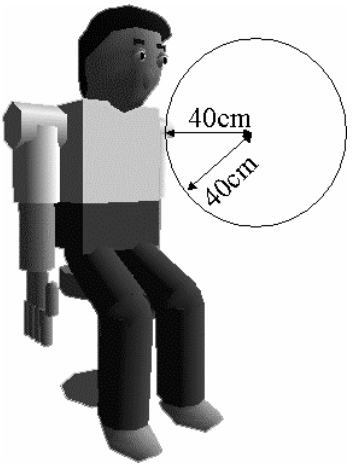

Fig. 4. Spelling space

Strong hand may cross the spelling space even when it doesn't spells. The authors also measured how long strong hand stays in the spelling space. The result clears that strong hand stays the spelling space at least one second during spelling. Additionally, the result clears that strong hand sometimes go out of the spelling space in several inflected characters as shown in Fig. 5. Therefore, the authors decided to regard avatar spells when strong hand stays in the spelling space more than 80 percent of preceding one second.

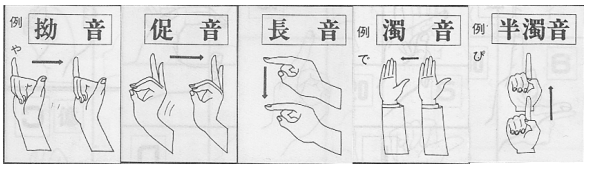

Fig. 5. Inflections of Japanese finger characters. From left, semivowel, geminated consonant, long vowel, voiced consonant and voiceless bilabial plosive consonant [11]

At last, properness of this definition is experimented by nine sign sentences given by three signers. The result is shown in Fig. 6. Recall rate is 93%, and precision rate is 89%.

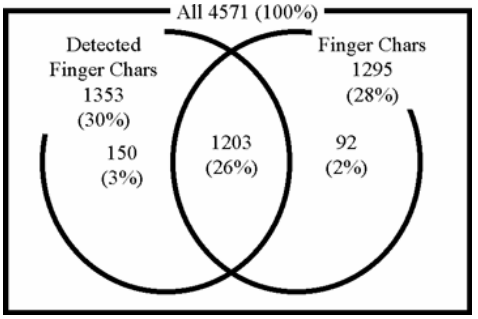

Fig. 6. Result of finger spelling detection

Most of undetected characters were first characters of words, because detection procedure requires, at least, 0.8 seconds. Most of miss-detected characters were poses between phrases. As these detection errors does not occurs continuously, and occurs unimportant parts of sentences, the errors cannot harm sign animation so badly. Therefore, the result shows that proposed finger character detection method is proper to produce triggers to change sign animation modes.

4. EXPERIMENT

In order to evaluate effectiveness of the proposed method, produced sign animation is evaluated.
A signer spoke 20 sentences including at least one word spelled by finger characters in Japanese sign language. Followings are example sentences. Here, capitalized characters indicate the finger characters.

- I have been to LO-SA-N-ZE-RU-SU (Los Angels), U.S. last week.
- I stayed in a hotel at SA-N-TA-MO-NI-KA (Santa Monica).
- I had much fun at YU-NI-BA-A-SA-RU-SU-TA-JI-O (Universal Studio).

Given signs were captured by the motion capture system for sign language.
Two types of sign animations were produced from these captured data. Type A doesn't have signing mode, and type B utilizes the proposed method. One sentence was given four times (two As and two Bs) to subjects in random order.

The subjects stood 1m away from 14 inches TV display, and subjects tried to read the given sign animations. The subjects were four deaf people, two sign experts, three sign intermediates and two sign beginners.

Fig. 7 shows the result. The proposed method realizes approximately 25% improvement of legibility of finger characters. The reason why the deaf people show lower score than sign experts is that they have a certain difficulties in reading finger characters, because they don't use finger characters so often. The fact that the deaf people and the intermediates show high improvement indicates that the proposed method is more effective for experienced people.

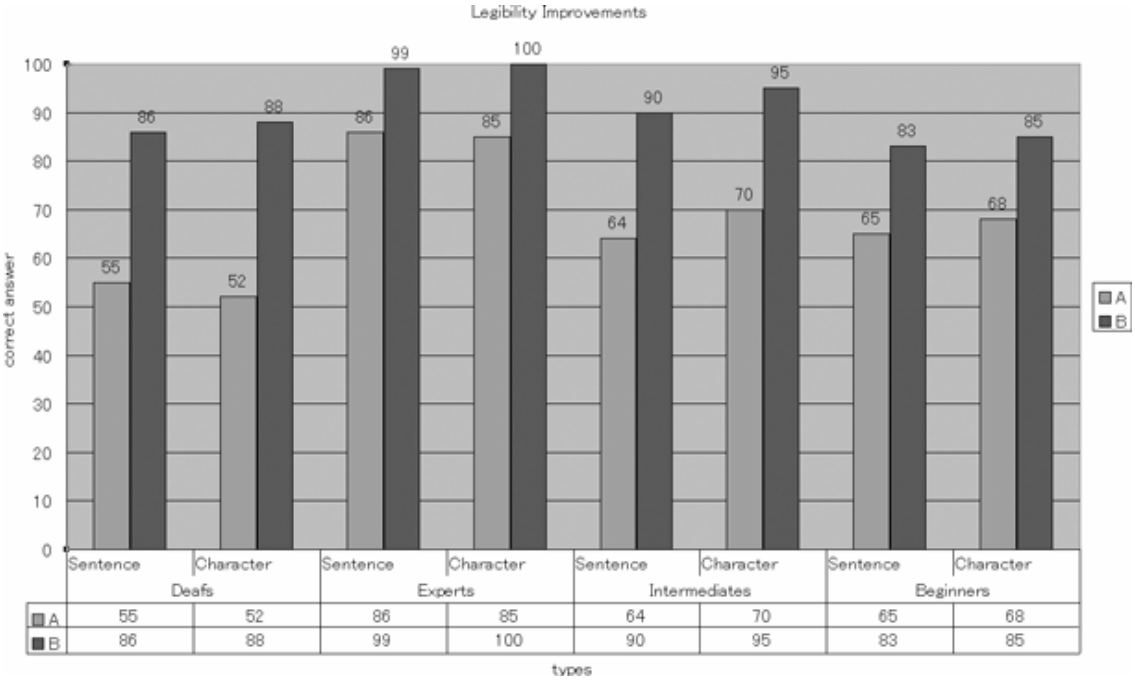

Fig. 7. Reading test score

Moreover, all the subjects except for two beginners didn't notice the fact that the strong hand is expanded while the avatar spells. This fact shows that sign animation produced by the proposed method gives no visual mismatch for experienced readers.

5. CONCLUSION

This paper presents a new method to give legible sign animation. The experimental result shows that the proposed method increases legibility of sign animation without any visual

mismatches. The authors expects the proposed method boost up popularization of sign language interfaces and contributes to make information systems more accessible for the Deaf.

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