Utilization of Avatar-based Technology in The Area of Sign language... A Review

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Abstract— Information and communication technology (ICT) has progressed rapidly in recent years, and it is becoming necessary for everybody including deaf people. This paper gives an overview of using a technology called Avatar-based technology in the area of sign language, which is the normal language of the deaf worldwide, although it is different from country to another. This paper covers the basic concepts related to the signing avatar and the efforts for applying it in different sign language worldwide, especially Arabic Sign Language (ArSL).

Keywords— Avatar – 3D animation - Sign Language - Arabic Sign language - ArSL - SL

I. INTRODUCTION

The deaf are part of the society that have hearing disabilities. According to World Health Organization (WHO), 360 million people (328 million adults and 32 million children) have disabling hearing loss. This constitutes over 5% of the world's population [4].

The communication by speaking between the deaf and the normal people has some difficulties since the deaf can't hear the voices. So there is a need for a way that enables them to communicate with each other and with the deaf themselves. Sign language (SL) is the normal language for the deaf which is a combination of signs represented by hand movements (manual gestures) and other postures of the body parts like eyes, mouth, cheeks, etc. (non-manual gestures). Like any other human language, sign language is different from a country to another, so it is not a unified language as some believes. To communicate with a deaf person, you should have either knowledge about sign language, write by a language understandable by the deaf or have a human or digital interpreter to translate the meanings among you.

Information and communications technology (ICT) has progressed rapidly in recent years, and it is becoming necessary for everybody regardless of age, gender, culture, health and individual disabilities. Deaf people are part of the society, and of course, they face many difficulties in their life. In fact, traditional method of representing the sign language by recording video-clips of human sign interpreter is an impractical method due to several reasons. For example, producing such videos needs the presence of human expert in sign language and also needs of availability of special equipment for the recording process. Also, the size of such videos is very large causing problems in the storage and transmitting over the net.

Actually, there are many efforts for creating systems and applications that are usable and beneficial for the deaf, and facilitate their communication with other people. One of those efforts is employing the 3D animations in which a virtual character (i.e. avatar) is designed and animated to represent the sign language instead of human interpreter.

This paper is intended to show different efforts of using avatars in the field of sign language. Section 2 presents an overview of avatar software technology. Section 3 shows latest trends in avatars in various sign languages. Section 4 focuses on Arabic sign language (ArSL) which serves as a case study sign language for this paper.

II. OVERVIEW OF AVATAR SOFTWARE TECHNIQUES

In this section, we discuss the definition, advantages, tools and basics concepts about avatar software technology.

A. What is Signing Avatar

Signing Avatar can be defined simply as 3D animations of virtual signing character that simulates natural movements of people [14]. The importance of using avatar-based approach for the representation of sign language have raised from many advantages offered by such approach and some defects of other traditional SL representation methods.

When we compare the appearance of animated avatar as a final output of SL with the output of different SL notation systems or individual images of signs, we find that animated avatar is much better in terms of: reality, comprehensibility [14], ease of

understanding by different age and level of deaf education and familiarity with them.

Also, when we compare the properties of the output file of avatar software with the conventional video file of human interpreter, we find that:

- The size of storage and transmission of avatar animations is much lesser than the video size, since most of avatar software produce the signs as a text file, then represent its content via specific sign players.

- The speed of avatar can be controlled as desired.

- The animation can be reused and edited easily.

- Ability to zoom avatar and rotate it for better visualization.

Figure 1 shows one of the most common signing avatars.

Fig (1). Still of Virtual Francoise, the JASigning Avatar

B. *Signing Avatar Tools*

Generally, the main objective of the sign language systems is supporting the communication between the hearing people and the deaf and vice versa. This communication can be achieved mainly by the presence of a translation system or an educational content.

There are many tools designed for creating the sequence of signs. Al-Ohali [23] and Elhadj et al.[15] has discussed many SL tools and compared between them regarding to certain parameters. We focus only on the tools that are specialized in 3D animation techniques, designed and implemented for the sign language purposes. Table 1 shows the summary of the tools. Many of them consist of two main parts: (1) sign editor that enable creating new signs or editing the

existing signs, and (2) sign player that render the created signs. Other features of the tools include:

- Supporting facial expressions.

- Choosing the properties of the avatar (e.g. male or female).

- Availability of speech recognition tool.

- Linguistic analysis of the text input.

- Dictionary database of the signs.

TABLE I.   TOOLS THAT SUPPORTS DIFFERENT SL

	Supported SL	Project Name
1	Malaysian Sign Language	3D-Sign
2	Australian Sign Language	Auslan Tuition System
3	American Sign Language (ASL)	The DePaul University Project
4	Working examples are in BSL, DGS and NGT. However, it is capable for representing any SL	eSIGN and ViSiCAST
5	British Sign Language (BSL)	Sisi
6	Arabic Sign Language (ArSL)	Tawasoul
7	Undefined	Vsign
8	American Sign Language (ASL)	Vcommunicator

III.   USING AVATARS IN VARIOUS SIGN LANGUAGES

The sign language is different from a country to another, and sometimes in one country many local sign languages can be found. In this section, we aim to present the latest projects that adopt the technology of 3D animations in the domain of sign language. This helps in broadening the horizons of developing and improving such systems for the same language and/or for another one.

Based on latest researches returned from Web of Science (WoS) and published recently, the following are various sign languages with the efforts of using avatars for each of them:

- *American Sign Language (ASL):*

(Pengfei Lu and Matt Huenerfauth) described their work in collecting motion capture corpus of ASL (CUNY ASL Motion-Capture Corpus) in order to contain sufficient quality data. They focused on developing ASL animation techniques especially for treating linguistics issues of ASL. As an evaluation of their work, they found that the participants in the

studies were able to understand some information content presented in the animations [20].

- *Spanish Sign Language (LES):*

Researchers from The Autonomous University of Madrid presented their work in building a rule-based translation system from written Spanish to Spanish Sign Language (LES). They suggested the output of the translation to be in the form of animations, but using the avatar technology was outside the scope of the published paper [21].

Another paper described the developing of two systems related to LES: translating textual messages from bus information panels and translating spoken Spanish into at the information point of the bus company. A 3D avatar animation module is used for rendering the signs. The animation module is actually a declarative abstraction module for all of the internal components. It based on XML, where each key pose configuration is stored defining its position, rotation, length and hierarchical structure. The composition of the final animation is based on Non-Linear Animation (NLA) techniques that used in film production to merge individual actions into complex animations. The evaluation of this system has been carried out at the customer information office in Madrid involving both real bus company employees and deaf people. Based on objective measurements from the system and information from questionnaires, the results show that the whole translation presents an SER (SignErrorRate) of less than 10% and a BLEU greater than 90% [19].

- *Italian Sign Language (LIS):*

ATLAS [22] is a project presented for automatic translation to Italian sign language (LIS). This project aimed to integrate LIS with MultiWordNet, which is a lexical database of English language. It used the avatar for rendering LIS through key frame animation techniques. Signs are exported as animation file and represented by a special tool developed in this project called ATLAS player.

- *Chinese Sign Language (CSL):*

Researchers from Beijing University of Technology in China provided very good research that produces animations for China Sign Language (CSL) with respect to the context of manual and non-manual gestures. The context is such as stress, feeling, tone and so on. The designed system is adopting China Sign Language Markup Language (CSLML) text, which is a collection of tags about context features and structure of CSL, as input for generating CSL animation containing context information. They provided an interactive tool to enable the users editing the context by editing the origin text to be a CSLML text. The evaluation of this proposal shows that their animation considering context is more accurate and intelligible than the animations that are not considering the context [13].

- *Portuguese Sign Language (PSL):*

José Bento et al., researchers from The University of Lisbon in Portugal, used the facilities of Microsoft Kinect in performing motion capture for conversion the movements to gesture signs. They applied this tool for describing educational application for PSL directed to the children. This application has other features like: translating Portuguese text into PSL. The results of evaluation show that the tool is applicable and avatar is useful for PSL [11].

- *Macedonian Sign Language (MSL):*

Sign Language Tutor is the project for educating MSL in an easy and entertaining way through animation and games. This project is initially a desktop application then it is rebuilt to a web platform to facilitate the developing of the tool and sign database. The evaluation of the project raised big interest and was approved and warmly welcomed by deaf people [12].

IV. PREVIEW ON ARSL SYSTEMS

According to statistics by [28], the number of deaf people in Arab world is around 10 million. So this big number of deaf community is increasing the need for efforts to facilitate the communication with them. Obviously, the deaf first language is the sign language, and like other human languages, it is different from region to another. However, there were trials to unify SL of the Arab countries into the Arab sign language (ArSL) to be, at least, used by the deaf, their families and sign interpreters, as a formal language in the education environment. Like other SL, ArSL is combinations of hand movements and other body and facial expressions.

A. Survey on Integrating Avatars to ArSL systems

There are many efforts in this area, but actually they are still insufficient. We can summarize the nature of the existing works in the following points:

- The majority of them focused on building a translation system.

- Some of them focused on building the sign dictionary with/without paying attention to the linguistic retrieval of the Arabic language and ArSL.

- Various schemas are used for animating the signing Avatar e.g. using eSIGN software.

- Some of them specialized for mobile devices.

The following paragraphs discuss these efforts to give an idea about them and to encourage the creation and development of different solutions to help the deaf community.

(Halawani Sami M., 2008) developed ArSL-TS, which is a translation system from Arabic text to ArSL used in mobile phones on the basis of WAP (wireless application protocol). The using of avatar is proposed to render the signs, exploiting its advantage in storage, transmission and using flexibility [1].

(Al-Nafjan and Al-Ohali, 2010) presented a multimedia system called "Tawasoul" for educating ArSL. This learning tool contains 3D animations for representing the signs using: Vcommunicator gesture builder, Sign Smith Studio and Macromedia flash. The functions of this tool includes: translator from Arabic text to ArSL, dictionary of 600 words in ArSL in different 15 categories and other features [8]. Al-Nafjan also presented another educational tool called "Labib" similar to "Tawasoul" project but specialized for the deaf children [9].

(Mohammed Abo El-Soud et al., 2010) proposed web_based E-learning system (LS) for the Arab deaf students, including a translator. They didn't discuss the details of using the avatar but they just proposed it to be the output of the translation process to ArSL [10].

(Al-Khalifa, 2010 & 2011) presented a mobile translator from Arabic text to ArSL. The research defined its own avatar skeleton by using the blender 3D graphics application to allow controlling avatar movements in the signing space. This skeleton has been simplified to put into account the storage requirements and to improve performance in the mobile. The used avatar is modelled as a 3D mesh attached to a skeleton. The skeleton consists of body bones that are connected by joints, and each bone has an ID. So any change in the bone will make a change in the mesh. Animation process in this project depends on a coordinate system which represents points in a space using a set of numbers that can be connected to form a shape. This shape can be transformed, rotated and scaled through specific calculations on coordinates of the shape's points. System Usability Scale (SUS) is the evaluation method conducted for this work, showing that the application is easy to use and user friendly but there is a need for other evaluation method to test the speed and whether the application is understandable or not [6],[7].

(Al-Masoud and Al-Khalifa, 2011) also proposed a translation system from Arabic text to ArSL, but on the basis of semantic web technology (called ontologies). The final output is a SignWriting notation instead of video clips or avatar animations. However, they noticed that the resulted notations from this system can be as an intermediate level for further avatar animation. The evaluation of this project is intended to be expert evaluation, but it is not conducted regarding their published paper [5].

Another big project presented by Yahya Elhadj et al. since 2011 and still not completed is building a system serving the Saudi Sign Language (SaSL) which is the local language for the deaf in Saudi Arabia. They exploit the advantages of using the animated avatar in building Islamic dictionary for SaSL through developing bilingual parallel corpus of SaSL ,and developing multimedia educational content in Islamic domain for the Saudi deaf. They adopted one of the avatar based animation systems according to specific properties which is (eSIGN) [3],[14],[15],[18].

(Basmah Faraj et al., 2012) aimed to educating ArSL through building a website including a dictionary and different levels of educational content like: alphabets, numbers…etc. They chose around 500 words from ArSL dictionary regarding their importance in deaf life. Also, they used eSIGN software as the basis of the sign synthesis animation for this project[17].

In addition, there is a wonderful project called "WebSign". It is a software developed by Research Lab, LaTICE, of the University of Tunis. It enables communication with the deaf over the web through automatic translation of written texts into sign language embodied in a virtual character and be used in multimedia techniques and three-dimensional image processing. This also included solutions to address problems related to the sign language, including:

- Multi-language translator, converting textual content of many different languages to its equivalent sign language as an avatar animation. This is achieved by designing a special easy interface that enables changes of the avatar movements and stores the resulted sign in the dictionary [26].

- Educational application helping in creating lessons for learning sign language for the deaf children based on images, video clips and SL texts in the form of avatar animation[25].

- Automatic conversion of written text to video clip containing the virtual avatar in the mobile devices, in which the text is sent as SMS and the received video clip is through MMS service [24].

Regarding the same project, (Aouiti, 2013) proposed a translation system from Arabic written text to animated ArSL to be integrated with webSign system that focusing on the analysis of syntax and semantic of the inputted text [16].

V. CONCLUSION

The field of researches and applications of Avatar-based technology to provide services to the deaf community is promising. As a future work, we plan to present a proposed system that take the advantages of this technology and overcome the weakness of the current sign language systems.

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