Technologies for Inclusive Education:

Beyond Traditional Integration Approaches

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Chapter 13
New Communication Technologies for Inclusive Education in and outside the Classroom

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ABSTRACT

This chapter explores new communication technologies and methods for avoiding accessibility and communication barriers in the educational environment. It is focused on providing real-time captions so students with hearing disabilities and foreign students, among others, could participate in an inclusive way in and outside the classroom. The inclusive proposals are based on the APEINTA educational project, which aims for accessible education for all. The research work proposes the use of mobile devices for teacher and students in order to provide more flexibility using the APEINTA real-time captioning service. This allows using this service from anywhere and at anytime, not only in the classroom.

INTRODUCTION

Historically, students with functional diversity (students with special needs, students with disabilities, etc.) and foreign students have found accessibility and communication barriers while trying to access the educational system. For instance, most of the hearing impaired students do not regularly assist to the classroom because they usually face communication difficulties with the teacher or other classmates. Foreign students can also find those communication barriers when they do not have enough level in listening and understanding the language spoken in the classroom.

This chapter presents new ways of communication for inclusive education inside and outside

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the classroom. The research work is based on the inclusive proposals of the APEINTA project (Iglesias et al, 2009) which main aim is to provide accessibility in education, whether it is in or out of the classroom.

APEINTA is the result of collaboration among the Department of Computer Science and the Department of Electronic Technology, Universidad Carlos III, and the Spanish Centre of Captioning and Audiodescription (CESyA)[1]. This project was initially supported by the Ministry of Science and Innovation (2007 I+D projects - EA2008-0312) within the program of Studies and Analyses - Actions to Improve the Quality of Higher Education and the Activity of University Professors. Currently, the research presented in this chapter is being partially supported by France Telecom España S.A. and the MA2VICMR (S2009/TIC-1542), GEMMA (TSI-020302-2010-141) and SAGAS (TSI-020100-2010-184) research projects.

The APEINTA project is focused in two main inclusive proposals: the first one deals with eliminating the communication barriers that hearing impaired students or foreign students usually find in the classroom, providing automatic real-time captioning and other mechanisms to ease the communication with the teacher and others students; the second one also deals in providing an accessible Web learning platform with accessible digital resources, so every student can access them, with independence of the place where he is.

The work presented in this chapter is focused in the first proposal, studying new communication technologies for making easier the communication inside and outside the classroom among the course's participants (teachers and students), stimulating the inclusive and collaborative education.

Real-time captioning has been demonstrated as a very useful tool in educational environments for all students. Students with hearing impairments can literally read the teacher discourse and they can participate in an inclusive way during the class thanks to real-time captioning. Foreign students who do not completely understand the teacher discourse are able to see the correct spelling in the captions, providing additional support to these students. But captioning can be useful for all the students, not only for students with disabilities or foreign students. For instance, real-time captioning can compensate noisy backgrounds, as it usually occurs in a classroom. Captioning is also useful in places where sound is not allowed, for instance, when the student is watching a pre-recorded or on-line video from the Web learning platform when travelling in public transport and he is not wearing earphones.

At this point, it is important to remark that APEINTA project has been awarded with the prize of the Spanish Confederation of Families of Deaf people (FIAPAS) in its 2009 call for applied research work related to hearing impairment in the area of education, where the first architecture of APEINTA was presented. It has also won the delegates award of the 2011 edition of the Web Accessibility Challenge in 8th International Cross-disciplinary Conference on Web Accessibility (W4A'11[2]), sponsored by Microsoft, where the new communication mechanism in APEINTA and its new architecture described in this chapter were presented.

BACKGROUND

During last decades, educators, pedagogues, psychologists, scientists, researchers and, in general, people from very different disciplines related to education have tried to achieve anti-discriminatory education environments according to the current laws related with inclusive education. These laws try to ensure an inclusive education system at all levels as a right of persons with functional diversity, rejecting segregation and discrimination.

There exist international and national laws which regulate the inclusive education. For instance, internationally, the normative of the United Nations remarks that students have to be educated in the least restrictive environment, according to the *UN Convention of the Rights of the Child* (UN, 1989), the *UNESCO Salamanca Statement* (UNESCO, 1994) and the *UN Convention on the Rights of Persons with Disabilities* (UN, 2006).

Traditionally, sign language interpreters have been the most common resource applied in order to improve the deaf students' inclusion. However, nowadays not every student with hearing disability uses sign language, thus signing does not provide deaf students full access to the classroom information (Marschark et al, 2005). Moreover, the high costs associated to this method it is not a cheap method of accessibility in the classroom.

Nowadays, some researchers around the world are working in lectures transcription based on Automatic Speech Recognition (ASR) in order to ease the access to the information in the classroom to students with hearing disabilities. Some previous works have demonstrated the benefits of speech technologies for students with disabilities (Newell & Gregor, 2000; Bain et al., 2005; Wald, 2004). The most relevant and oldest work using speech technologies in education is the Liberated Learning Consortium (LLC) (Leitch and MacMillan, 2001), in collaboration with IBM[3]. They developed ViaScribe software based on the ASR ViaVoice (Bain et al., 2005). Another interesting project is the Spoken Lecture Processing Project which was initially designed for video indexing (Glass et al., 2004).

Most of the current works in transcribing use ViaVoice system, although we can find in the literature other initiatives as VUST (Kheir and Way, 2007) from the Villanova University, which uses the Microsoft Speech Recognition Engine (MSRE). On the other hand, other initiatives developed their own ASR system instead of using commercial ones. That is the case of iCAMPUS (MIT, 2003) developed in the M.I.T. or the CHIL Project (Lamel et al, 2006).

Most of the research works in ASR for educational environments are developed for English language, but currently research works in other languages are emerging in education, as the LECTRA Project (Trancoso et al., 2008) in Portuguese, which demonstrated the utility of speech technologies on recorded media, like videos or audio files; The eScribe project (Bumbalek et al., 2010) in Czech or the APEINTA project in Spanish (Iglesias et al., 2009) among others, which presents some of its last research works in this chapter.

APEINTA Project is the first initiative in real-time transcription and captioning of spoken Spanish lectures. Moreover, it also provides students with different methods to see transcriptions within individual devices (Personal Digital Agendas –PDA-, laptops, etc.) or in a projection screen for all the audience. Furthermore, APEINTA can be considered as one of the few projects that pay attention to speech problems of the students. Text To Speech (TTS) tools are used in the classroom, so foreign language students or students with speaking difficulties are able to participate in the class with their comments or questions thanks to this service. Moreover, an accessible e-learning platform with accessible pedagogical resources is provided in this inclusive educational project.

This chapter is focused in the study of new communication technologies for avoiding accessibility barriers in educational environments and it is based on the APEINTA real-time captioning service. The works presented in this chapter are centered on analyzing the utility of the use personal devices for interacting with this APEINTA service, from the teacher side and from the student side.

The use of mobile phones by the teacher is proposed to speak through and connect to the APEINTA real-time captioning service in order to be transcribed and received by the students. Previous researchers in voice recognition have developed different applications in mobile phones relying on embedded ASR (Vargas and Kiss, 2008), as software for dialing, phone book search, command-and-control, etc., but most of them were based on recognizing isolated speech, this is, single words included in a database of the domain, or discontinuous speech, full sentences separated by silences. This kind of ASR based on isolated or discontinuous speech are easier to develop and lighter than the ASRs based on continuous speech, composed by naturally spoken sentences (Karat et al., 2007). Even though this difficulties, continuous voice recognition systems are been used in commercial projects, as the Hammilton Cap Tel phones (Endres, 2009). This new commercial service allows users with hearing loss to listen to and read captions through the use of a specially designed CapTel phone. Captions appear on the CapTel phone display screen in nearly real time, but not in real-time because of the high complexity of the voice recognition algorithms that implies a variable delay as a side effect. Moreover, this service is only in English language and requires a special device to use it.

That is why in this chapter we propose to send the voice signal from the mobile phone to a separated server where an ASR for continuous speech recognition is installed, instead of embedding the ASR in the mobile phone itself. eScribe project (Bumbalek, 2010) proposed something similar for the Czech language. They proposed a first approach to use human transcribers and later combining ASRs with human editors for error fixing, because ASR systems for Czech languages are not very advanced yet to provide enough accuracy levels for the service. In this chapter, the study is done with Spanish language in order to provide ubiquitous real-time captioning technically based on IP streaming and displaying the transcription online, available on a web page, so the captions can be accessed from any student device with 3G or Wi-Fi connections.

It has been also studied the usefulness of tablets for the students to receive the captions and transcriptions on them. Among the recent devices that have been made available in the market, tablets are creating a great impact and almost every month a new device is announced that goes beyond previous ones in mobility and performance. It is reasonable to foresee that in the next future most people will own and use tablets in their daily life. They would carry them permanently and even elder people would also be familiar with those devices. That is why we chose this personal device for this work.

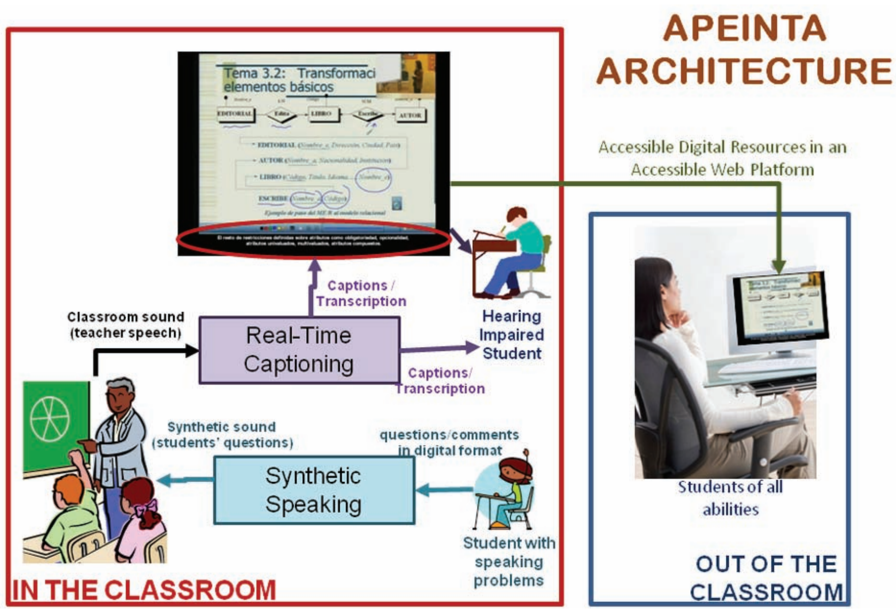
In the last years, tablet-PCs and pen-based technology have had a great impact on education environments (Berque et al., 2010). In many cases, this new technology devices have been used to overcome the obstacles that traditional instructional methods show for effective learning and teaching in engineering and computer science courses, as “text-based or static mediums to convey equation- and graphics-heavy concepts, a disconnect between theoretical lecture presentations and applied laboratory or homework exercises, and a difficulty in promoting collaborative activities that more accurately reflect an engineering approach to problem solving” (Huettel et al., 2007). This kind of devices offer the possibility to integrate technologies and this is the reason why the Spanish Centre of Subtitling and Audiodescription (CESyA)[4] has been involved in different research projects to develop applications and interaction models over them, applied to mitigate hearing or visual impairments in different environments (theatres, museums, education, etc.) (DeCastro et al., 2011). One of these projects is the APEINTA project presented here.

SYSTEM ARCHITECTURE

The objective of APEINTA is to provide an inclusive education for all students, regardless of any kind of disability they may have. It is a technological bet for inclusive education. This project proposes the use of new technologies in the fields of computing and electronic technology to overcome the barriers in the access to education and learning that unfortunately they still exist in the classroom.

The APEINTA project was initially centered on two different inclusive proposals: one focused in providing an inclusive environment within the classroom and the other addressing inclusive

Figure 1. Initial architecture of APEINTA



education outside the classroom (Iglesias et al, 2009). Figure 1 shows the first architecture of APEINTA project, where these proposals were well differentiated. Now, both proposals are explained in detail:

1. **In the classroom:** In this inclusive proposal two mechanisms are used to overcome the communication barriers that still exist today in the classroom. One is the application of automatic speech recognition mechanisms (ASR: Automatic Speech Recognition) to provide real-time transcriptions, useful for all those students who have temporary or permanent hearing impairment. This service is called *real-time captioning service* (or transcription service) and it deals with eliminating the difficulties that hearing impaired students or foreign students, for instance, usually find in the classroom. The other is the use of speech synthesis mechanisms (TTS: Text To Speech) to provide support for oral communication between teacher and students. This service is called *synthetic speaking service* and it is useful for eliminating the communication barriers that foreign students or students with speaking problems, for instance, find in the classroom. It allows these students to participate in an inclusive mode in the classroom with their questions or comments through this service, avoiding embarrassment or disabilities problems among others.
2. **Outside the classroom.** This proposal provides an accessible education platform in the Web where students can access accessible digital resources at any time with independence of the place or device where they are accessing the information.

This first architecture of APEINTA presented some limitations for teacher and students that we wanted to tackle in this research work. This work is mainly centered in the real-time captioning service, but the results obtained in this work can be easily applied in the future to other services, as the synthetic speaking service.

The main limitation of the captioning service was that the first prototype of APEINTA was intended only to overcome the communication barriers inside the classroom, but is this service useful for all the communication sceneries between the teacher and the students? For instance, what happens if a student with hearing disabilities has a question and he wants to go to the teacher's office for a tutorship? The teacher and the student could find communication problems and the real-time captioning could be also useful in this scenario. It is not the only one and many other use cases can rise during the interactions between teacher and student.

Therefore, we are currently studying new communication methods between the teacher and the captioning service of APEINTA, so the teacher would not need to be physically connected with the APEINTA server, allowing him to use it anywhere.

Moreover, we are studying new communication methods for the students, analyzing if their own personal devices (smart phones, mobile phones, tablets, etc.) can be used for receiving the captions, so they do not need to carry specific and sometime heavy equipments (personal computers, laptop, etc.) to anywhere they could need the captions. They only requirement is the installation of a specific light software in their devices or simply connect to the captioning service through Internet.

Next sections detail these research works carried out during the lasts years in the framework of the APEINTA project.

NEW COMMUNICATION METHODS FOR THE TEACHER

When we talk about providing accessibility in the classrooms as a really crucial and special environment due to its strictly direct relation to people's individual and social development, we are focusing in the way people interact and share information to detect potential barriers which could difficult that information flow.

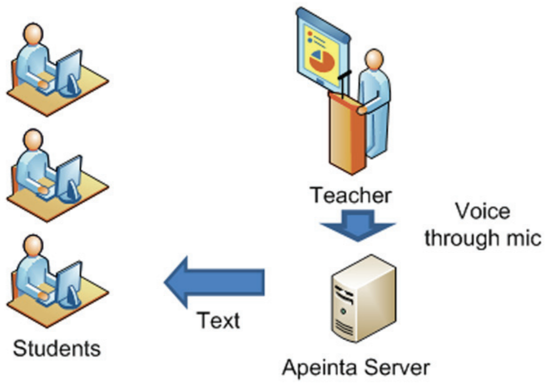
New communication methods are analyzed in this chapter in order to provide an alternative channel differing from the classical audio one. This chapter is centered in how to offer to the students other ways to receive the information without the need of hearing the teacher's voice.

In the communication process, we can detect two relevant sides to be taken into account: the transmitter and the receiver. In this chapter, in order to limit the problem to explain it more easily, we will focus in magisterial classes, were the teacher assumes the role of information sender and the students assume the role of information receivers. Therefore, these two sides are the ones that will interact with any intermediate system inserted between them to provide an alternative channel.

In previous phases of the real-time captioning service of APEINTA, the teacher had to be physically placed in the classroom because this service was created just to be used into the classroom. This was required because the Automatic Speech Recognition (ASR) software used in this service of APEINTA requires a microphone connected to the computer where it was installed to receive the audio stream from the teacher's voice. Figure 2 shows the initial architecture of this service. This restriction implies several problems that increase the deployment costs and requires some effort from the teacher to use it, because this architecture reduces de range of use of the system to the microphone's one. Therefore, each system deployment required a computer in the classroom, maybe even a network connection if the class is intended to be accessible outside the classroom, and if we think about it, this avoids many possibilities of remote administration in fail cases, requiring a person to go to the classroom to solve any problem. Those are not desirable situations with associated costs that are potentially removable if we move the real-time captioning server outside the classroom.

Therefore, one of our main aims in this research work is to decouple the microphone and the speech recognition audio input. In order to do it, we have studied how to replace the usual microphone

Figure 2. Previous architecture of the APEINTA real-time transcription system



audio input, directly plugged in the computer, with a device with audio streaming capability through the network. Obviously, this solution will imply that the system will need an Internet connection with enough bandwidth to receive an audio stream but this new configuration does not reduce the number of sceneries where the system can work. This is, if the room where the system is going to be placed does not have an Internet connection or if it has any problem to receive remote live audio through the network, it still could work with the classical architecture of the service (with a high quality microphone plugged in the computer).

At this point, it is decided to use IP stream voice with the APEINTA captioning service, where the speech recognition system is working. Now it is time to decide what sort of device is better to be used by the teacher for that approach. Some years ago, there could be only a few options for it, but nowadays we have many devices to do the job (tablets, smart phones, etc.), all of them ensuring that our prototype could fulfill the requirements needed for APEINTA (good voice signal, etc.).

The use of smart phones was the choice to develop our application because this sort of devices is widely used and nowadays most of the people have one of them in their pockets as a personal device. Thus, teachers would not need other specific hardware for interacting with the service. iOS, Android, Windows Phone, Blackberry OS, etc. are just some of the most obvious options in terms of mobile operative systems to develop the application. At this point, to implement the first prototype of this new channel of communication we established our criteria to choose one of them: it is better if to paid licenses are not required for development; the system should have good market coverage and expectations for the next years; it should have an streaming API or, at least, capabilities to do so; and finally, it should use a well known programming language and IDE to reduce the development time. With that premises, we finally developed an application over Android, this is, in Java language, based in open source projects were its only interface was the one that allows the user to configure the connection with the APEINTA service, shown in Figure 3.

Therefore, the new architecture of the captioning service of APEINTA is detailed in Figure 4, where a mobile phone can be used for the communication teacher-APEINTA_captioning_ser-

Figure 3. Mobile application interface for configuring the APEINTA service connection

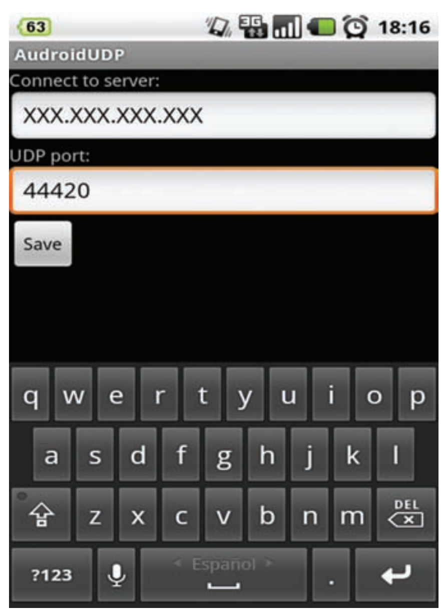
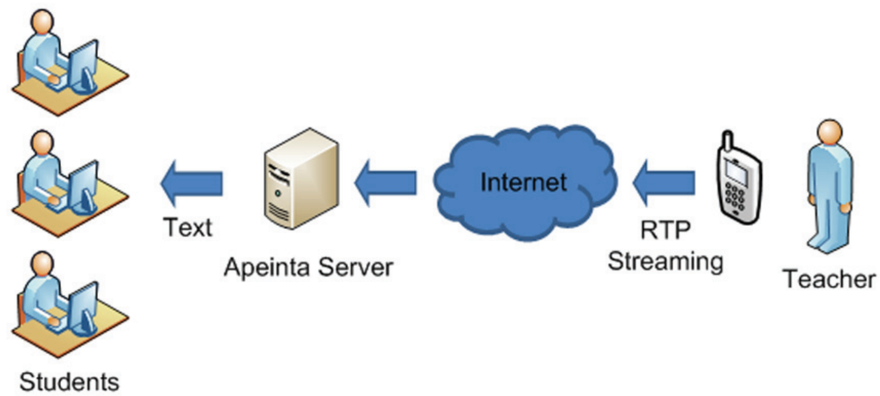


Figure 4. New architecture of the APEINTA real-time transcription system



vice by using the Realtime Transport Protocol (RTP) for transmitting streaming data.

With this new application, the teacher could stream his voice from his mobile phone to the system but there is still something to do to make the whole system work. The APEINTA server's interface must be adapted to receive that audio stream and redirect that input to the Automatic Speech Recognition software of the captioning service. At this point, the decisions taken for the implementation of this first prototype were completely dependent on the way the ASR software is configured in APEINTA to receive the audio.

In our case, we used Dragon NaturallySpeaking as our ASR engine in APEINTA due to the characteristics of its API to develop applications with it. However, one of its main disadvantages for the APEINTA system is that it can only run one recognition engine per CPU so we cannot apply multitasking in our system to use one server to process many audio streams. Actually, this problem is common for most of commercial ASRs. This is why we are currently working on looking for new solutions to this problem: studying different ASRs, even studying the possibility of developing our own multi-task ASR.

Moreover, another difficulty found related to the use of Dragon Naturally Speaking client was that this ASR software is configured to receive the audio through directly plugged-in microphones, not through the network. This implies that it is necessary to find a workaround to redirect the input to the software. In order to overcome this problem, in our first implementation, we chose a mixed hardware/software solution to receive the stream by using a player to receive the stream coming from the network and decode the audio to play it through an audio card. That card, then, would be connected to the system as if it were the microphone, making the audio input available to be chosen by Dragon Naturally Speaking.

Finally, we obtained a system where the teacher is able to send his voice over an RTP streaming in any mobile network through Pulse-Code Modulation (PCM) or Adaptive Multi-Rate (AMR) audio encoding methods. So it is important to remark that it could be also used with low bandwidth Internet connections to the transcription server. That is to say, it allows using the captioning service through a connected screen or through an HTTP connection.

With the architecture exposed, it must be explained that some terms had to be taken into account to make the system work because, it is a great advantage to replace the microphone by a mobile phone and give the system a huge flexibility to be accessed but streaming audio from a mobile phone can imply coverage and bandwidth problems while being used. Knowing that, several low bandwidth audio encoders with several configurations were used during the implementation process to find which one offered a satisfactory bandwidth – quality ratio to be included in the application. The low bandwidth requirement is an obvious need in order to reduce the number of audio glitches in some environments but it has always to be in mind that it is mandatory to have enough audio quality in the receiver, this is, after decoding, as the audio stream has to be injected into the speech recognition system.

USE OF NEW PERSONAL DEVICES FOR THE STUDENTS

Once the problem of communicating the teacher with the system providing an alternate way to the classical microphone plugged into the computer, it is time to pay attention to the communication between the students and the captioning service of APEINTA because there are several different ways to provide the information contained in the server as a result from the speech recognition process usually applying caption formatting to improve their readability.

If we attend to the way the people is able to see the captions, this is, to the place where the captions are being showed, we can distinguish between open captioning and closed captioning.

Open captioning is the term applied to the way of showing the text to be read by several people simultaneously, for example, projected on a big screen during an event. This is often an easy and cheap solution to provide captioning in events because it only needs one device to show the captions for the whole crowd of users but, by the other hand, it can cause distraction or it can hide graphic information for all those ones who just don't need it. Thus, for all those environments or events where open captioning can be confusing, distracting, or simply, undesired, closed captioning must be raised as the alternate choice.

Closed captioning is the other option we have while showing captions in an event, or more specifically for this case, in a class. This sort of captioning works as an individual resource for each person, showed in a personal device as a computer, laptop, mobile phone, tablet, etc. or definitely, in any screen intended to be used by only one user at each time. By using these personal devices, students in difficulties as hearing disabilities or foreign language problems can access to the transcript generated in real-time while the teacher speaks. This configuration implies higher costs because it requires a device for each caption viewer and a system with caption sending and receiving capabilities but it solves the some open captioning disadvantages and does not require any amendment in the classroom or using any additional equipment. The key idea of open and closed captioning is that there is no solution fitting every event, environment or set of users. There will be some events more thought to include open captioning but we could find some others were closed captioning will be the best option. With this in mind, it was chosen to include both options in APEINTA so it could cover any situation 'ad-hoc'.

For the sake of solving the lack of accessibility at education, this research work was developed in order to study the use of tablets, this new personal device in this scenario. Previously smartphones, captioning glasses, laptops, and personal computers were studied as students' devices for receiving captions in the APEINTA project (Jiménez et al., 2010).

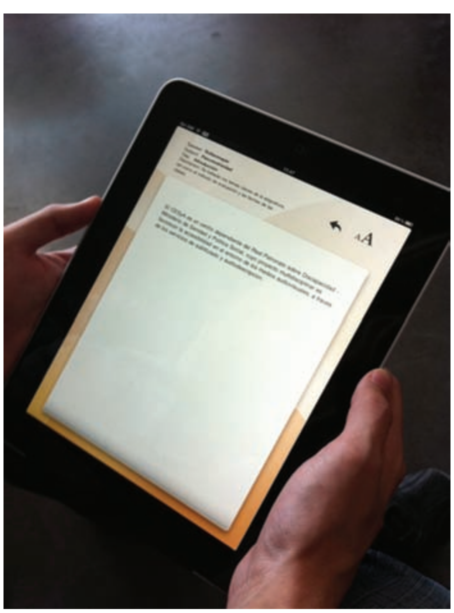
In order to implement a first prototype of this approximation, the iPad tablet was selected for it. The iPad device was chosen because it provides a 9.7'' LED-Backlit screen with 1024x768 pixels resolution. This feature allows designing a user interface with larger fonts and buttons than the ones designed for conventional smartphones interfaces. Besides, it also offers an orientation sensor which enables screen adjustment for the application interface according to the device orientation.

The application was developed giving more priority its usability, looking for a simple and intuitive use, following the graphic and compositional guidelines for the iOS operating system. A special emphasis was taken on the accessibility of its interface in order to ensure the compatibility with the iOS native accessibility functions (i.e. screen reader). The application was also designed to take advantage of the iPad capabilities. This developed application also adapts its interface to both vertical and horizontal orientations of the device to respectively display the transcription like a continuous text blocks queue or like successive captions. The images in Figure 5 and 6 show both operating modes respectively.

In captioning mode, the application displays the classic couple of text lines which makes easier the tracking of the teacher's current speech easier. By the other hand, in transcription mode, the application shows a global view of the speech. By this way, every new text block is placed at the end of the page and the user can access not only to the current speech but to the previous context too.

As additional feature, the application provides the capability of managing the class notes by saving all the text received from the classes, making them accessible once the class is finished. Hence, a new educational resource is provided complementarily to the usual class notes, so the student can focus in the information provided and not only in transcribing what is being said during the session.

Figure 5. iPad application for receiving the real-time transcription: Transcription mode



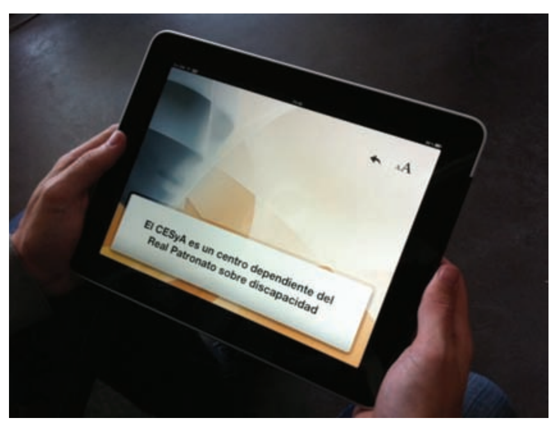
FUTURE RESEARCH DIRECTIONS

Although this research work is focused on the APEINTA real-time captioning service, new communication technologies and methods can be analyzed for the other services of APEINTA like, for instance,, designing these services to be based on the cloud computing paradigm.

Dealing with the teacher and students' devices, a comparison of which are the preferred devices for being used with the APEINTA services is recommended.

The iPad application introduced in this chapter is prepared only for receiving captions, but it can be easily extended to include the text-to-speech functionality of APEINTA and better interaction and usability capabilities. That is, students could send textual messages to the teacher via the iPad and they would be later reproduced with computer voice in the teacher's device. This new function-

Figure 6. iPad application for receiving the real-time transcription: Captioning mode



ality would allow taking part of the class in an inclusive way to students that could not assist physically. For instance, this functionality is very useful for students that are in the hospital.

Dealing with the APEINTA real-time captioning service, the use of the Dragon Naturally Speaking ASR software in this service implies a big disadvantage that we want to solve. This ASR, as it occurs with most of the ASR software for continuous speaking recognition, only allows one recognition server per CPU. It is a single task application. This lack in the ASR software limits tremendously the functionality of the real-time captioning service. For instance, it is prepared for transcribe only the speech of one person. This is not a problem for magisterial classes, were the teacher is almost the only speaker, but when the aim is to transcribe everything in the classroom (questions, comments and participation from all the students, not only from the teacher), it becomes a big problem. That is why we are working on analyzing other ASRs for continuous speaking or even in developing our own ASR software.

Moreover, we are studying the inclusion of other accessible proposals in the APEINTA project.

CONCLUSION

This chapter proposes new communications methods for inclusive education in and outside the classroom, which are mostly based on the captioning service of the APEINTA project, which main functionality is to convert the teacher's speech to captions. This APEINTA service is focused on removing the accessibility and communication barriers that students with hearing disabilities or foreign students, for instance, usually find in the classrooms.

The APEINTA real-time captioning service was initially created to be used inside the classroom, but in this chapter its functionality is extended thanks to the proposal of alternative communication methods for both teacher and students in order to provide ubiquitous real-time captioning from anywhere and at anytime.

On the one hand, we propose the use mobile devices by the teacher while using the APEINTA captioning service. Previously in APEINTA, the teacher needed to be physically near the system server because he needed a plugged-in microphone to use this service. Currently, thanks to the use of mobile devices studied in this chapter, the teacher can use its own mobile phone by installing a light application to connect with the APEINTA captioning service, just requiring an internet connection.

On the other hand, the usefulness of tablet-PCs as personal devices for the students to receive the captions is studied. The portability, screen size and performance characteristics of this new device and the great impact and acceptation that it has had among the students during the lasts months make it a good option as student device for receiving captions.

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KEY TERMS AND DEFINITIONS

Automatic Speech Recognition (ASR): Software that automatically converts spoken words (an audio speech) into readable text.

Inclusive Education: Education in equal conditions for all the students, nevertheless of their functionalities, capabilities or special needs.

Mobile Phone: It is a personal device which allows making and receiving phone calls over a radio link.

Personal Device: It is a device which belongs to an individual or family. In this chapter, we refer to electronic personal devices which allow students to receive the real-time captioning (mobile phone, laptops, tablets, smart phones, etc.) or which allow the teacher to connect with the APEINTA captioning service.

Real-Time Captioning: Is a captioning method in which captions are simultaneously prepared and transmitted at the time of the speech.

RTP Connection: It is a connection which uses the Real-time Transport Protocol (RTP). This protocol provides data delivery in real-time and it can be implemented over both TCP and UDP protocols.

Tablet: It is an electronic personal device. It is a kind of new mobile computer of reduced size and weight.

ENDNOTES

1. Spanish Centre of Captioning and Audiodescription (CESyA): www.cesya.es
2. 2011 W4A Conference. 8th International Cross-Disciplinary Conference on Web Accessibility: http://www.w4a.info/2011/index.shtml
3. IBM enterprise (http://www.ibm.com/us/en/)
4. CESyA: Spanish Centre of Subtitling and Audiodescription. http://www.cesya.es