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An Avatar Based Natural Arabic Sign Language Generation System for Deaf People

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Abstract

Research demonstrates that individuals who are deaf are significantly aggrieved in the fields of education. A contributing factor to this difference is the difficulty deaf children have in acquiring learning concepts early in life. This paper will present an idea for highly interactive software using avatars (three-dimensional character modules) to process and translate free Arabic input to ARSL (ARabic Sign Language). A prototype for teaching maths and dictation for elementary schools will be discussed. This research could be valuable as a teaching tool in increasing: (1) the opportunity for deaf children to learn maths and dictation via interactive media; (2) the effectiveness of ARSL teachers.

Keywords: Avatar, ARSL, Finger Spelling, Hand Shape.

1. Introduction

ARabic Sign Language (ARSL) is a visual/spatial natural language used primarily by thousands of deaf individuals in Arabic countries. Arabic-to-ARSL translation is as complex as translations between pairs of written languages, and, in fact, the difference in modality (from a written/spoken to a visual/spatial manually performed system) adds new complexities to the traditional Machine Translation (MT) problem.

Many deaf accessibility aids (e.g. television closed captioning or teletype telephone services) assume that the viewer has strong Arabic literacy skills. Since many of these individuals are fluent in ARSL, despite their difficulty in reading Arabic, an ARSL MT system could make more information and services accessible in situations where Arabic captioning text is above the reading level of the viewer or where a live Arabic-to-ARSL interpreter is unavailable (Huenerfauth, 2004; Al-Daoud, 2003).

Researchers in graphics and human figure modelling have built animated models of the human body that are sufficiently articulate in performing ARSL that native signers can understand them (Huenerfauth, 2003; Al-Barhamtoshy & Halwani, 2000; Almohimeed, Wald, & Damper, 2011). Most animation systems use a basic instruction set to control the character's movements; so, an MT system would need to analyse an Arabic text input and produce a "script" in this instruction set specifying how the character should perform the ARSL translation output (Aran & Akarun, 2008; Elliott et al., 2008; Halawani & Zaitun, 2012). The MT task is conceived as the translation from the Arabic text into this script because ARSL has no written form. While linguists use various ARSL glosses, all were designed to facilitate linguistic study, not to serve as a natural writing system, and so they omit certain details (Adamo-Villani, Doublestein, & Martin, 2004).

While there are currently many different approaches to the digital presentation of ARSL, from video clips of ARSL signs to letter-for-letter translation of Arabic to still images of finger spelling hand shapes, the best approach is animated three-dimensional (3-D) computer graphics.

2. Proposed System

Figure 1 shows the typical process flow of the foregoing system that translates from Arabic into ARSL**.**

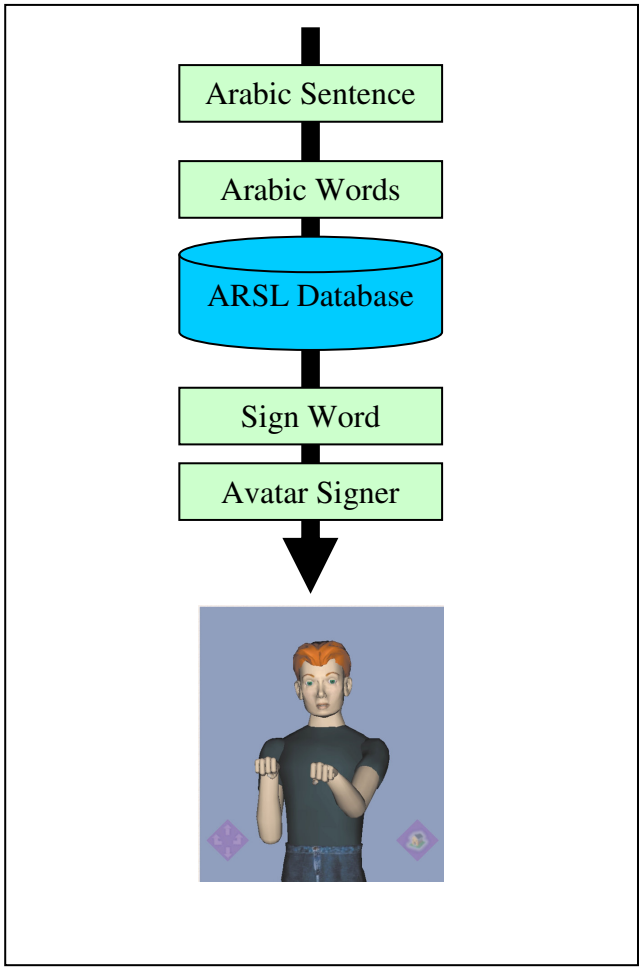

Fig. 1 Structure of Translation System.

3. The Nature of ARSL

ARSL is a rich and varied natural language. While ARSL shares some vocabulary with Arabic, it is not a direct translation of the Arabic words and sentence structure (Al-Barhamtoshy & Halwani, 2000; Marshal & Safar, 2004). There are two major subsets of ARSL – signs that express words, concepts and complex phrases, and finger spelling.

The word/phrase signs can express an extraordinary range of meanings by using the natural geography of the body and facial expressions in addition to the hands. As practiced by fluent signers, word/phrase signs are economical and of endless variety. Positioning and facial expressions as well as level of intensity convey differences in sentence type (e.g. questions vs. exclamations). Word/phrase signs account for the vast majority of a typical ARSL conversation (Al-Barhamtoshy & Halwani, 2000; Al-Daoud, 2003).

Finger spelling is the use of the hands to spell out Arabic words and numbers letter-by-letter. Finger spelling is used for proper nouns, technical terms, acronyms, and in situations where no word/phrase sign exists. Finger spelling slows ARSL conversation, but is necessary for complete communication.

Although word/phrase signs and finger spelling have very different roles in ARSL communication, they share a common physical building block, the hand shape. All signs and finger spelling are composed of one or more hand shapes. Additional information is conveyed by facial expression, hand orientation and position, but the hand shape is a key factor in conversation (Al-Barhamtoshy & Halwani, 2000; Al-Daoud, 2003).

Computer graphics is the most appropriate choice of technology for the presentation of ARSL on a digital translator. Its support for "on the fly" creation of new animations based both on existing rules/conditions and input from outside sources provides the flexibility necessary for ARSL sign translation (Lombardo et al., 2011; Al-Jarrah & Halawani, 2001).

4. Discussion

For the research, opinions on the system were sought by questionnaire. The questionnaire was sent to Saudi Arabian Institutions working on education and rehabilitation for the deaf. It was also sent to doctors interested in sign language research. The questionnaire focused on the basic matters of Quality, Reliability, Usability, Difficulty and Cost.

5. Results

5.1 Quality

Figure 2 shows the quality of the translation and shows that dividing the system for age and specialty groups increases the quality of the system.

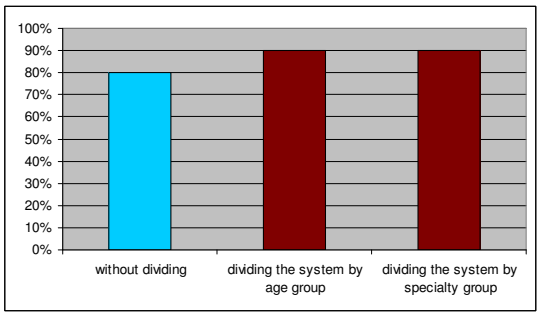

Fig. 2 Quality of Translation System.

5.2 Reliability

Figure 3 shows the reliability of the translation and shows that usability of the system will increase while the processing time will decrease.

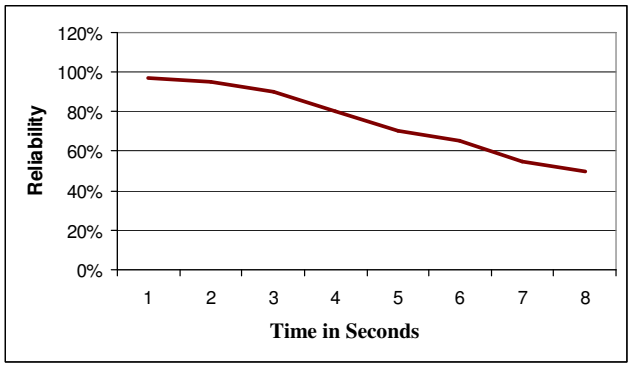

Fig. 3 Reliability of Translation System.

5.3 Usability

Figure 4 shows the usability of the translation and shows that if the percentage of errors in the translation is above 25% the usability of the system is less than 70%.

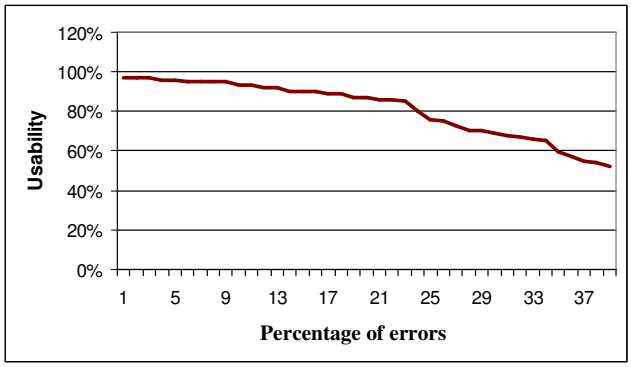

Fig. 4 Usability of Translation System.

5.4 Difficulty

Figure 5 shows the difficulty of the translation system, with 80% of pollsters thinking that it is simple to deal with and train.

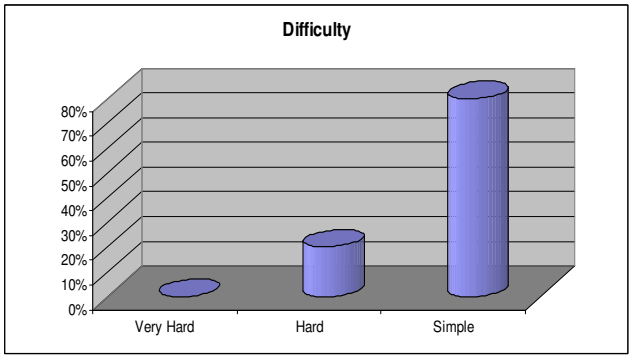

Fig. 5 Difficulty of Translation System.

5.5 Cost

Figure 6 shows the software cost of the translation system and indicates that 90% of the pollsters said that the cost is suitable. In the same vein, Figure 7 shows the hardware cost of the translation system and indicates that 60% of the pollsters said that the cost is agreeable and 10% said that it is not.

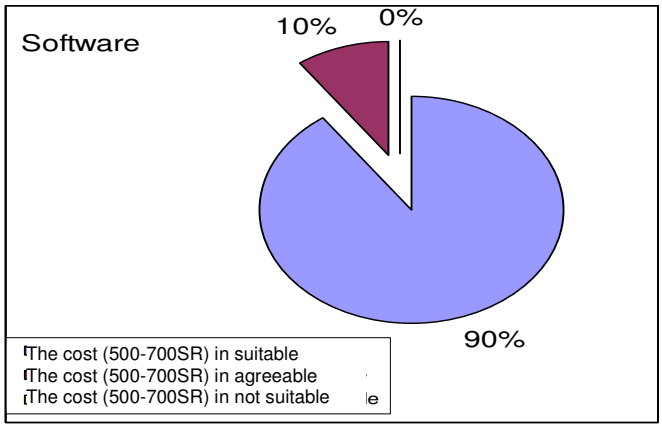

Fig. 6 Software Cost of Translation System.

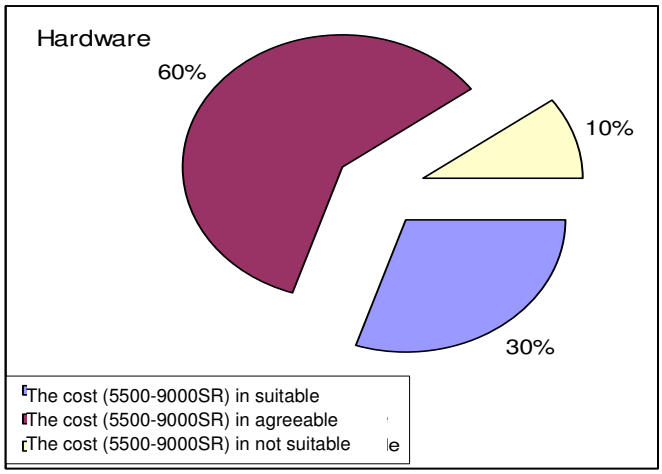

Fig. 7 Hardware Cost of Translation System.

When the two component of the system are assemble together the cost of the system will be as shown in Figure 8

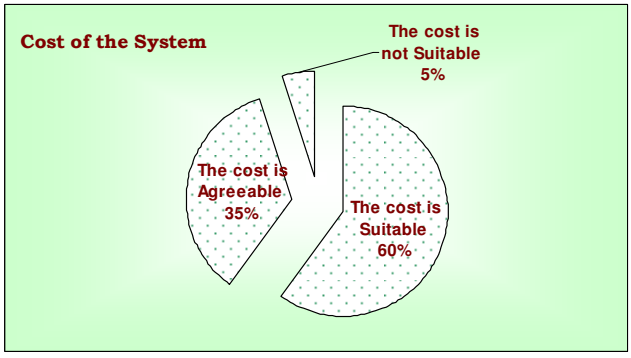

Fig. 8 Cost of Translation System.

6. Conclusion

This paper showed the need to increase the effectiveness of the ARSL system and apply it to teaching deaf children via interactive media. This paper also proves that everybody will support this kind of system and it will be a very useful system for deaf people in every way.

The key challenge of this paper has been the realization of a clear and natural gesture language by computer animation. So far, 3-D animation technology applied to the education of the deaf has been unable to represent sign language with fluidity and realism so as to enhance self-image rather than being emotionally inhibiting (Aran & Akarun, 2008; Elliott et al., 2008; Halawani & Zaitun, 2012).

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