Systems and interfaces

for disabled people

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Contents

Abstract

This publication has been made for the Human Computer Interfaces (HCI) module, at the Cork Institute of Technology (lecturer: Paul Rothwell). The goal of this report is to see why interfaces for disabled people (and people with special needs) are so important, what accessibility means to disabled people considering computing devices, and which systems exist currently.

We begin by talking of accessibility for disabled people in real life, to make a parallel and illustrate what is accessibility in computing. Then, we present some existing systems for some of the main disabilities: mobility-impairment, blindness, deafness. After the external systems, we see how accessibility is implemented in software, by seeing what exists in some operating system window managers. We finish by treating one of the most important aspect of software accessibility: accessibility to the Internet.

Introduction

There are quite a lot of illnesses which can lead to huge disabilities. Among these are deafness, blindness, and mobility impairment. These can make the use of some tools impossible for people in everyday-life. Computer use is not make an exception to this rule. As computers have become a more and more useful tool, and nearly indispensable for certain people, it has become important to gure out a means to enable disabled people, as everybody, to use this kind of tool. In a lot of jurisdictions, governments and authorities make rules, laws, and other eorts, to make a lot of things accessible: buildings, transport, etc. In computing and software design, the case of disabled people can be [11] and has been taken into account. But it is a non-trivial domain, and a lot of developed systems are still subjects of research elds.

Firstly, we will highlight the accessibility of the real world, through some examples. That will enable to us to move on to accessibility in software. So we will see, in a second chapter, some of the means which exist to enable disabled people to use software (systems for disabled people). Then, we will see one of the best example of interfaces for disabled people: accessibility of websites on the Internet.

Chapter 1

Generalities

1.1 Examples of disability aid in civil life

1.1.1 Example of the design of homes considering disabled people needs

The "Technology and disability journal" provides a very interesting example of how to build an accessible system for disabled people. In computing, metaphors are often used and comparisons made. This the case with computing elements such as the "mouse", a "folder", a "library", etc. We also see it in ideas for systems and algorithms For example, genetic algorithms in articial intelligence, where researchers have been inspired by the workings of nature (an example of this is explained in [14]). So it is interesting to consider the methodologies of other elds, because some elements can be applied to software design.

The presented methodology is developed as a set of questions to ask about the system conception (is the space secure and safe? How many floors are there? etc.). Several sets of relevant questions are asked, each dealing with a precise domain. Then eventually, the system is designed to be adequately accessible, visible, and usable. For more information on that process, see [17].

1.1.2 IT system for civil accessibility: the example of teleshopping

Another good civil example is shopping. The big and heavy bags, for people who are limited to move, is an important issue. On that subject, *Teleshopping for older and disabled people* [13] is very interesting. Indeed, the authors analyze several possibilities of making teleshopping, by the use of information technologies, in order to facilitate the transfer of goods for people who couldn't move a lot.

We can take one examples of how teleshopping can be made. It is called "assisted online shopping". Thanks to a laptop installed in the house of disabled people, they access to a "virtual shop" online. The costumer are connected to this virtual shop, and the virtual shop is connected to the supermarket. Costumers can order their command, and pay by credit card. This way makes transactions very fast, compared to other means [13].

1.2 Accessibility project launched by authorities: examples in IT

The political powers have already studied the question of accessibility of information technologies for disabled people. Some authorities have launched projects around that. We see here one example of such a project in Europe.

According to the Information Society Technology (IST) [21], between 10 and 15% of European people have disabilities, and, among those over 60 years old, this figure is 20%. Many of these need the use of a computer. In response to this challenge, the European Union has launched, via *e-Europe*, a project with several goals aimed toward the stimulation of the use of the Internet. As a part of this, the IST programme has been launched. This programme continues what has already be done at European level, including[1]:

- Graphic User Interface for blind persons (GUIB) ;
- Web accessibility initiative guideline (WAI) [7];

[1] Cf. presentation [21], slide 18

- "Design for all" (telephones for all).

So authorities play a great role in the management of disabilities. As they try to improve the life of citizens, they try to provide civil help (for example, the Irish authorities, which have published a *disability act* in 2005[2]). That lead us to the following part : examples of help to disable people in civil domains.

1.3 Assistance to disabled people: from real-life to computing

Just as civil help for disabled people is not only humanistic but is also politically popularity, help and accessibility in computing is not only a matter of philanthropy. Indeed, according to *Human-computer interaction: towards the year 2000* [12], help and accessibility of software is also a "large and growing market"[3]. Surveys show that 5% of the American population have a disability (blindness, cerebral palsy, language-impairments, hearing-impairments, etc).

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[2] `http://www.oireachtas.ie/documents/bills28/acts/2005/a1405.pdf`

[3] Cf. *Human-computer interaction: towards the year 2000*, page 673.

Chapter 2

Systems for disabled people

There are some systems to help disable people understand the contents of software systems, hugely depending on the disability. We will begin by the most serious disabilities.

2.1 Systems for people with movement disabilities

2.1.1 Systems of voice recognition

For people with troubles for making proper movements, the voice-recognition system can be interesting.

The goal of that kind of systems is to be able to capture words, from a sound source (generally people's voice - so they are more commonly called speech recognition systems). These kind of systems have begun to appear in some mainstream computers, natively integrated in software (like in Microsoft Windows Vista, for example [8]), even if the mainstream systems are not always very efficient. There is still a lot to do in research to improve these kind of systems, to have better results. According to researchers of the University of Geneva [23], these improvements can be made at a lot of levels:

1. the mathematical and theoretical representations of voice in a machine ;
2. the hardware level, to have more powerful equipments, generating less noise and better voice ;
3. training systems.

We can take an example of a study to improve speech recognition. Researchers of Finland and Slovenia have studied the influence of encoding / decoding on the quality and the deformation of the speech [26].

One of the main issues with speech recognition in general, is that this is very dependent of the considerate person. This kind of issue is present in other domains, like in writing recognition. Indeed, the voice has a great variability, and depends on a lot of factors: emotion, tone, fatigue... That is confirmed by the conclusions of the researchers of University of Geneva study [23].

These kinds of systems have been developed to make interfaces usable, nearly without the help of a mouse and a keyboard. One of the main motivations to do that is improving user's comfort and productivity. But obviously, this sort of system can also be used to help people with movement disabilities. Besides, this can be broadened to a lot of people, with little or fleeting disabilities, due to fatigue, pain... or disabilities like dyslexia. So this sort of systems is very interesting, because it can helpful for a lot of disabilities, and because it is becoming mainstream (around $200 for a full system) [1].

2.1.2 Navigation by eyes and head movements

Another field of research for people with paralytic disabilities is the capture of the only movements they generally can do, such as eyes movements for example. Some computers, thanks to sensors, are able to detect these tiny movements, and activate the mouse.

There are two possible ways of acquiring movement information [10]. The first, electrophysical, considers the action of the muscles which control the person's eyes. This is the oldest technique, and seems not to be extremely efficient. Indeed, other movements of nearby muscles and tissues can interfere with the eyes muscles, and make accurate detection difficult. Moreover, another problem is that putting the required electrodes on the subject is quite heavy, for the simple use of a computer.

The directly second records the movements of the eyes, by reflection of light in the eyes. Here the person looks at a special point on a screen, so that the sensor can detect relative movements and interpret it to transform it into a real mouse movement. This technique also has some limitations,

because eyes movements are not fluids ; there are a great number of little uncontrolled movements which can interfere with the relevant move.

For people who are less disabled, and can move the head for example, there exists a third technique, which exploit this possibility. A classic keyboard is shown on the screen, with a cursor on it. Again by light reflection on the eyes, the sensors captures the movement of the head, and moves the cursor on the keyboard. Then the person will make a signal (whatever it is) to validate the key.

2.2 Accessibility for blind people

It seems that, currently, for blind people, there are two technologies: display information in relief to allow for reading by touch, and to output information in some audible format [27].

2.2.1 Overview of the two main possibilities

The main example of the first technology is the *Braille* technique. The goal of this technique is to make points in relief, in a certain position. The points have a certain meaning, corresponding to the position in which they are. But this technique is not straightforward, because it takes some times to make Braille supports and so it cannot adapt to moving, evolving and changing content. Moreover, it generally needs a lot of storage space [27]. That is why this kind of thing is more specially present in libraries, for example.

The second technology seems to be easier to put in place, and cheaper. Indeed, registering the voice is quite easy for mainstream computing, and moreover, it is easy to reproduce magnetic supports and audio tapes, by copy.

2.2.2 Focus on hearing correspondence to written content

Otherwise, there is another possibility, in audible format information. That consists in making a machine capable of translating written information into audible speech. These are screen readers, which are able to tell what is displayed on the screen, and which are able to, through keyboard shortcuts, move a cursor on the different parts of the screen, so as to read what is relevant.

As an example, we can cite *JAWS*, which allows vocalization of Microsoft Windows and Oce applications [22].

2.3 Accessibility for deaf people

2.3.1 Communication from computers to people

Helping deaf people having a complete and efficient use of a computer is less hard than for blind people, for example. Indeed, as they can see what happens on the screen, they can consequently navigate through the applications, they have access to the content by reading, and so forth.

The main problem, for deaf people, is to find and implement alternatives to all alerts and events which use sounds to warn the user, or to give him/her some feed-back. For that, there is no special device or system. It is mainly to software designers to consider that the case, and to adapt their software so that it can be used properly by hearing-deficient people. In general, one of the main things to do is to replace sound alerts and feed-back by visual stuffs.

There are quite a lot of examples in software. We will see some of them in the section below which deals with accessibility in software (Cf. section 2.4).

2.3.2 Communication from people to computers

There are also systems which are developed, whose goal are for deaf people to be able to communicate with or through their computer. For the communication with the computer, this is comparable with voice-recognizing systems, that begin to appear (like in Microsoft Windows Vista for example [8]). For the communication with other people through the computer, this could be comparable with microphones and VOIP systems (like Skype, for example).

An example of the research in this domain is that of a group of French and Greek researchers that has studied how to recognise forms of *cued speech*. Cued speech is a set of positions of the hands, which correspond to the sound or a letter [4]. The researchers have lmed these hand positions, with several means of video-capture (like webcams, for example). Then, thanks to images and form-recognition

techniques, they make the computer extract the global shape of the lmed hand, and match it with an internal library of shapes. With this technique, sounds, letters and words can be acquired by the computer, and this data can be used by other software. The main problematic of the study, is to know when to use 2D and 3D recognition, to extract the shape of the hand: is one more relevant than the other? In which condition(s)? Eventually, their result is that 2D acquisition is more adapted when the hand has a very good "segmentation", that is to say, when shapes are very clear. Besides, 3D recognition is more relevant in the other case, that is to say, when there is quite a lot of "noise" in the images captured by the video support [15].

2.4 Examples in operating systems

The Operating System (OS) is probably the most important piece of software in computers, because it is through it that the computer become usable (and consequently, it is mainstream). Thus, accessibility seems particularly important for operating systems. We will see in that section some example of actual accessibility systems.

2.4.1 Windows Vista

There are a lot of systems to improve accessibility to disabled people in Windows Vista. A brief description of these are available on Microsoft website[1]. There are also guidelines and tutorials available, to be able to set up the accessibility systems[2].

2.4.1.1 Navigation and devices alternatives

Windows Vista includes a on-screen keyboard, which can replace the real keyboard. It includes also shortcuts, which enables to use arrow keys instead of the mouse, or to open some windows and services by a combination of keys. The OS has also a feature of "filtering keys" : in ignores keystrokes that happen too quickly, to prevent unintentional strikes. This last thing can be interesting for some

[1] See `http://www.microsoft.com/enable/products/windowsvista/default.aspx`

[2] See `http://www.microsoft.com/enable/training/windowsvista/`

disabilities where people shake.

2.4.1.2 Narrator

An interesting system to help blind or visually impaired is called *Narrator*. This is a system which contains recorded sentences, and which plays some of these sentences while an event occurs. For example, it can tell the user that he has just opened a window, or that there was just an error (describing the error), and so forth.

2.4.1.3 Other systems

There are speech recognition systems, of which we have talked before (cf. subsection 2.1.1). There is also a visual system of notifications, with blinking screens, that can replace sound notifications. Finally, there is a centralized control panel, to allow control a lot of parameters from a single point.

2.4.2 Linux Ubuntu

The window manager mainly used in Ubuntu is Gnome. The features browsed here are mainly from in that window manager[3].

2.4.2.1 Visual themes

Gnome includes a set of graphic themes specifically designed for visually impaired people. These are high-contrast themes, with characters of great size.

2.4.2.2 Keyboard modifiers

Ubuntu includes also a screen keyboard, which is extensible through macros. You can also modify parameters of reaction rate and repeat rate of keyboard and mouse keys (respectively *Slow keys* and *Bounce keys*). So it looks like the *filtering keys* of Windows Vista, but there you make your own parameters on this, so that the system ignore unwanted keystroke, but don't ignore too much (potentially wanted keystroke).

[3]See http://www.ubuntu.com/products/whatisubuntu/accessibility

2.4.2.3 Screen reader and magnifier

Ubuntu includes a screen reader and magnifier, named *Orca*. This piece of software supports and provides key-mapped functions for magnifier, navigation, speech and Braille devices. And ubuntu includes also a magnifier.

Chapter 3

Interfaces for disabled: case of web accessibility

To illustrate how accessibility is implanted in software, we will take the example of the World Wide Web. This is probably the best example of a domain where accessibility is required for people with special needs. Indeed, it is a domain more and more important, which will become nearly a non-avoidable source of information, social and part-of-life area. Moreover, we will be able to take technical computing examples, to illustrate the talk.

3.1 Web sense of accessibility

Considering the World Wide Web, accessibility is not only considering disabled people. It considers special needs of disabilities, but it is even more general [16]. For the Web, accessibility covers these notions [16] :

- accessibility to desktop browsers, like Mozilla Firefox, Apple Safari... (the easiest to do) ;
- accessibility to "full text browsers", like Lynx [5], which are browsers with only text, accessible in a terminal for example ;
- accessibility to browsers on smaller platforms, for example browsers of mobile phones ;

- and of course, accessibility for devices made for disabled people, like voice browsers.

Because websites are generally aimed at a wide sudience most people should be able to access the content of the websites. As Jonathan Snook says, "accessibility is just usability but marketed to a particular segment of the population" [25].

The main and most followed standards are provided by the World Wide Web Consortium (W3C). This consortium was founded and is headed by Sir Tim Berners-Lee, who is considered as the inventor of the World Wide Web. This organisation provides recommendations and guideline about the web, and its technologies (HTML, XML, CSS...) [20].

3.2 Accessibility : make content reach the user

3.2.1 Overview

When building a website, an individual or an organization aims to communicate some information to the public. So the goal is for the original information known by the publisher to arrive in the reader's mind. For that, the way is composed of a succession of stages, using the Web, described in figure 3.1 page 14 (published by the W3C[1]).

In that picture, there are two branches for the information traveling : from the producer to the main support, the Internet, and from this intermediate support to the user. For each of that branch, there are tools and technologies to insure the information will be able to travel correctly.

3.2.2 Setting the content

The first part of the information way is going from the source to the web.

3.2.2.1 Authoring tools

First of all, the producer needs to create the website. To do that, there are a lot of development tools which help in building a proper website.

[1] Cf. `http://www.w3.org/WAI/intro/components.php`

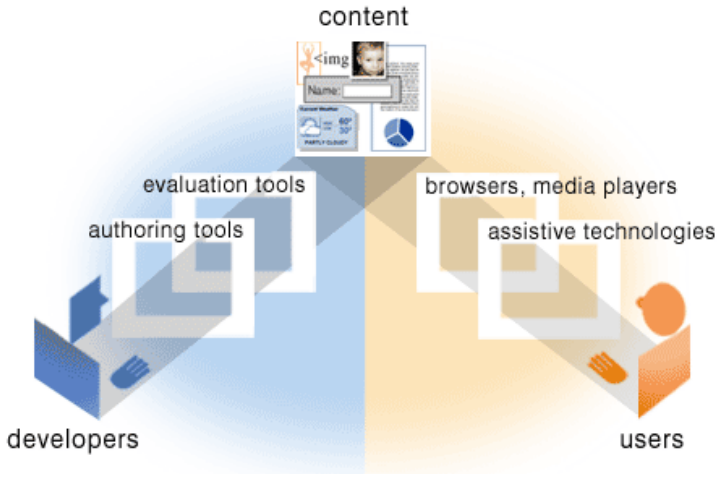

Figure 3.1: information flow (from W3C)

Some of the biggest WYSIWYG[2] tools (like *Microsoft Word*, *Microsoft FrontPage*, *Macromedia Dreamweaver*) don't necessarily produce webpages which are compliant with the web standards [24].

Some other tools, in contrast, enable the developer to easily make webpages which are compliant with the Web standards. For example, NVU[3] is another WYSIWYG editor, which places HTML 4.01 Transitional valid tags. It also includes a HTML validator (cf. part of evaluation tools) [6].

But the drawback of the pieces of software like NVU, is that they are only capable of making good (X)HTML and CSS products, and they do not support useful web script languages like PHP or Perl. That is a great limitation, given that most of the dynamic websites need PHP to work.

3.2.2.2 Evaluation tools

Evaluate the website Once the website has been created, before put it online, it is important to check that the developed product is really compliant with the web standards. In order to do that, there are a lot of evaluation tools. In general, these evaluation tools are parsers, which take the webpage (or a set of webpages) in input, analyze the tags, the structure, the content, check the points provided

[2]acronym of "What You See Is What You Get" : refers to tools where you can build the product with the final result, and not with code lines (for example, MS Word is a WYSIWYG tool , contrary to LaTeX).

[3]NVU official website : `http://net2.com/nvu/`

by the standard guideline, and give a result with errors, warnings, info, tips...

The W3C validators One of the main tools of validation is the set of validators from the World Wide Web Consortium. They provide tools which validate code according to standards of XHTML 1.0, HTML 4.01, CSS 2.1, and accessibility. They are available online : juste give it the webpage, and it tells if the page is compliant or not[4]. These tools are so important, that they are included in development plugins for browsers. For example, there are validators on Mozilla Firefox. Thanks to that, during implementation, the web developer can ensure that what is done is correct.

Page purifiers There are other systems, named *page purifiers*, that can take a webpage as input, and try to make it compliant with a chosen standard (HTML 4.01 strict, HTML 4.01 transitional, HTML 2.0, etc.). An example is *Delorie web page purifier*[5].

Browser testers There are also tools which check if the webpage will be supported or not by browsers. They do it by making tests on the webpage, knowing how browsers implement the technologies. The probably most known was *Bobby*[6], but it has been acquired by IBM, so now it is an IBM product[7].

Built tools There are other tools, developed by associations, developers, and so forth, which can help to control and validate the code. Generally, they are based on the standards dened by the W3C. We can take the example of the "Eval" tool, promoted by the Braille Association and WatchFire. This tool carries out a requirements analysis phase, a automatic test phase, and a manual evaluation support phase. It is possible to select a set of pre-dened guidelines [19].

[4] the validator is available at the URL `http://validator.w3.org/`

[5] `http://www.delorie.com/web/purify.html`

[6] `http://www.cast.org/products/Bobby/index.html`

[7] `http://www-01.ibm.com/software/awdtools/tester/policy/accessibility/`

3.2.3 Understanding the content

Once put online, the contents are read by browsers. The main browsers are currently Internet Explorer (Microsoft), Firefox (Mozilla), Safari (Apple), and Opera (Opera Software). But there are other browsers, like Mozilla, Netscape Navigator, Konqueror...

These browsers can be classied into two categories: the *Gecko* browsers, and the others. Gecko is an engine for web browsers, in which are based all the *Gecko* browsers: (Firefox3, Netscape9 for example). Gecko has been made in order to implement open web standards [3]. By extension, others browsers, like Opera or Safari, can be considered as Gecko, as they correctly implement the W3C standards. The web developers generally dierentiate between all those web browsers, and Internet Explorer, for which a special style sheet is generally needed, as it doesnt correctly implement the web standards.

Web standards are made to provide a logical structure, and a structured content, readable by systems for disabled people. So, by correctly implementing the standards, web browsers should be able to display any page, and the assistive technologies to read them correctly.

3.3 Doing accessibility

3.3.1 General principles

There are some general principles to the W3C guidelines, in order to make things accessible. We are not going to make an exhaustive summary of all the detailed principles, but we just list here some examples, the most important examples, so as to give an idea of how it is possible to make accessibility principles in web development.

- Separate content from presentation : like that, screen readers are able to read the contents, making it accessible.
- Provide text equivalent to multimedia supports : legend to images, summaries to videos, etc.
- Clarify the style, the usage of natural language, provide clear navigation systems, etc.

3.3.2 Technologies

We are going to see an overview of some of the most used technologies on the web, and see what are their relationships with accessibility.

3.3.2.1 (X)HTML / CSS

As we have seen, it is necessary to separate the content and the presentation. The couple HTML / CSS is perfect for that. All the structure and the contents are made with HTML, which is a simplified description language (like XML), and the presentation is made thanks to CSS. Thus, it will enable the screen readers to read only and clearly the HTML. XHTML is a standard of HTML, provided by the W3C, which insures the building of a correct structure, and some good practices for accessibility.

3.3.2.2 Javascript, Ajax

Javascript is a language that enables to make effects and change the contents of the webpages without having to reload them.

Ajax is a technology that uses a special Javascript object (`XmlHttpRequest`), in order to make a call to a server, retrieve asynchronously information thanks to XML format, and print these information in the webpages via Javascript, without reloading the page. The advantage is an important time gain for the user (the content can be updated, without necessitating a PHP or other script language call, so the page doesn't have to refresh).

So these are dynamic language and technology, which can cause accessibility problems, as the page content can be change without a reload – and so, probably without a re-read of helping systems. Moreover, most of the time this is readable by graphical browsers, but not by text browsers, which can make content disappear for browsers which don't read Javascript.

So there are best practices, recommendations, guidelines for the use of Javascript / Ajax in webpages (for example, there are some in IBM website) [18].

3.3.2.3 Flash

Flash is a language that enables to make fancy introductions, moving menus, and other graphical effects, on webpages. Like for Javascript, it is a dynamic language, which makes the webpage change without reloading the page, which can cause accessibility problems. According to Jeffrey Zeldman [28], the main problem of Flash is the fact that it is inappropriate to a lot of content and commerce websites. So Flash is used in appropriate situations, juste in order to make fancy effects, the result being a lack of attention in accessibility. The other problem is, as some developers make flash without taking care of accessibility, they make effects readable by two of three browsers[8].

3.3.3 Some examples of accessibility implementation

Here, we show some examples of what, precisely, accessibility means in term of implementation. These are some points from Minimum Web Accessibility Standards, from the university of Ohio [2], which seems similar to W3C recommendations [16] as well [9].

The goal is not to list exhaustively all the points of the guideline, but rather to give an idea, with precise and technical examples, of how this can be implemented. So we only put here some points, for the others you can refer to the W3C official guideline [16].

- **Provide an equivalent to multimedia**: for example, it is necessary to use the alt eld to display an alternative text explaining the picture [9].
- **Use markup properly**: use title tags to put titles (from `<h1>...</h1>` to `<h6>...</h6>`), identify changes in languages (`<p>A <span lang="fr">magnifique</span> day,...`).
- **Clarify natural language**: use acronym and abbreviations tags:

  ```
  <p>Welcome in the <acronym title="World Wide web">WWW</acronym></p>
  ```

[8] Cf. [28] chapter 3, page 96.

[9] That can also be found in [28] chapter 14, pages 346 – 357.

3.4 Some problematics and issues related to accessibility

There are a lot of problematics raised about accessibility. Some people are completely convinced that complying with accessibility standards is a good thing, whereas some other don't believe in this being a miraculous solution. We will here highlight two discussion points about that.

3.4.1 Accessibility compliance: beneficent for everyone

As we have seen, accessibility standards, as they are defined by the W3C, are not only points to insure a correct reading by special devices. They are also recommendations to define a proper markup, using well-known tags.

Making a proper markup is obviously interesting even for non-disabled people. Indeed, a well-structured text is clearer to read and easier to understand.

The use of well-defined open tags increases universality and interoperability of the code. Indeed, the open standards can be known by everyone, so new software can comply with these. So the open-standard-compliant code will work on the new software.

3.4.2 Are there negative aspects in standard accessibility compliance?

It can be objected by that stick the standards will prevent from using some technologies, like Flash or Javascript. Indeed, it can seem nearly impossible to follow accessibility standards with that technologies. But actually, it is nevertheless possible to follow the standards using this technologies: it is just necessary to consider the guidelines implementing with this technologies.

For example, about Javascript, it is possible to reason in terms of "layers". All the website should be done completely without Javascript/Flash, all the content in the HTML, and once all is accessible, an optional layer (removable by the user) can be added above that, for the graphical browsers.

Conclusion

In Human-Computer Interactions there are a lot of aspects to be aware of. One of the most fundamental is the fact that the interfaces should be designed for the greatest possible number of people. Indeed, the computers provide now so much information, that it is very important that everyone can have access to it. Otherwise, it would perhaps be a partial isolation for some people, or at least mean a lack of access to an important tool. So the problem here is generally to make the content accessible to impaired and elder people.

A parallel can be made with accessibility in public locations. The state authorities, at least in Europe, set up project to insure a minimal level of accessibility. In software, this is the same. A lot of systems have been created to allow blind, deaf, or other disabled people, to be able to reach the contents. Most of the operating systems have implemented some systems, in order to provide accessibility help, e.g. high-contrast themes, sound alerts, task automatisation...

One of the domain in which accessibility is the most important is the WWW. Indeed, considering the tremendous database the Internet is, web accessibility is hugely important. For that, guidelines and standards have been defined (in particular by the W3C), to insure the accessibility of the contents. But in spite of the interesting goal of web accessibility, there remain some aspects that can be discussed, as we have seen.

In conclusion, is a very improvable domain, in hardware like in software. This is s in hardware, because systems are very perfectible. This is so in software, because it is important to adapt to software systems, and because the awareness of this aspect is needed when creating a piece of software or a website.

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