MOBILE SIGN LANGUAGE TRANSLATION SYSTEM FOR DEAF COMMUNITY

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ABSTRACT
Nowadays, web technologies are a very efficient way to ensure communication between a large and heterogeneous audience. Furthermore, web information is mainly based on textual and multimedia content and consequently, some people with special needs, such as deaf and hard of hearing people, have difficulties to access to information or to communicate with hearing people. This problem is due to the lack of services that facilitate sign language learning for hearing people or text translation into sign language for persons with hearing impairment. In this context, we present in this paper a new approach based on web services, X3D and android operating system to build a mobile translation system from text into sign language using virtual signing agent. The main feature of this work is that it can be used to learn sign language and to provide sign language translation of written text for people with hearing impairment.

Categories and Subject Descriptors
K.4.2 [Computers and Society]: Social Issues – Handicapped persons/special needs, Assistive technologies for persons with disabilities.

General Terms
Design, Human Factors.

Keywords
Web services, X3D, android, sign language.

1. INTRODUCTION
According to many linguistic researches, it turned out that the learning process of hard of hearing people differs compared to the classical learning process. In 1996, Marschark and Harris confirmed that their learning progress is extremely slow (Marschark, M. and Harris, M. 1996). For instance, the gain of experience collected by deaf children in four years is equivalent to the gain of one year for hearing children.

In the world, there are around 70 million people with hearing deficiencies (information from World Federation of the Deaf http://www.wfdeaf.org/).

There are varying degrees of deafness: hard of hearing, "profoundly" deaf, and completely deaf. Deaf or profoundly deaf people may wear no hearing aid. Some will be able to lip read and understand you nearly perfectly. But some may have problems with verb tenses, concordances of gender and number, etc., and they have difficulties when creating a mental image of abstract concepts. However, many communicate with sign language rather than with written and spoken language (Wheatley, M. and Annika P., 2010). Consequently, the communication with hearing people who do not know sign language is more difficult.

In this paper, we propose a new approach which uses mainly a web-based interpreter of sign language. This tool offers the possibility to translate automatically written texts to sign language using avatar technology and web services. This service can be used as mobile learning tool for sign language. Users who do not know sign language can access easily to the translation service from smart phone. For instance, a child can use this tool by introducing the word to be translated and just pushing play button to visualize animation. In this manner, he learns how this word can be translated to sign language. In other context, persons with hearing impairment and low English literacy can take advantage of this service by translating short message to sign language. Consequently we improve the accessibility to written information for persons with hearing impairment.

The remainder of this paper is organized as follows. In section 2, we present the benefits of web information systems and technologies for our translation service and how it can be attached to accessibility problem and sign language. Section 3 is devoted to previous works. In section 4, we present our approach and we explain the different parts of our translation system architecture. Finally, we conclude by a conclusion and some perspectives.

2. BENEFITS OF WEB TECHNOLOGIES FOR OUR TRANSLATION SERVICE
Today web technologies are almost indispensable in our daily life. We use web technologies as data and content sharing, as a social platform for generating, repositioning and consuming content (Abhari A. and M. Soraya, 2010). However, web technologies

encompass a variety of different meanings that include new ways of interacting with Web-based applications (Abrahão S. and Poels G. 2009), collaborative approach and new alternatives to enrich the learning process. Furthermore, recent research (Albert L. H. 2009) showing the benefits of collaborative learning (Whitney, G., all, 2011) is being conducted across disciplines and looks at the use of web and virtual world technologies to improve the classical learning ways.

In our context, we focus on the use of a collaborative approach based on web and virtual world technologies to build solution that improves sign language accessibility for hearing people and textual information accessibility for persons with hearing impairment. We are based mainly on virtual reality description X3D. Signs can be created using our tool and saved into database on X3D format. However, this approach gives the possibility to combine several signs and to build fluid sign language animation.

The objective is to overcome traditional video limitations related to bandwidth constraints and video merging problem. In fact, when we merge video signs, there is no fluid transition between signs and therefore, the video meaning can be lost. Furthermore, we are based on web services to create signs and to provide sign language translation. This solution offers many benefits such as sign language diversity thanks to our multi-communities interface which gives the possibility to each community to create its own sign language dictionary. Also, web services can be used by smart phones and this increases the user area and provides anywhere access to our translation service. Moreover, we can exploit this work as sign language learning tool through the correspondence between word and sign language animation or as interpreter tool for people with hearing impairment to read textual content as SMS or E-MAIL.

3. PREVIOUS WORK

Up today, most of previous works on SL are based on video support such as sign language video recognition (Dreuw P., & al., 2008), ELAN video corpus annotation (Crasborn O., Sloetjes H. 2010) or (Efthimiou E., & al. 2010) work. However, video based solution is not efficient if we want to provide a good sentence translation because video sign language recognition is not a reliable solution and when merging separate video signs, the meaning can be lost. In this context, few studies have been carried out upon the deployment of Virtual Signers on the Web. Two main techniques are employed: pre-synthesized animation and generated animation. The first one is based on motion capture pre-recorded animation using avatar technology such as Mathsigner or DIVA framework (Annelies B., & al. 2010). However, this approach depends on expensive material to build signs and decreases the user interactivity to create new signs according to chosen community. The second technique consists on automatic and real-time generation of animations. Furthermore, in this area there are some works as eSIGN, signSMITH (Signing Science) or (Baldassarri S., Royo-Santas F. 2009) work. eSIGN is based on synthetic signing works by sending motion commands in the form of written codes for the Avatar to be animated. SignSMITH provides a gesture builder to create signs with elementary movement. However, those products do not give the possibility to share the created signs to be used by the others communities. In addition, all existing systems are not able to give a multi-community real time translator service that includes a mobile access and share all signs created by others communities.

4. OUR APPROACH

4.1 Architecture

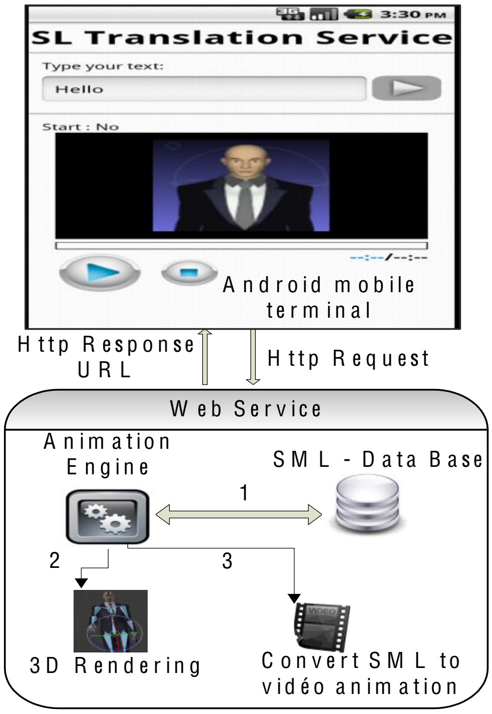
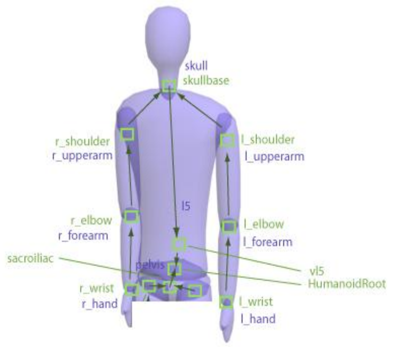


Figure 1. Our translation web service

As shown on Fig.1. our web service architecture is divided into three principal parts. The first part is devoted to provide the SML animation related to each word in the sentence. The second part ensures the automatic generation of SML animation to 3D rendering animation. Finally, the third part is devoted to convert SML to video animation.

4.1.1 Sign Modeling Language SML

The Sign Modelling Language SML (Jemni, M., Elghoul O.) is an XML based descriptive language, which we had developed to codify gestures and to store description of signs in the database. We had built this descriptive language to provide an extra layer around X3D to facilitate 3D virtual agent manipulation. However, SML considers that a sign is an animation of many joins. The animation is a successive movement of a group of joins. Every movement has a fixed time; during it the rotation of every join of group is done. The armature description respects the H-Anim specification (as shown in Fig. 2 A), in which each join has a specific name and specific initial orientation. In Fig.2 B there is a part of SML description according to "hello" word with each join (bone) to be animated. For example, we apply EULER angle rotation to right shoulder join (r_shoulder) with heading=75, attitude=50, bank=53 and 0,5 seconds as duration of the movement.



SML part of « Hello » sign description

```
<Sentence>
 <word>
  <mouvement>
    <duration>0.5</duration>
   <join name="r_shoulder">
    <rotation type="euler">
      <heading>75</heading>
      <attitude>50</attitude>
      <bank>53</bank>
    </rotation>
   </join>
   <join name="r_elbow">
    <rotation type="euler">
      <heading>68</heading>
      <attitude>28</attitude>
      <bank>63</bank>
    </rotation>
   </join>
   <join name="r_pinky2">
    <rotation type="axis-angle">
      <x>-0.768604</x>
      <y>-0.268653</y>
      <z>-0.580581</z>
      <v>0.0091299</v>
    </rotation>
   </join>
   <join name="r_ring2">
    <rotation type="axis-angle">
      <x>-0.768604</x>
      <y>-0.268653</y>
      <z>-0.580581</z>
      <v>0.0091299</v>
    </rotation>
   </join>
```

B

Figure 2. [A] H-anim human body nomenclature used in our sign language translation system. [B] Part of SML description **related to "Hello" sign.**

4.1.2 SML animation and sign creation

After sending the text from a mobile terminal as http request, the web service engine fetches our database and gives the SML animation according to each word on the sentence. However, we had built a web tool (as shown in Fig.3) to create signs around virtual communities. The user can creates his sign and store it in his community on SML format. Furthermore, our database contains signs of different communities according to group of users that can build and share a common dictionary of sign language.

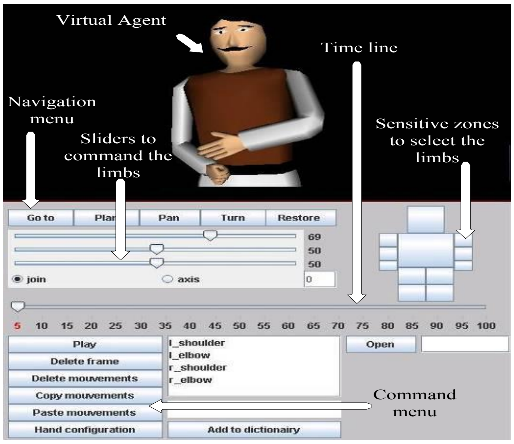


Figure 3. Web tool to create signs.

4.1.3 3D rendering

As it was presented in Fig.1, the 3D rendering module interprets the SML description of signs and converts it to 3D rendering animation using our virtual agent. Then, it creates the different key Frames and inserts each join (bone) position on dedicated Key Frame. However, to do this properly, we need to convert EULER angle rotation from local coordinates related to SML description to global coordinates used in Blender environment. The 3D coordinates of each join (bone) rotation are modeled by X, Y and Z in this conversion formula:

X = - (180- (float (head) / 50) * 180).
Y = - (180 - (float (attitude) / 50) * 180).
Z= - (180-(float (bank)/50)*180).
All steps in our system are completely automated.

4.1.4 Mobile solution and technical details

Nowadays, Mobile phones have very similar features compared to personal computers such as web surfing, electronic mail access, GPS, video streaming and other interesting application of assistive technology (Mata, F., Jaramillo, A. and Claramunt, C., 2011). In this work we are focused on the fact that users can access easily to a web service for sign language translation anywhere. However, it is now possible thanks to the technological advances (Plebani P.,all, 2011) that have affected mobile operating systems and mobile networks communications such as 3G network which provides a download speed up to 14.4 megabits per second that increases the reactivity rate of our mobile service. In this work, we used a mobile access to our web service and android OS. Furthermore, we built an easy to use interface (shown in Fig.1) with assisted auto-completion text area which provides existing signs on our remote database. This application has two text input mode. Either the user enters himself text or he chooses to translate the received short text messages SMS in his smart phone. After this, mobile application connects to the web service and the text will be transmitted as http request. Once the text is received, our animation engine tries to find firstly if the associated animation was generated before or no. The already existing animation will be directly sent as a multimedia URL to mobile terminal. However, new requests will be first treated, rendered and then sent also as a multimedia streaming URL. Furthermore, this process increases the reactivity rate of our mobile application and allows a real-time translation according to existing animations. Nevertheless, the service response time depends mainly on mobile network and 3D rendering machine power. We tested this service with i5 processor, 4GB RAM and ATI RADEON HD 5650 graphics card. For five new words (signs) the service response time is 25 seconds this means average of 5 seconds per sign. In other words, if we deploy this service on a more powerful machine we can reduce the rendering time to reach the real time translation.

5. CONCLUSION AND FUTURE WORKS

This paper described a web service solution for sign language translation with mobile access. This service incorporates two principal aspects. The first aspect was devoted to create signs with our web tool to be stored as SML notation system. This process is based on collaborative approach which offers to different communities to create their own signs dictionary and this is very important to understand sign language translation according to their culture. In the second aspect, we described how our web service translates text to sign language animation. We discussed the different parts of our web service and how mobile access can be used to obtain real time translation through smart phone. This system can be used as an assistant to learn sign language to children or adult persons. Our service allows translation of received short text message to sign language animation. Consequently, we improve accessibility to information and to new technologies for hard of hearing people with low English literacy.

As a perspective of our work, we intend to build an interface which allows hard of hearing people to communicate with hearing people by converting animation to text. Also, we can improve application reactivity to reach real time translation.

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