Multimedia with Animated Sign Language for Deaf Learners

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Abstract: This paper describes how animated sign language can be integrated into multimedia teaching material for deaf learners with a sign language as their first language. For the creation of animated sign language special techniques were developed in which the animation is driven by a special sign language notation system. This so-called synthetic animation enables a trained sign language user to easily create signed content at the computer at his/her own pace. To demonstrate and evaluate the quality of synthetic signing, several web applications were developed and tested with deaf users. The results were sufficiently promising to develop other applications and our focus is now on educational applications for deaf pupils at primary and secondary level. Several examples of this are presented.

Deaf children have insufficient access to spoken language input for normal language acquisition. Because of this, the spoken language and reading skills of many deaf people are often, at best, those of a second language. Recent research in the Netherlands (Wouters 2005) shows that only 25% of deaf adolescents up to 20 years old have reading skills that equal those of hearing nine year olds. On the other hand, many people who were born deaf or became deaf before they learned to speak have acquired a sign language as their first language. It is now generally recognised that sign languages are natural languages with their own grammar and lexicon. And in contrast to what is sometimes believed, different sign languages are not mutually comprehensible.

Because most teaching material is provided in text, it is inherently difficult for deaf learners and can be made more accessible by providing sign language in addition to the text. This can be done either by presenting a video of a person signing or through animation of a virtual human or avatar. While video has the advantage of providing more lifelike signing, it is also more cumbersome to make changes in already existing material. Each time a signed sequence needs to be changed, a new video has to be made. This can be especially impractical if an expert signer is not readily available. An animated signed sequence on the other hand can be changed on the computer by omitting existing or inserting new signs. Other advantages of animated sign language are: firstly, that the viewer can control the speed of signing and rotate the avatar to be viewed from different angles; and secondly that sign language content can be transmitted over the Internet at much at much lower bandwidth than is required for video.

Sign Language Animation

The most common animation method is through motion capturing. This technique has also been used for sign language animation (see Elliot et al. 2000, Kennaway 2002), and a user evaluation of captured signing on web pages with deaf signers (Verlinden et al. 2001) showed reasonably good comprehension and subjective approval. However, a drawback of motion capturing is that it is labour-intensive and requires expensive equipment.

Animation Driven by Notation

An alternative to motion capturing is the so-called synthetic creation of animation. The techniques for this were developed by a consortium of German, British and Dutch universities and deaf institutes in two consecutive EU-funded projects ViSiCAST and eSIGN. Signs are first notated in accordance with a sign language notation system developed by the University of Hamburg (Hanke 2002). With this system called HamNoSys (Hamburg Notation System) for which also a computer font has been designed, all of the sign components can be given specific values. Subsequently, because it is not possible for computers to process the HamNoSys fonts as such, they need to be translated in a language that is amenable to computer processing. For this purpose, the University of East Anglia designed the Signing Gesture Markup Language or SiGML, which is an XML encoding of HamNoSys, and a translator from HamNoSys to SiGML. Subsequently, these animation data together with a description of the geometry of the avatar can be sent to the avatar, who then makes the requested signs (see Kennaway 2003 for more details). An example of the HamNoSys transcription of a sign and its translation into SiGML is given in (Table 1).

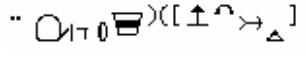
HamNoSys		**SiGML**
	→	<hamgestural_sign gloss="Ham2HPSG"> <sign_manual both_hands="true" lr_symm="true"> <handconfig handshape="flat" thumbpos="out"/> <handconfig extfidir="uo"/> <handconfig palmor="l"/> <location_bodyarm location="chest" contact="close"/> <par_motion> <directedmotion direction="o" curve="u"/> <tgt_motion> <changeposture/> <handconfig extfidir="o"/> </tgt_motion> </par_motion> </sign_manual> </hamgestural_sign>

Table 1: HamNoSys transcription and SiGML translation of the Dutch sign for 'to visit'

Handshape (flat hand with spread thumb) is expressed by in HamNoSys, orientation of fingers and thumb by the respective symbols and . The initial hand position is near the chest () and the movement consists of a curved forward movement (), with a simultaneous change in finger orientation (). The dieresis () indicates that the non-dominant hand mirrors the dominant hand. The sign, as performed with the eSIGN avatar called 'virtual Guido', is illustrated in (Fig. 1).

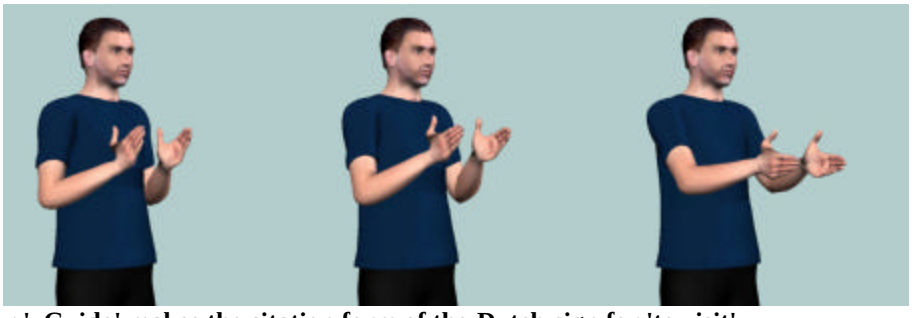


Figure 1: **Avatar 'vGuido' makes the citation form of the Dutch sign for 'to visit'**

The HamNoSys transcription system originally focused on the manual part of signs, but it is now also possible to represent most of the non-manual part of sign language such as positions and movements of body parts (shoulders, back, chest), head, and face (eyebrows, eyes, nose, lips, tongue and lower jaw).

Tools for Synthetic Creation of Sign Language

The ideal method to create sign language content to supplement or replace text would be an automatic translation tool. However, for various reasons this is not possible now or in the near future. The current knowledge of the grammar of most sign languages is still insufficient, and even for well-known spoken languages such English and French, automatic translation of texts is still problematic. Thus, in order to create sign language content or to translate text into sign language we still have to rely on a human sign language user. To enable this person to create sign language, a sign language editing programme (SL-editor) was developed by the University of Hamburg (Hanke & Popescu 2004). With this program, sign language users can construct content on the basis of the knowledge they have of their own language. The person creating content retrieves signs stored in the database of the program, puts them in the right order and provides the string of signs with the correct prosody. This is comparable to writing a text on a word processor in that all that is needed are the sign language skills, the necessary software and the skills to use the software. A person can create signed content at his/her own pace and easily repair mistakes and adapt previously created content.

Evaluations of Web Applications

To demonstrate and evaluate synthetically created sign language content several web applications were developed, each containing information in sign language:

- a webpage with a daily updated weather forecast in sign language;
- webpages that offers assistance in sign language to fill in forms (e.g. application form for interpreting services);
- a website with information in sign language on job vacancies ;
- a website with information in sign language on government regulations and practices;
- a website explaining and promoting the signing avatar.

All these applications except for the last one were evaluated with deaf users (Verlinden et al. 2001, Van der Schoot et al. 2003, Verlinden 2004a,b). Subjective methods were used as well as sign recognition tests. The results of these evaluations can be summarised as follows.

- The comprehension of the signing was adequate, but could be further improved by improving the mouthing and facial expression.
- The appearance of the avatar pictured in (Fig. 1) was judged to be fairly realistic, but the movements were considered to be still somewhat robotic.
- Control of the speed of signing appeared to be especially important and subjects usually liked the design of the websites. Most means for navigation were judged easy to use, but hyperlinks within text presented problems.
- The provision of information in sign language on websites was considered useful, especially on sites with complex content such as regulations and forms to be filled in. Subjects also suggested many other applications in which they would like to see a signing avatar. This varied from government information to fun applications such as games or announcements of events. Providing information in public areas such as train stations, airports and town halls was also mentioned as potentially useful.

Educational Applications

We are currently focusing on learning applications for deaf pupils at primary and secondary level. They often have sign language as their first language, while the learning material and the instructions are usually in Dutch. Especially when new topics are presented, this can be very hard to understand for these pupils. One way to overcome this problem is to have the lesson introduced by a fluent signer, who also knows all the signs for all the special terms (jargon) that occur in the content. This is a very labour-intensive solution and very often no one would be available to do this. Alternatively, a video might be created, but this is also dependent on the availability of an expert in both sign language and the specific terminology for the lesson. Creation of such videos is a substantial investment and if the content changes entirely or even slightly, a new video would have to be produced. Another kind of problem occurs with software for young children. Software for hearing children that do not yet read (say under 7 years old) usually contains instructions and feedback in audio. For deaf children, this would have to be presented visually but not in text. To realise this, some software has been adapted to include pictograms or videos showing instructions in

sign language. However, pictograms are very limited in their expressiveness, and videos enlarge both the production process and the size of the software. Moreover, the instructions cannot be updated easily if a new version of the software is to be created. For both these types of problems the signing avatar and the synthetic animation technique can provide a much better solution. We will now show a few examples of how this can be done. The first one illustrates how to solve the language problem, that occurs when new topics are introduced. (Fig. 2) is a sketch of a cooking and catering lesson with the material presented in short sections, with both sign language and text. Such bilingual material can be used plenary in a classroom or for individual tuition.

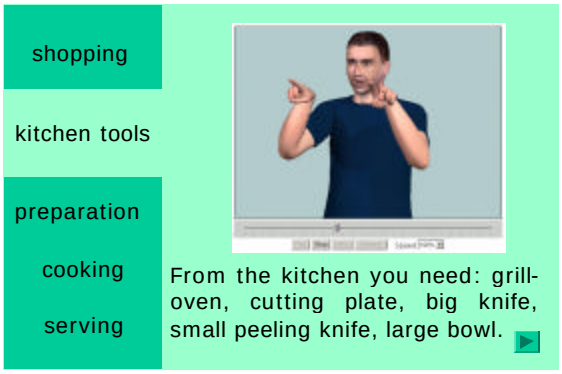


Figure 2: Bilingual lesson material

Secondly, solving the audio problem for young deaf children is illustrated with the following examples. (Fig. 3) presents a categorisation exercise with instructions and feedback signed by the avatar. This makes it possible to reflect on the exact concept that has to be learned. Creating comments in sign language for the same type of exercise can be done quickly, because the signs for the particular categories can simply be replaced using the SL-editor.

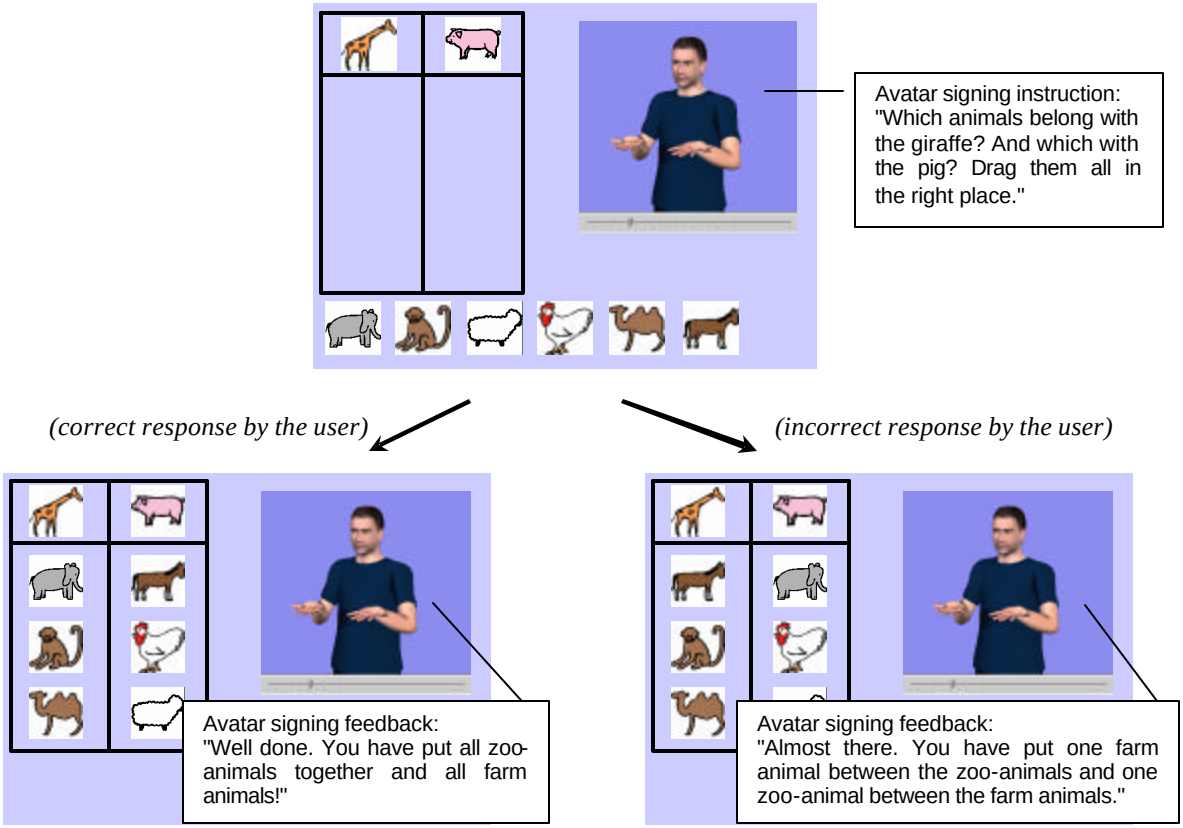


Figure 3: Sign language instead of audio

Synthetic signing can also be used in other exercises, e.g. exercises where objects have to be put in the correct order. As in any educational software, various types of objects can occur in such an exercise: pictures, words, sentences. And the goal of the exercise can vary from learning what is a good story line or relations like 'big-bigger-biggest' to what is a grammatically correct sentence. (Fig. 4) presents a situation in which the signs are presented in pictograms and the pupil has to put them in a grammatically correct order. The sequence is then signed by the avatar in the order that the pupil put them; although the order of signs may be incorrect, the avatar will sign any order fluently. Subsequently the avatar could explicitly mention that he did what the pupil asked him and whether it was correct or not.

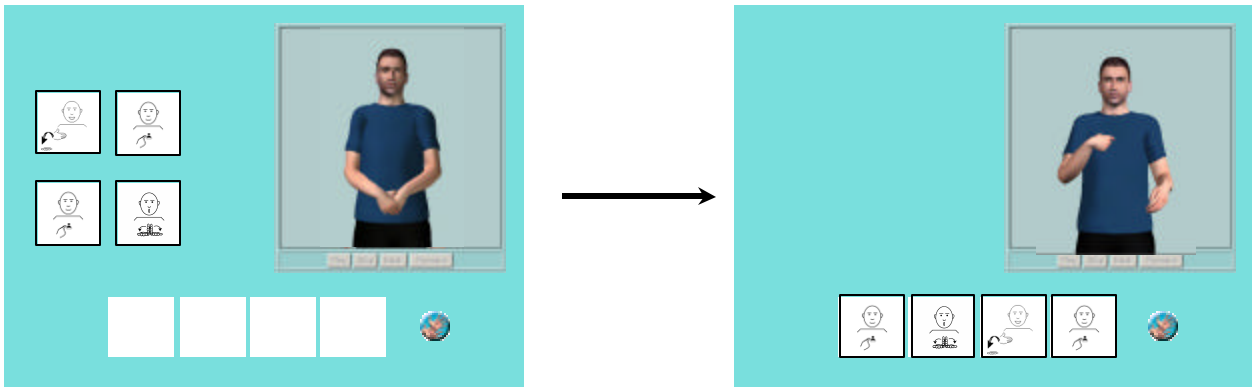


Figure 4: Signed feedback strongly depending on the users input

Concluding Remarks

The techniques described in this paper can in principle be used in a wide range of multimedia applications for deaf people. Although their success can no doubt be improved by further technical development, the techniques seem to be sufficiently mature to move from demonstrators to real-life implementation, possibly starting with a pilot phase. In education they can help to make text-based information more accessible for deaf people, especially where there is a clear need to supplement text with sign language and this need is not already provided for.

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