A sign language screen reader for deaf

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Abstract. Screen reader technology has appeared first to allow blind and people with reading difficulties to use computer and to access to the digital information. Until now, this technology is exploited mainly to help blind community. During our work with deaf people, we noticed that a screen reader can facilitate the manipulation of computers and the reading of textual information. In this paper, we propose a novel screen reader dedicated to deaf. The output of the reader is a visual translation of the text to sign language. The screen reader is composed by two essential modules: the first one is designed to capture the activities of users (mouse and keyboard events). For this purpose, we adopted Microsoft MSAA application programming interfaces. The second module, which is in classical screen readers a text to speech engine (TTS), is replaced by a novel text to sign (TTSign) engine. This module converts text into sign language animation based on avatar technology.

Keywords: Screen reader, TTSing engine, Deaf, Avatar.

1 Introduction

Despite the technological advances in communication and information process, deaf people suffer from several difficulties to communicate and access to the information. Let know that visual information are visible, but not accessible for them if they are illustrated by textual representation. This is due to two main reasons: the illiteracy of the majority of deaf people and the non adapted information used by computers (like audible feedbacks). In this context, our project “Screen reader for deaf” aims to translate significant contents displayed in the screen after an event generated by user activities to sign language animation. The system represents a screen reader with an output different from those generated by classical screen readers.

The paper is organized as follows. Section 2 presents the motivation. Section 3 describes the survey of existing solutions for deaf accessibility. The technical architecture of classical screen readers is illustrated in section 4. The last section is devoted to describe our approach and to detail the technical architecture of the proposed system.

2 Motivation

2.1 Literacy of deaf

In 2003, the World Federation of Deaf confirmed that 80% of deaf people lack education or are undereducated, are illiterate or semi-literate [11]. Moreover Sign language is banned in many countries and programs. In addition, the average of deaf high school graduate is unable to exceed the fourth grade level. Deaf children have much trouble to read. Many of them still to have comprehension difficulties on reading into adulthood. Moreover, reading levels of hearing impaired is lower than the reading level of hearing students. In 1996, Marschark and Harris [8] have confirmed that their learning progress is extremely slow. In fact, the reading capability of the high-school graduate deaf is similar to the reading potential of 8 to 9 year old hearing child. Consequently, the gain of experience collected by deaf children in four years is equivalent to the gain of one year for hearing children [8].

2.2 Difficulty to understand menus and textual information

Because they can see visual information and use mouse and keyboard easily, we believe that visual computer contents are accessible for deaf. However, using computer and internet represents a big challenge for the majority of deaf people, due to their lack of education or their written language illiteracy. Understanding feedbacks or choosing menus is still difficult for hearing impaired because they are written in textual format. For this reason, their computer use is limited to the video chat or some deaf accessible websites. Furthermore, they have serious difficulties to use Hypertext links to navigate on the internet or to understand textual web contents. However, there exists few number of web contents on sign languages, mostly by embedding video files which contain sign language translations of the website's texts. These video translations are still limited to some administrative or deaf organization websites.

2.3 Many audible feedbacks

In general, computers are useable without having to listen to any sound. We can write text, navigate on the internet, or send mail without need for any hearing capacity. However, some sonorous feedbacks are generated by computers as alerts to certain events. An example is an error message or a sound to indicate that a new mail has arrived. These feedbacks require visual alternatives to be accessible by hearing impaired people. For example, when a new mail arrives, some applications show a message box or change the color of the mail client telling the user that there is a new message.

2.4 Deaf have to adapt their skills to use technology

Operating systems of different machines are available in a multitude of languages in the worlds except sign language and others spoken languages used by a minority of people. There are three reasons explaining this fact: the first is that the mainstream society chooses the mode of communication the most used (sign language is used by little number of people). The second reason is that there are hundreds of sign languages in the words. It's hard to make machines supporting this large number of visual languages. The last cause is due to the difficulties to implement an operating system using such languages because it requires the storage of many video sequences. Consequently, hearing impaired people have to adapt their communication need to the mode of communication chosen by mainstream society [9].

3 Survey of existing solutions

In order to improve the accessibility of hearing impaired people to the information and overcome the problems presented in last section many solutions and studies appeared during the last few years. In this section we illustrate three techniques offering to the deaf community a minimum of comfort to access to the information.

3.1 Websites translation into sign languages

The most evident way to develop an accessible website to deaf person is to translate textual content into sign language. Many companies specialized on sign languages interpretation offer same services to translate websites' contents into sign language video sequences. However, the translation is a very hard task. It consumes times and money. The disadvantages of this solution can be summarized on the necessity of large bandwidth to be able to see video in streaming mode in the first hand, and in the second hand, textual links (Hypertexts) still inaccessible for reading disabled persons.

3.2 Hypertext in sign language or pictograms

There exist very few websites in the World Wide Web based on sign language video interpretation. However, all these contents ignore Hypertext links despite their importance. Hypertext links are as significant as the information itself. In fact, they represent the most efficient and the most used navigation tool in the Web. If sign language contents exist, it would be hard to find by deaf users. Because, before to be able to see sign language content, a deaf should navigate several text-based web pages. As a solution, Andreas Kaibel and al. [6] have proposed a new technique which allows making Hypertext links in sign language format. All contents of pages are shown on video format accessible to deaf people[6]. In another hand, researchers have used pictograms as alternatives to the textual information in the Hypertext links[3].

3.3 Improving deaf users' accessibility in hypertext structure

Due to its importance, some researchers have focused their studies to determine the impact of the hypertext structure on the accessibility (simplicity, content finding) of websites. It is argued that the structure of links between pages have an influence on the information finding [2]. The depth and breadth of website affect the speed of searching information. In fact, depth is the number of layers of nodes in the website structure and breadth is defined as the items number in the same node.

3.4 Synthesis

It is clear that many efforts are done to pick up the accessibility of deaf persons to the internet and digital information. However, these works are still insufficient to satisfy the need of deaf due to the cost and/or the difficulties to make. *Table1* illustrates the disadvantages and argues the unsatisfactory of each solution.

Table 1. Disadvantages of existing solutions

Solution	disadvantage
Websites translation into sign languages	- Cost (time and money); - Translation is limited to the content; - Navigation is difficult; - Need large bandwidth.
Hypertext in sign language or pictograms	- Cost (time and money); - Translation of hypertext links; - Easy navigation; - Hard to implement.
Improving deaf users' accessibility in hypertext structure	- Easier navigation; - Textual information; - Unusable for illiterates.

In this context, we propose a screen reader for deaf. The output is the translation of textual information, feedbacks, menus and message box into sign language. The proposed solution offers many advantages to deaf. The first one is the use of existing resources (such that, there is no need to develop operating systems or applications in sign languages). Furthermore, deaf can access to a wide range of web contents and not only to those presented in sign language. In particular, it becomes possible to read all existing textual web contents despite the medium quality of the translation. Moreover, the system is free and it is easy to use: the deaf has to put the mouse cursor over the text or the graphical content to be interpreted by a virtual character. The architecture of the proposed application is described in the next section.

4 Screen reader architecture

The most common definitions of a screen reader are in agreement that it is a software for visually impaired persons and that it serves to translate contents shown on the computer screen to vocal or/and Braille contents. Others definitions enlarge the set of persons who are able to use screen readers to illiterates or learning disabled persons because screen readers can read textual information. In this project, we have extended the set of screen reader users to cover persons who are learning disabled and hearing impaired.

In order to allow screen readers to access to the user interfaces, operating systems should have a specific architecture allowing screen readers manufactures to develop separate screen reader applications. In this context, Apple and Microsoft have developed their own architecture. For instance, in this work, we are using Microsoft design and our application has been developed on Microsoft Windows.

As shown on *figure1[1],* the screen reader is a separate application but it communicates with the operating system and other applications via many interfaces. Thanks, to MSAA (Microsoft Active Accessibility) it becomes possible to communicate with the operating system in order to catch events, to get the focused GUI component and to read its textual properties and/or contents. In other words, MSAA represents an ideal interface to develop an application able to communicate and fetch textual information from the screen. However, some windows applications do not support or totally support the MSAA.

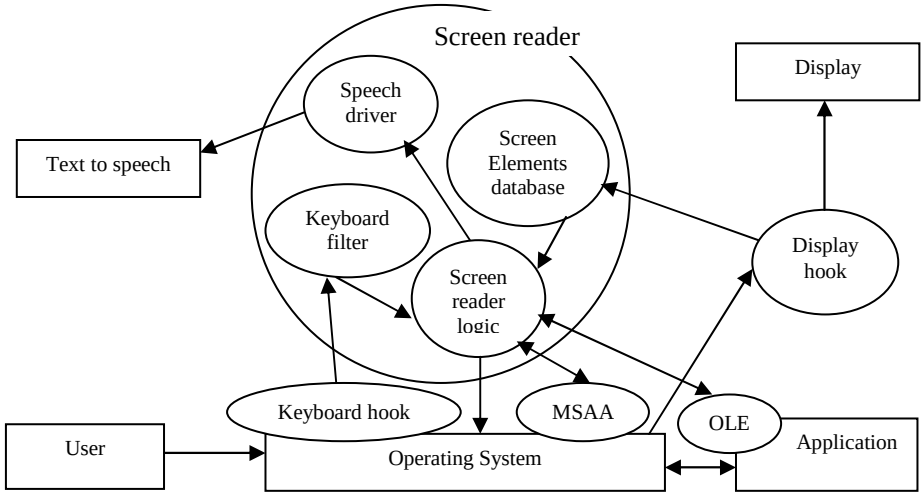

Fig. 1. General architecture of a screen reader [1].

To cover this gap screen readers use traditional techniques which consist on hooking keyboard and display. Captured keyboard events will be routed to the keyboard filter witch analyzes them and sends the result to be treated by the screen reader logic. At the same time, the display hook is responsible to monitor windows messages in order to determine screen updates and maintain an off-screen model

(Screen Elements database). The off-screen model is a data structure with an associated API for screen information. It serves to specify to the screen reader information about the contents of the screen.

5 Our approach

A screen reader for deaf is unlike any other screen reader not only because the output is in sign language but also for the reason that the input is based on the use of the mouse. For this reason, the classical screen reader architecture needs to be updated to satisfy new requirements (*figure2*). Firstly, the software should capture mouse events instead of keyboard events captured by screen readers for blind. Secondly, the application requires also an off-screen model to be used in the case of applications that do not support or support partially the MSAA technology. Concerning the output, we propose to integrate to the screen reader a new "text to sign language" engine. The system is controlled by a sign driver.

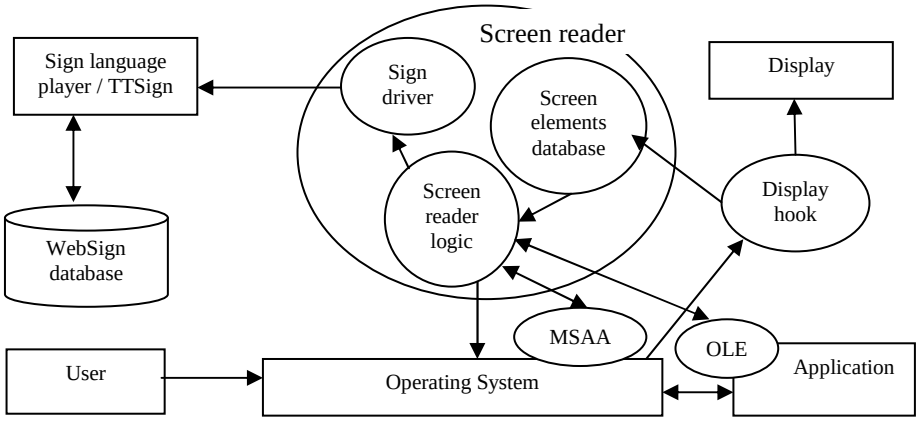

Fig. 2. Architecture of the proposed screen reader.

The difference between our tool and screen readers for blinds resides not only on the input/output modules but also on the screen reader logic. A screen reader for blind should read the focused object. However, a deaf needs to read the textual description of the mouse pointed objects. In another hand, unlike classical screen reader, our tool does not identify visual GUI objects. For example, when a new window is displayed on the screen of blind persons the system should indicate this information. Furthermore, if the user changes the focus to a button, the system should indicate that the focused object is a button and should also indicate the title of this button. However, this information is not essential for deaf because it is represented in visual way.

The Text to Sign player is an application developed in our research laboratory of technologies of information and communication UTIC [10]. It is based on the avatar technology. It can play directly signs by sending a movement request and it can

interpret, in real time, textual sentences into Sign language. The player is described in previously published papers [4][5]. The two services are exploited as follow: most useful words and sentences (like open, close, save, shutdown …) are stored locally and manipulated by the Sign driver. The movement requests are sent directly to the Sign player. If words or sentences are occasionally used (like texts in web pages or menus in newly installed applications), the system sends the entire sentence to the "text to sign" engine which contacts the server to get the translation using Websign database.

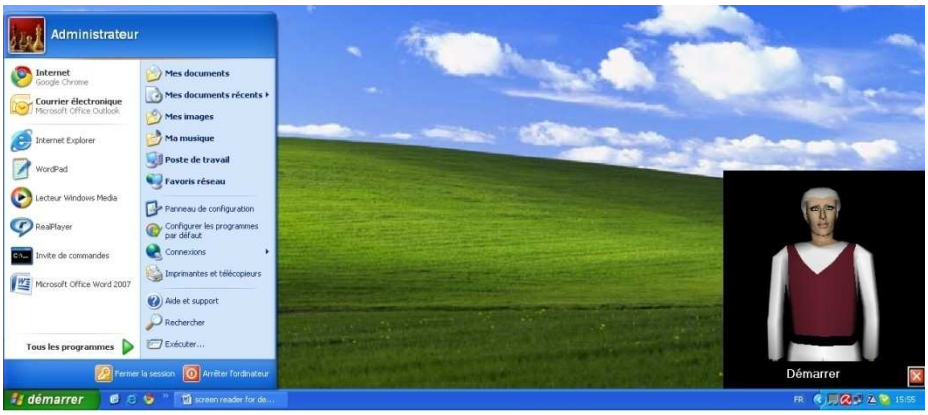

Fig. 3. Screenshot of the screen reader.

6 Conclusion

In this paper, we have presented a new screen reader dedicated to deaf using avatar technology and real time sign language machine translation. The system is tested locally with a small dictionary and we obtained promising results. In this step of the project, we have implemented only the part which uses the MSAA technology and we plan to start the development of message hooking solution soon.
As perspectives, we plan to ameliorate the websites interpretation, in the first step, by analyzing HTML tags. In a second step, we plan to run a set of experimentations with deaf persons.

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