Opportunities of Information and Communication Technologies in Total Communication

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INTRODUCTION

According to the European Committee on Equality and Non-discrimination, there are more than 80 million people with disabilities in Europe and this number is expected to increase in the future[1]. Most of the vast literature available on disabilities is focused on people with some capacities at a certain point. Some authors agree that there is a need to provide resources to people with severe disabilities and special communications needs (Light & McNaughton, 2014, p.107; Mirenda, 2014, pp. 19-27). Resources like Makaton (Vinales, 2013), PECS (Bondy & Frost, 2002) and total communication (Schlesinger, 1986) are valid alternatives for communicating with people with severe disabilities, but, frequently, they are not easily available when there is a communication need.

Nowadays, it is very common to have a smartphone in our pockets or a tablet at home or in our work place. Thus, a mobile application containing all the resources to help in an effective communication with severely intellectually or developmentally impaired people would be a valuable tool for families, caregivers, leisure assistants, teachers, healthcare workers, and community interpreters. They can simply install such a tool and search for a word they want to use in their communication.

Mobile devices are an example of Information and Communication Technology (ICT) that are effective and useful for multimodal or Total Communication. However, other ICT tools, like desktop computers and laptops can also be useful. Multimedia resources covering the multiple modes of communication can be available in the form of desktop or Web application, as well as mobile device application. We focus, however, on mobile devices because they are portable devices that we can bring with us all the time. Thus, it is more convenient to use in most of the cases compared to a desktop or laptop computer that is a heavy device that does not fit in the pockets.

In this document, we discuss a set of advantages and limitations of the mobile devices for total communication (Section 2). After a brief review of some applications for these devices in Section

[1] See http://assembly.coe.int/nw/xml/XRef/Xref-XML2HTML-en.asp?fileid=21339&lang=en (accessed in November 2017).

3, we focus on one particular application in Section 4: EC+, a tool developed in the context of an Erasmus+ project where the authors collaborate as developers. In Section 5, some potential future lines of research in the context of ICT for total communication are outlined and Section 6 concludes the document.

ADVANTAGES AND LIMITATIONS OF MOBILE DEVICES FOR TOTAL COMMUNICATION

A mobile device is a small computer. In spite of their size, there are mobile phones today that are more powerful than desktop computers. They have a powerful microprocessor and enough memory to run complex programs and applications.

We can find many kinds of mobile devices in the market. The most common examples are the mobile phone and the tablet, but there are some others. For example, smart watches are devices with the size of a watch that send notifications to the user and gather some information from their sensors, like the pulse of the user, the amount of oxygen in the blood, etc. Some other examples of mobile devices are Personal Digital Assistants (PDAs), pocket calculators, digital photographic cameras, portable gaming consoles, CPU sticks, digital camcorders and so on.

In the context of Total Communication, the most appropriate mobile devices are the smart phones and the tablets because they have a screen large enough to visualize pictures and videos, and a powerful microprocessor to run applications.

The evolution of mobile phones in the last decades has been very fast. The first phones in the 1970s were big devices only able to do phone calls. With the advances of circuit integration and miniaturization, the size of mobile phones was reduced until 2003 (approximately). However, the trend changed completely in the mid 2000s, due to the change in the habits of the users and the popularization of the touch screens in mobile phones (see Figure 13-1). In effect, the increase in the power of the microprocessors for mobile phones allowed the use of the devices as multimedia centers, the access to Internet, and the use of new apps to assist the user in their daily life, thus replacing the old PDAs. On the other hand, the touch screen replaced the keyboard and the only interface with the user in a mobile phone was the screen. The higher the screen, the easier to use. These facts explain the increase in the size of the mobile phones.

Regarding tablets, although they existed since the beginning of the XXI century, an important event in their popularization was the launch of the iPad by Apple in 2010. The tablet replaced the paper in many activities, for example, in the health domain, where the doctors could use a tablet to visit their patients and keep some notes about him/her, or the sales representative of a company, who had the opportunity to show his/her clients multimedia resources showing the product.

When talking about mobile devices, an important aspect to take into account is the Operating Systems that controls the device. An Operating System is a piece of software that offers an abstraction layer to the developers of the mobile devices, hiding the details of the hardware of the device. There are many Operating Systems for mobile devices. However, there are two that cover the 99.7% of the mobile devices in the market. The most popular is Android, installed in 85.0% of the mobile devices; and it is followed by iOS, installed in 14.7% of the mobile devices[2]. The other 0.3% of the mobile devices have another operative system like Windows Phone, Bada, Blackberry OS, Tizen, Symbian OS, etc.

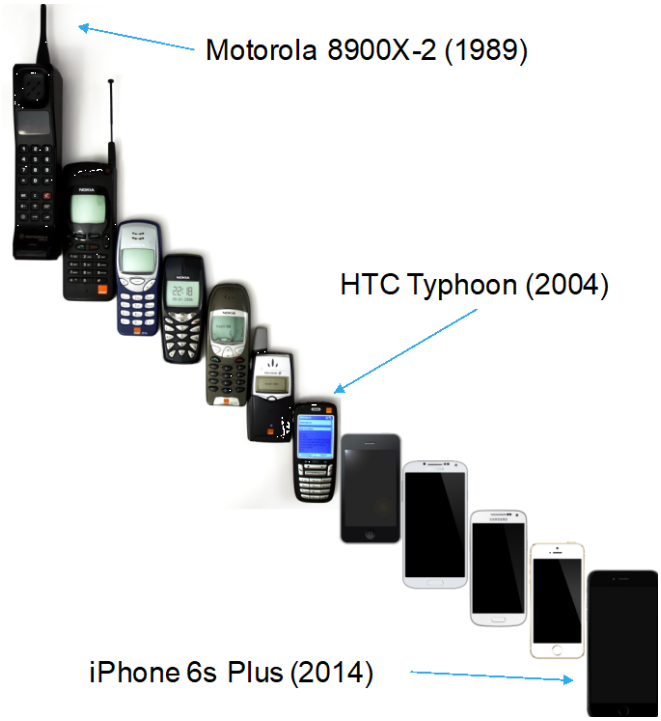

Figure 13 1: Evolution of mobile phones.

From the point of view of the developer, there are big differences between Android and iOS. While the former is completely open (the source code is available) and many resources and hints are available out there, the operative system of Apple is closed, there are more requirements to run a mobile application in a device and it requires a more expensive developer subscription than Android.

Independently of the Operating System installed in the device, there is a set of advantages and limitations that mobile devices have when they are used as tools in Total Communication. In the next lines, we will discuss these advantages and limitations.

[2] Source: IDC, http://www.idc.com/promo/smartphone-market-share/os

Advantages

We identify six advantages of using mobile devices for total communication. They are the following:

1. Portability: the mobile devices can be taken with the user because they have a reduced weight and size. This contrasts with the computers of a few year ago, which were quite heavy and they could not be easily transported. Nowadays, we can have a device with a great computation power in the pocket.

2. Versatility: since the mobile phones have a general-purpose processor, they have a great versatility. The user can run applications of any kind, not only communication applications. For example, they can be smart applications that can act depending on the sensors using Artificial Intelligence; they can connect to the Internet to communicate with other devices and applications. This offers a great opportunity to develop smart applications for people with special communication needs.

3. Openness: this means that anybody can develop applications for mobile devices. In the case of iOS it is more difficult, but in Android, using App Inventor it is easy to develop a small application and install it in the mobile device.

4. Always with us: we usually have the mobile phone with us because it is a communication tool that we use to talk to the family and friends, using phone calls or text messages. Thus, if we need a special communication with a person with special needs, we do not need to use a special tool; we can simply take the phone from our pocket and use the corresponding application.

5. Communication tool: as a communication tool, the mobile phone can be used to communicate with a person in front of us or with a person which is thousands of kilometers apart. Thus, total communication can be used with persons far away.

6. Sensors: nowadays the mobile devices bring many sensors. Many of them are related with health (steps counter, oxygen in the blood, etc.). All these sensors of the mobile phones can be used to create new modes of communication in total communication. Perhaps some persons cannot communicate the health state, but the mobile phone can do it on his/her behalf.

Limitations

However, the mobile devices also have limitations for total communication, and the ones identified are:

1. Battery: since the mobile device cannot be connected to the electric grid, it has a battery that provide the power, and it reduces the charge as time passes. As the computation power and the size of the screen of the devices is higher, the battery charge is exhausted earlier. The

mobile devices of a few years ago could be working with a battery charge during a week, but mobile devices nowadays require a daily charge.

2. Memory: the memory is limited in mobile devices. The typical value for most of the devices today is 32GB, while in the case of computers the storage space is around 1TB (1 thousand GBs). The developers have to carefully think how to manage this small amount of memory to be able to run all the applications in the memory of the device.

3. Computation power: in the mobile phones, the processors have a lower performance, compared to the desktop processors. Developers have to take into account this fact to avoid that the battery charge is quickly exhausted. They also have to check if the mobile device is ready for a computationally costly task, because it could affect the temperature of the processor and the live of the mobile devices itself.

4. Screen: the size of the screen is also limited. There are things that are not appropriate in a mobile screen. For example, an application with many controls (buttons, for example) is not comfortable to user.

5. Bandwidth and coverage: the bandwidth of mobile devices is limited compared to other devices, like a desktop computer. The application in the mobile phone has to take into account this limited bandwidth to avoid a bad experience for the user. On the other hand, the connection of the mobile phone to the Internet is not permanent; it is only possible to connect to the Internet when a wireless network (cellular or WiFi) is available.

6. Variety: there are many mobile devices with different features; different CPU power, different screen sizes, different screen resolution, different Operating System, etc. It is hard to develop an application that works in all the different devices. This is the so-called the fragmentation problem, and is a challenge for the developer, who has to make an extra effort to ensure that the application will work in any device.

EXAMPLES OF ICT TOOLS FOR TC

Many tools for mobile devices are available to help disabled people in their communication (see Table 13-1). They all are Alternative and Augmentative Communication (AAC) tools, each one based on some multimedia elements. For example, JabTalk is based on real pictures. Most of the applications are based on pictograms. Arasaac is database of pictograms that are used in many AAC applications. Some applications allow the user to customize some pictograms, replacing them by a real picture taken with the mobile device (e.g., Words in Pictures and TalkInPictures). There are also applications whose main resource is a set of sign language video clips (e.g., Sign Language!). We can also find applications focused on providing information for caregivers, like Asperger's & Autism Community. However, as far as we know, there is no single

application that contains information for caregivers and put together all the resources available for communication (pictograms, pictures and sign language video clips).

Table 13-1: Some AAC tools available for mobile devices.

Application	URL	Features
JabTalk	www.jabstone.com	Real pictures
AAC Speech Communicator	zemleris.com	Pictograms
Avaz	www.avazapp.com	Pictograms
CPA	www.comunicadorcpa.com	Pictograms
LetMeTalk	www.letmetalk.info	Pictograms
Pictotraductor	www.pictoaplicaciones.com	Pictograms
PiktoPlus Autism AAC	www.limbika.com/team/	Pictograms
Pixwriter	www.suncastletech.com	Pictograms
Proloquo2Go	www.assistiveware.com	Pictograms
Sc@ut	scaut.ugr.es/scaut/	Pictograms
Words in Pictures	www.fingertalks.it	Pictograms (can be replaced by real pictures)
Arasaac	arasaac.org	Database of pictograms
TalkInPictures	www.myautisticapps.com	Pictograms (can be replaced by real pictures)
Sign Language!	www.everydayasl.com	Sign language video clips
Asperger's & Autism Community	www.aspiescentral.com	Information for caregivers

THE EC+ TOOL

In this section, we describe the EC+ tool developed in the context of an Erasmus+ KA2 project EC+-Enhancing Communication. The interested reader can find additional information of the project and the EC+ tool in the EC+ website[3].

This tool is composed of a mobile application to be installed in the smartphones or tablets and an academic portal that is available on-line. In practice, the mobile application should be the preferred way to access all these resources, since mobile devices are very common in our daily life. The main goal of these applications is to provide in a centralized location a valuable set of resources to ease the communication with disabled people having communication difficulties.

[3] http://ecplusproject.uma.es

EC+ Requirements

In order to obtain this main goal, several requirements were defined for each application. The requirements of the mobile application are:

- The application must show a list of words relevant for a basic communication with disabled people.
- Each word must have a series of multimedia resources associated with it that can help the user to communicate with disabled people.
- Three kinds of resource are considered: video clips with sign language interpretation of the word, pictograms with a clear image representing the word and pictures of real-world objects representing the word.
- The application must show a list of syndromes that could affect communication with a detailed description, potential treatment, and external references.
- The list of words and syndromes must be in four languages: Spanish, Catalan, Dutch, and German.
- Both lists (words and syndromes) must be downloaded and updated through Internet from an academic portal.
- The multimedia resources must be available in three different resolutions for them to be adaptable to the screen resolution and the network bandwidth of the mobile devices.

The requirements of the academic portal are:

- The academic portal must show to any user the list of words and syndromes (see the requirements of the mobile application above) and related multimedia resources in the three available resolutions and the four languages.
- Both lists (words and syndromes) and the multimedia resources must also be available through a Web Service (Alonso et al., 2010), where the mobile devices connect to download and update their content.
- Administrators of the academic portal must be able to log in with a user and password to edit the content of the academic portal.

The resources

The tool provides multimedia resources associated to a list of more than 400 words that are basic in any communication. These resources include (for each word):

- Video clips: The video clips, as the rest of multimedia resources, will be used to represent the different object and actions in order to ease the communication with disabled people having

communication difficulties. In concrete, the clips show sign language interpretation of the word. In addition, we have created some video for some actions where pictures are not possible nor representative.

- Pictograms: A pictogram is a quite simple drawing schematizing the main features of the object or the action. Since they are created (usually by a specialized painter) instead of being taken from the real world, we can use lossless formats to represent it.
- Pictures: The picture of real-world objects representing the word in order to ease the understanding of some concepts.

All these resources were taken with the highest possible quality and, then, we apply some post-processing steps to correct small errors and to generate the final resources with the required format and resolution. The multimedia resources are available with three different qualities: low, medium and high quality. On the one hand, low and medium qualities are thought to be use in the mobile application to reduce the storage space and the bandwidth requirements (which are very important factor for this kind of devices). On the other hand, the higher qualities will be used in the web application in which the space and bandwidth limitations are not a problem. In any case, the user can decide which quality of resources used by his/her application.

This tool also contains information about 15 specific syndromes related to severe intellectual and developmental disabilities and special communications needs (e.g., Angelman, Pitt-Hopkins, sever autism, etc.).

These resources are available in four languages: Spanish, Catalan, Dutch, and German. In additional, the information about the syndromes is also available in English. As we said before, all the multimedia resources and the description of the syndromes have been originally created for this tool.

The Resulting Applications

The two applications of the EC+ tool are linked by mean of a Web Service (see Figure 13-2). The mobile application downloads the list of words, syndromes and resources from this web service, which is located in the same machine as the academic portal. Both, the web service and the academic portal access to exactly the same database and resource files, since they are run in the same machine.

Now, we will describe the two applications, we will start with the mobile one. The current mobile application works in devices with Android Operating System version 4.0.3 or higher. We chose Android because it is the most used smartphone Operating System (more than 85% of the mobile devices in the market run Android); and version 4.0.3 because than 99% of the Android

devices use this or higher version, at the time of writing these lines. This application can be directly installed from the Google Play (the Android Market).

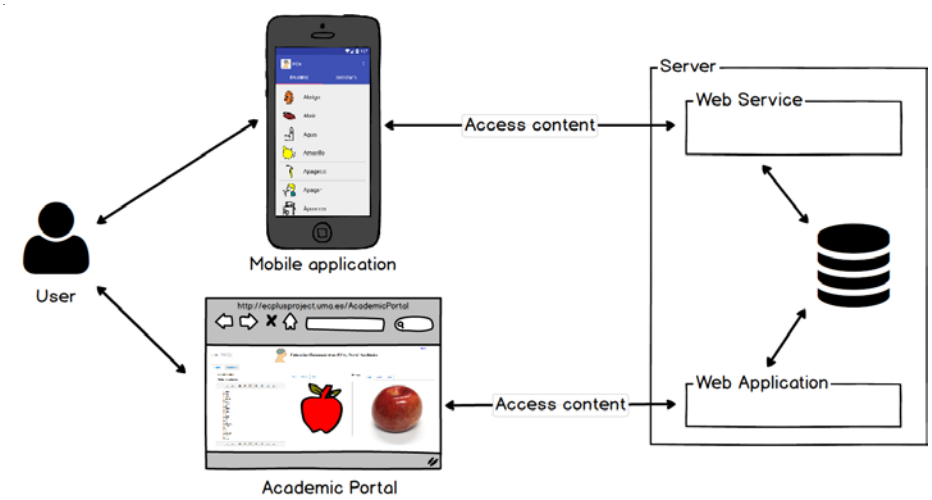

Figure 13-2: Architecture of the application.

The mobile application shows the list of words and syndromes in different panels (see Figure 13-3, left). In the case of the list of words, the pictogram of each word is also shown at the left of the word for a fast identification. If we click in a word we can access a new view where all the multimedia resources associated to that word (video clip, pictogram and picture) are shown (see Figure 13-3, center). The video clips can be reproduced and the pictogram and pictures can be enlarged. There are two lists of words: the basic ones and the advanced ones. The difference is related to the amount of available resources and the level of abstraction of the word itself. The set of advanced words contain, for example, all the prepositions, which are difficult to illustrate and require a higher level of abstraction.

The application also includes a panel with all the pictograms of the words (only the pictograms) and a list of general communication documents. The panel with pictograms can be used by the disabled people to point what s/he wants to communicate. The communication documents contain basic scientific information of a few concepts related to the communication, like the concept of total communication.

Each time the application is launched by the user, it contacts the web service to check if any of the resources or the lists have been updated. If there are new updates, they are downloaded. The mobile application downloads the resources in the language of the device, if there are resources in that language. However, the user can also select the language of the resources from the ones available. New languages and resources can be added to the EC+ tool using the academic portal and they will be immediately available to be used in the mobile application.

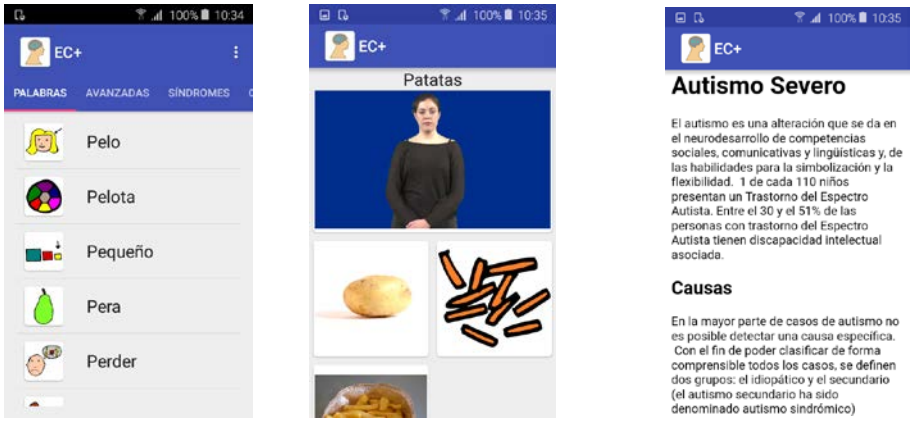

Figure 13-3: Screen capture of the list of words (left), resources of a word (center), and information of a syndrome (right) in the mobile application.

Currently, we are also developing a version of this application for iOS, which allows iPhone and iPad users to have access to the same information. With this version, we will cover most of the devices in the market: more than 99% of the mobile devices in the world.

The academic portal is an on-line website accessible using any web browser. The academic portal has two main uses. On the one hand, it allows accessing the resources (list of words and syndromes and multimedia elements for the words) in a similar way to the mobile application (see Figure 13-4). This is freely available for any user using the following URL: http://ecplusproject.uma.es/academicPortal/. On the other hand, it is also an administration tool to add new resources (languages, words, syndromes, and multimedia elements) or to update existing ones. These new or updated items will be immediately available for the rest of the users through the mobile application or the website. The ability of adding/updating items to the system will be restricted to some specific registered users approved by the administrator of the academic portal.

Figure 13-4: Screen capture of the academic portal showing the details of a word (left) and the description of a syndrome (right).

THE FUTURE OF ICT IN TOTAL COMMUNICATION

Most of the applications that are available today to help in Total Communication are databases. They contain many resources to help in the communication with the persons having special

communication needs. These resources can be videos, pictures, audios, symbols, etc. EC+ is not an exception; it contains a database of resources organized by words. Moreover, this is very useful in many cases.

However, taking into account the current advances in Computer Science, it is possible to apply also these advances to the field of total communication and conceive applications that do smarter things to help the disabled people.

One of the new advances of Computer Science that can be used is the Internet of Things. The idea of Internet of Things is to connect all the smart devices with Internet with the final goal of taking global smart decisions between the devices or control the network of things in some way. Smart sensors today are common and cheap. For example, there are many home automation solutions that allow the users to see what's happening at their home, open the windows or start the washing machine from a mobile phone. In the case of total communication, the Internet of things could be used to allow the disable people to communication not with a person, but with the things themselves, bypassing one communication step and improving their autonomy. For example, the disabled person could open the window or the door, by communicating with the window or the door directly.

The audio and video recognition can also be used in total communication. In this case, the disabled people simply talks, or make a gesture to a camera that is automatically understood by the devices, providing a direct communication with the machine.

Augmented reality adds virtual objects to a real scenario. This can be used to help the disable people by adding a hint in a scenario to ease the communication with the environment. For example, it could be possible to add information to go to a room or to find the exit based on the image recorded by a mobile device.

Artificial Intelligence and Machine Learning are very popular domains nowadays. There are autonomous cars that are able to see the road and drive from an origin to a destination taking into account the other cars and pedestrians. There are computers that are winners in games like Chess or Go. And all this intelligence could also be used in total communication. For example, using machine learning techniques, the machine could learn how to better communicate with disabled people. This idea has already been applied in other contexts, like voice recognition. In the case of the voice recognition applications, there is a learning stage where the machines hear the voice of the user reading a given text. This learning idea can also be used in the communication with disabled people and the computer could learn the meaning of the different gestures, sounds and behaviors of the disabled user.

CONCLUSIONS

In this document, we have shown how ICTs can be useful tools for easing the communication with people with special communications needs. Specially, we have focused on mobile devices because they are portable devices that we can bring with us all the time. These devices have a set of advantages when they are used as tools in Total Communication, such as portability or versatility, but they also have some limitations, mainly related to their intrinsic nature (small screen or limited hardware resources).

We have also presented some ICT tools used to help disabled people in their communication. In particular, we have focus on the EC++ tool, a set of applications for easing the inclusion of people with severe intellectual or developmental disabilities in their communities. The tool allows to access the information and a large number of multimedia resources. These multimedia resources (videos, pictures and pictograms) were originally created for this tool in the context of an Erasmus+ KA2 project: EC+-Enhancing Communication. All this is available in four different languages (Spanish, Catalan, German and Dutch).

We also describe the two main components of our tool, the mobile application and academic portal, showing how they present the different resources. These resources can be added or updated with an authorized account through the academic portal.

Finally, we have discussed the utilization of some of the most recent advances in Computer Science (Artificial Intelligence, Machine Learning, Augmented Reality, Internet of the Things …) in order to build applications that do smarter things to help the disabled people.

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