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# Tablet PC and Head Mounted Display for Live Closed Captioning in Education

Javier Jiménez, Ana M. Iglesias, Juan F. López, Julián Hernández and Belén Ruiz

**Abstract** — *Automatic Speech Recognition is a powerful tool for inclusive education. Captioning helps disabled students but distract other students. We propose and evaluate the use of Tablets PC and Head Mounted Displays for live closed captioning.*

**Index Terms** — Automatic Speech Recognition, Closed captioning, Inclusive education, Displays.

## I. INTRODUCTION

In inclusive education context, speech technologies have become as the best tool to enhance students' learning. Particularly, Automatic Speech Recognition (ASR) provides a cost effective solution for any student with disability when they cannot easily follow the speech or take notes (e.g. deaf, hard of hearing, blind or physically impaired students).

However, we have to ensure that live captioning does not disturb students who do not need it during the class. This is why closed captioning is necessary in education [1] (and other fields such as cinema). Hence, it is important to distinguish closed captioning from open captioning.

In this paper, we highlight the importance of live closed captioning in the inclusive education. Closed captioning provides individual captions to those users who need or want it and avoids distraction of other students. We present a proposal for live closed captioning in education with two emerging devices, Tablet PC and Head Mounted Displays (HMD). And we carried out a user evaluation using a Tablet PC and a HMD to read captions compared to reading captions from a big screen (open captioning).

## II. SPEECH TECHNOLOGIES IN EDUCATION

Researchers around the world are working on removing educational barriers in education through speech technologies, especially Automatic Speech Recognition (ASR). The common idea is that, the ASR software provides a real time transcription of teacher's speech.

The most relevant and oldest work using speech technologies in education is the Liberated Learning Consortium [2]. They developed ViaScribe where they also considered the use of personal displays and real time ASR errors edition. There are other important and similar works. With VUST (Villanova University Speech Transcription), authors reported that accuracy strongly depends on speaking behavior [3]. LECTRA system (Classroom Lecture Transcriptions in European Portuguese) demonstrated the utility of speech technologies on recorded media, like videos

or audio files [4]. Another interesting project is the Spoken Lecture Processing Project which was initially designed for video indexing [5].

### A. Closed Captioning vs Open Captioning

Closed captioning refers the fact of displaying captions only to those people who need or want it. Contrary to closed, it is open captioning where captions are displayed to the whole audience regardless of whether each person wants to read it.

On the one hand, open captioning is cheaper because it is only necessary a screen where projecting the captions on for all students. Besides, depending on captions location, this method may be the best way to read because both video and captioning are in the same focal plane. On the other hand, the main disadvantage of open captioning is that non disabled students may be distracted.

Closed captioning is well known in television but it is not so well in education. While in television is as easy as switching on/off captioning, in education it is needed a device for each student who want to read captioning. Therefore, it is more expensive compared to open captioning. However, it is the only way to avoid students without disabilities to get distracted by live captioning in education. Besides, closed captioning allows students to configure individually some captions parameters (i.e. size, color, speed and font). Apart from costs, a priori important problem in closed captioning is that there are two information sources, the teacher plane (with slides, blackboard, etc.) and the individual device plane (where reading the captioning). Focusing on two different planes may be hard and tiring for students.

## III. A PROPOSAL FOR LIVE CLOSED CAPTIONING IN EDUCATION

The proposal is framed within the APEINTA system [6]. Inside the classroom, APEINTA provides a transcription of what the teacher is saying in real time. This transcription is displayed to disabled students to assist them in note taking. Outside the classroom, the use of APEINTA provides automatically synchronized educational resources (i.e. slides, notes, video or audio) and allows media mining indexing.

Considering the closed captioning problems, we implemented new clients in a Tablet PC and in a HMD where students can read captions<sup>1</sup>.

The main objective of this work is to evaluate the potential and utility of two emerging technologies as device for live closed captioning in education.

<sup>1</sup> As Tablet PC we use an iPad and as HMD model T3-F by Teleglass.

Dqj "erlepwa" ctg'eqo r cldrg'y kj 'CRGHP VC'u{ ugo 0' CRGHP VC'at' ctej kgewtg'eqpuku'qh' y q'r ctvuoHktu'r ctv' eqttgur pfp u'vq'c'ecr vqplpi 'ugt xgt' y j kej 't'cpuetkdgu' vgej gt'at' ur ggej 'd{ 'o' gcpu'qh'eqo o' gtekn' CUT' uqhy ctg'OC'p'f' ugeqpf' r ctv'eqttgur pfp u'vq' lpf kxf wcn' erlepvf gxlegu'y j gtg'qpn' egvclp'uwf gpv'ecp'tgcf 'y g'ecr vqpu' \*enugf'ecr vqplpi '0C' dki 'uetggp'ecp'dg'wugf'cu'enkpv' f'gx'leg'dw'p'qy . 'gxgt' {dqf { " ecp'tgcf 'y g'ecr vqpu'\*qr gp'ecr vqplpi -0

Vj g'i' ppgtcv'f'ecr vqplpi 'y kj kp 'y g'u{ ugo 'ku'hqto cvwg' 'lp' y q'y c' u0Hktu'v'q'p'g'ku'ikng' eqo o' qp'v'grgxkukp'ecr vqplpi " ceeqtf' lpi 'v'ucxpf'ctf' u'c'p'f' 'tgi' w' vqpu'0Vj' ku'y c' { 'ku'pco' gf' 'cu' -awd/ w0'0Vj' g'ugeqpf' y c' { 'v'q'hqto cv'ecr vqplpi 'ku'pco' gf' -awd/ vgz w0'0'p' y' ku'hqto cv'ecr vqpu'tgo' clp'lp' y' g' uetggp' dw' ctg' uetqmgf' 'w' 'y j' gp'c'p'gy' 'ecr vqpl'ku'i' ppgtcv'f' 0Y j' gp'y' g'Vcdrgv' RE' ku'wugf' cu'enkpv'f' gxlegu' -awd/ vgz w0'hqto' cv'cmqy' u'y' g' wugt' vq'tgcf' r' cu'ecr vqpu'0Vj' ku'ku'xgt' { 'vughwn'y j' gp'y' g' wugt' o' kuugu' ugo' g' lphqto' cv'q'p'0

**KX0 GXCNCVQRP**

Y g'f'k' c'wugt' gxcnvcvq'cdq'w'v' g'wug'qh'c'Vcdrgv'RE'cpf' "c' J O F' hq' h'xg'emugf'ecr vqplpi 0 "Vj' g'gxcnvcvq'au'qdl'v'x'ku' ctg'3+eqo r ctg'emugf'ecr vqplpi "xu'qr' gp'ecr vqplpi =\*4-" eqo r ctg'dqj' f'gxlegu'hq't'emugf'ecr vqplpi "0'Vcdrgv'RE'ku' J O F' =\*5+eqo r ctg'dqj' 'ecr vqplpi "o' qf' gu'0' -awd/ w0'x'u' -awd/ vgz w0'6+gxcnvcv'f' h'ht'g'pegu' dgvy' ggp' r' gqr' r'g'y' kj' j' gctkpi " f'kucdkk'f' 'xu'r' gqr' r'g'y' kj' qw'w'0

Y g'gxcnvcv'f' "322'r' gqr' r'g' f'kxf' gf' 'lp'v'q' y' q' i' tqw' u'r' gqr' r'g' y' kj' j' gctkpi "f'kucdkk'f' 'cpf' 'r' g' q' r'g'y' kj' qw'w'0' Gxgt' {dqf' { 'y' cu' q'xgt' "38" {gct'u'q'f' 0Y' g'r' r'c' {gf' "c'x'k' gq'lp'c' dki' uetggp' \*r' tql'g'v'q'p' u' ugo' +0'Vj' g'x'k' f'gq' y' cu' "cp' q'pn' "ur' gcn'gt' "ej' cv' cdq'w'c' i' p'p'g'c'n' q'r' ke'0Dqj' 'cwf' k'q' p'f' 'ecr vqpu' r'p'i' wci' g'y' g'tg' "lp' y' g' wugt' u'0' q'y' g't' r'p'i' wci' g' \*Ur' cp'kij' +0C' w' k'q' y' cu' u'y' kej' gf' " qh'hq't' c'm'wugt'u'f' gch' j' c'tf' 'q'h' j' gctkpi "cpf' j' gctkpi +0'

Ec'r vqplpi 'y' cu'r' t'g'x'k'w'w' i' p'p'g'c'v'f' y' kj' kp' 'CRGHP VC' u' ugo' . 'dcugf' 'q'p' CUT' uqhy ctg'0G't'q'tu'cpf' r' w'p'w'v'q'p' o' c'tm' u' y' g'tg'gf' k'g'f' 'd' { 'j' c'p'f' 0J' q'y' g'xgt' . 'v'ko' lpi' 'y' cu' p'q'v' o' q'f' h'k'f' "lp' q'tf' g't' "v' u'ko' w'c'v'c' t'g'c'n' h'x'g'ecr vqplpi 'ukw'v'q'p'0Vj' g'tg'ht'g' . " x'k'f' g'q' c'p'f' 'cwf' k'q' y' g'tg' p'q'v' u' l' p'ej' t'q'p'k' gf' y' kj' 'ecr vqpu' / 'p'g'k'j' g't' emugf' 'p'q't' q'r' gp'0Vj' g'tg' ku'c' f' g'nc' { 'f' w'g' v'q' CUT' r' t'q'g'au'0

Vj' g'gxcnvcv'q'p' j' c'f' 'y' t'g'g' r' j' cu'g'u'0'p' y' g'y' q' " h'ku'r' r' j' cu'g'u' y' g' gxcnvcv'f' emugf'ecr vqplpi " y' j' g'tg'cu' q'r' gp'ecr vqplpi 'lp' y' g' y' j' k'f' "q'p'g'0'p' g'cej' "r' j' cu'g' j' c'hi'v'ko' g'y' g'ecr vqplpi 'y' cu' u'y' q'y' p'cu' -awd/ w0'hqto' cv'cpf' j' c'hi'v'ko' g'cu' -awd/ vgz w0'Ch'g't' g'cej' "r' j' cu'g' . " wugt'u' h'k'ng'f' 'lp'c' s' w'g'u'k'p'c't' { 'cdq'w'j' k'ul'j' g't' g'z'r' g' t'k'p'eg' w'ul'p'i' c' " h'x'g' r' q'lp'v' N'ng't' v'ue'cn' g'0Vj' g' { 'c'nu'q' f' k'c' t'c'p'nc'p'i' 'q'h' y' g' d'g'u'v' f' g'x'legu' h'q't' h'x'g'ecr vqplpi \*emugf' c'p'f' q'r' gp' +0'

**X0 TGUWNVU**

\*3+ Ceeqtf' lpi 'v' h'ku'v'q'dl'g'v'x'g' . o' q'tg' wugt'u'r' t'g'ht' " q'r' gp' " ecr vqplpi " y' cp' emugf'ecr vqplpi "d'g'ecw'g' x'k'f' g'q' c'p'f' 'ecr vqpu' " y' g'tg' 'lp' y' g' u'co' g' uetggp' . 'u'q' t'g'cf' lpi 'ku'g'cul'g't'0\*4+Eqo r c'tkpi " Vcdrgv'RE' x'gtu'w' J O F' . 'cdq'w' '82' " q'h' wugt'u'r' t'g'ht' "Vcdrgv'RE'0' K'j' cu'c' d'ki' i' g't' uetggp' c'p'f' 'h'q'p'v' ecp'dg' o' q'tg' t'g'cf' c'drg'0T' g'cf' lpi " ecr vqpu'lp' y' g' J O F' 'ku' o' q'tg' v'k'lp'i' 0Vj' g'r' qu'k'x'g' h'g'c'w't'g' " q'h' J O F' 'ku' y' cv'wugt'ecp'ugg' y' g' " x'k'f' g'q' c'p'f' 'y' g'ecr vqpu' cv' y' g'

uco' g'v'ko' g'y' kj' q'w'o' q'x'lp'i' 'y' g'j' g'cf' 0P' gi' cv'k'x'g' h'g'c'w't'g' q'h'd'q'y' " Vcdrgv'RE' c'p'f' J O F' 'ku' y' g' p'g'g'f' " q'h' e'j' c'p'i' lpi " y' j' g' h'q'ewu' h'g's' w'p'w'f' 0\*5+O' qu'v'wugt'u'r' t'g'ht' -awd/ w0'hqto' cv'cu' y' g' d'g'u'v' y' c' { " v'q' t'g'cf' 'ecr vqpu'lp' i' g' p'g't'c'n'f' g'ur' k'g' y' g' f' g'nc' { 'd'g'y' g'gp' " ecr vqpu'cpf' x'k'f' g'q'0J' q'y' g'xgt' . -awd/ v'z' w0'hqto' cv'ku'r' t'g'ht'g'f' " lp' y' j' g' Vcdrgv'RE' d'g'ecw'g' y' g' wugt'ecp' dt'q'y' u'g' y' j' g' " y' j' q' r'g' " t'c'p'uet'k' v'q'p'0Vj' g' J O F' 'wugt'u' t'g'cf' d'g'w'g't' -awd/ w0'v'j' c'p' " -awd/ v'z' w0'6+Y' k'j' t'g'ur' g'ev'v'q' y' j' g' f' h'ht'g'p'eg' d'g'y' g'gp' " y' j' g' y' q' " g'x'c'w'c'v'f' i' t'q'w'u' y' j' g' o' clp' q'p'g' ku' y' cv'wugt'u' y' kj' " j' g'c'tk'p'i' " f'kucdkk'f' " r'k'ng' " o' w'ej' " o' q'tg' q'r' gp'ecr vqplpi 'y' cp' emugf' " ecr vqplpi 0J' q'y' g'xgt' . " o' c'p' { 'q'h' y' go' " ctg'cy' ctg' q'h' y' g' p'g'g'f' q'h' emugf'ecr vqplpi " u' ugo' u'lp' g'f' w'ec'v'q'p'0

**X10 EQPENWUQP**

T'g'u'w'u'v'm'w'u'v'j' cv'h'k'x'g'emugf'ecr vqplpi 'lp' g'f' w'ec'v'q'p' ku'p'q'v' u'q' g'cu' {0Q'p' y' g' q'p'g' j' c'p'f' . " c'emugf' u' ugo' " g'ri'ko' l'p'c'v'g'u'uwf' g'p'w0'f' f'k'w'c'v'q'p'0D'w'w'q'p' y' j' g' q'y' g't' j' c'p'f' . 'f' g'r' g'p'f' lpi " q'p' y' j' g' f' g'x'k'g' " wugf' . " wugt'u' o' c' { " j' c'x'g' v'q' o' c'ng' c'p' g'z' t'c' g'h'ht' v'v'q' t'g'cf' " ecr vqplpi "c'p'f' p'q'v'o' ku' l'p'hqto' cv'q'p'0

Q'r' gp'ecr vqplpi "ku' y' g' d'g'u'v' y' c' { 'v'q' t'g'cf' t'g'c'n'v'ko' g'ecr vqpu' " lp' " g'f' w'ec'v'q'p' " h'qto' " u'w'f' g'p'w' y' kj' " f'kucdkk'f' au'r' q'lp'v' q'h' x'k'g'y' 0' J' q'y' g'xgt' . 'l'p'ew'k'x'g' g'f' w'ec'v'q'p' u'q'w' v'q'p'u' o' w'w'v'd'g' f' k'g'v'g'f' " v'q' r'k'x'g'emugf'ecr vqplpi "v'q' " c'x'q'k'f' u'w'f' g'p'w'u' f' k'w'c'v'q'p'0' Vj' g't'g'ht'g' . " k' " ku' " ko' r' q't'c'p'v'v'q' f' g'x'g'nc'r' g'f' emugf'ecr vqplpi " u' ugo' u' y' j' cv'd'g'u'v' u'q'w'g' " j' g'c'tk'p'i' " f'kucdkk'f' u'w'f' g'p'w' p'g'g'f' u'c'p'f' " c'nu'q' g'p'j' c'p'eg' y' j' g'k' t'g'c't'p'k'p'i' " g'z'r' g't'k'p'eg'0

Vj' g' o' clp' c'f' x'c'p'c'i' q'h'emugf'ecr vqplpi 'ku' y' g' h'g'g'f' q'o' "v'q' l'p'f' k'k'f' w'c'n'f' 'eq'p'h'i' w'g' u'q'o' g' r' c't'c'o' g'y'g't'u' u'w'ej' "cu'ur' g'g'f' . 'h'g'w'g't' " u'k' g' c'p'f' ecr vqplpi 'h'qto' cv' -awd/ w0'x'0'c'p'f' -awd/ vgz w0'0Vj' g' d'ki' " r' t'q'd'r'g'o' 'u'k'm'ku' h'q'ew'ul'p'i' "y' q' " f' h'ht'g'p'v' u'q'w'eg'u' q'h' l'p'hqto' cv'q'p' < y' j' g' v'g'c'ej' g't' c'p'f' ecr vqplpi 0Y' g' y' j' k'p'n'y' cv'd'q'y' " Vcdrgv'RE' c'p'f' " J O F' " c't'g' i' t'g'c'v'f' g'x'legu' y' j' g't'g' t'g'cf' h'x'g'emugf'ecr vqplpi 0' Vcdrgv'RE' ku' t'g'cf' { 'v'q' d'g' y' k'f' g'nc' { wugf' 'lp' g'f' w'ec'v'q'p' y' j' g't'g'cu' " J O F' 'ku' o' q'tg' u'g'p'uk'x'g' v'q' wugt' au' c'd'k'k'f' { 'c'p'f' r' t'g'ht'g'p'eg'u'0

**TGHGTGPEGU**

- 13\_ 00Y c'f' c'p'f' M'Dclp' .0' G'p'j' c'p'el'p'i' 'y' j' g'w'ucdkk'f' 'q'h't' g'c'n'v'ko' g'ur' g'gej' " t'g'eq'i' p'k'k'p'ecr vqplpi 'y' j' t'q'w' i' r' g't'q'p'c'k'k'g'f' f'k'ur' r'c' { " u' " c'p'f' " t'g'c'n'v'ko' g' " o' w'k'r' r'g'ur' g'c'ng't' g'f' k'k'p'i' " c'p'f' "c'p'p'q'c'v'q'p' .0' W'p'k'g't'uc'n' C'ee'g'u'lp' J' w' c'p' / E'q'o' r'w'g't' 'f'p'v'g't' c'v'q'p'0' r' 0668/ 674042290
- 14\_ M'Dclp' .U' D'c'w'q'p' c'p'f' 0'0Y' c'f' 06' U'r' g'gej' "T'g'eq'i' p'k'k'p'lp' W'p'k'g't'ul'k'f' " E'rc'u'ut'q'q'o' u'c' N'ld'g't'c'v'f' N'g'c't'p'k'p'i' "R't'q'l'g'v'0' " R't'q'eu' q'h'7'j' " C'p'p'w'c'n' 'f'p'v'g't' p'c'v'q'p'c'n' C'EO' E'q'p'ht' g'p'eg' q'p' C'u'uk'k'x'g' V'g'ej' p'q'q'i' k'g'u'0' r' 03; 4/ 3; 80' 42240
- 15\_ M'j' g'k' .T'0'c'p'f' Y' c' { .V'06' h'p'ew'ul'p' q'h'f' g'c'h' u'w'f' g'p'w'lp' " eqo' r' w'g't' u'el'g'p'eg'u' e'rc'u'ut'g'u'w'ul'p'i' t'g'c'n'v'ko' g'ur' g'gej' "t'c'p'uet'k' v'q'p'0' " R't'q'eu' q'h' y' g'34'y' 'c'p'p'w'c'n' U'K' E'U'G' e'q'p'ht' g'p'eg' q'p' f'p'p'q'c'v'q'p' c'p'f' "v'g'ej' p'q'q'i' { 'lp' e'q'o' r'w'g't' u'el'g'p'eg' " g'f' w'ec'v'q'p' t'r' 0483' "487042290
- 16\_ V'ic'p'eq'u' .K'0'0' c't'v'p'u' .T'0'0' q'p'k' .J' 0'0' c'v'c' .C'0'K'0' c'p'f' X'k'c'p'c' .0' 0E'06' V'j' g' N'G'V' T' C' E'q't'r' w'u'0' E'rc'u'ut'q'q'o' "N' g'ew'g't' v'c'p'uet'k' v'q'p'u'lp' G'w'q'r' g'ep' " R'q't'w'i' w'ug'0' " R't'q'eg'g' l'p'i' u'q'h' y' g'U'c' y' j' f'p'v'g't' p'c'v'q'p'c'n' N'c'p'i' w'c'i' g' " T'g'u'q'w't' e'g'u' c'p'f' G'x'c'nc'v'q'p'0422: 0
- 17\_ I'rc'u'ut' .I'0T'0'J' c'f' g'p' .V'0L'0' E' { r' j' g't'u' .F'0U'0' U'ej' w'w'g' .M'0'c'p'f' "R'c't'm' C'0'0'v'J' G' " O' K' "ur' q'w'p' h'g'ew'g't' r' t'q'g'au'k'p'i' " r' t'q'l'g'v'0' R't'q'eg'g' l'p'i' u'q'h' J' N'V'IG'O' P'N'R' " q'p' f'p'v'g't' c'v'k'x'g' F' g'o' q'p'w'c'v'q'p'u' .r' 04: /4; 042270"
- 18\_ I'0L'lo' 2' p'g'l' .R'0T' g'x'w'nc' .N'0'0' q't' g'p'q' c'p'f' "C'0'K' r'g'u'k'c'u'06' G'x'c'nc'v'q'p'i' " y' j' g'w'ug' " q'h'U'r' g'gej' "V'g'ej' p'q'q'i' k'g'u' " l'p' " y' j' g' E'rc'u'ut'q'q'o' < V'j' g'CRGHP VC' R't'q'l'g'v'0' " R't'q'eu' q'h' Y' q't'f' "E'q'p'h' q'p' " G'f' w'ec'v'q'p'c'n' O' w'k'o' g'f' k'c' . " J' r' g't'o' g'f' k'c' " c'p'f' " V'g'g'eq'o' o' w'p'k'c'v'q'p'u'0" r' 05; 98/5; : 20L'w'042320