Bringing Accessibility to Multimedia Content: using Social Web

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Abstract— Many authors and institutions claimed for the integration of disabled individuals into society by the use of the technology. In the case of multimedia content, the problem of accessible information is not seen to be chronic or unsolvable. In the new social web scenario, an increasing number of multimedia resources are available on the internet. Unfortunately, most of them are not accessible. Given that the conversion process of such resources is human capital intensive, and not always viable from an economic point of view, new and effective solutions must be made to address this accessibility gaps. In this scenario, methods stemming from Computer-Assisted Cooperative Work (CSCW) and Social Web can be an effective way to achieve audiovisual accessibility in an affordable and effective way. The current work proposes the definition of a reference architecture which uses CSCW techniques based on social web, with the objective of converting multimedia resources into accessible resources in a quicker and more effective and efficient way.

Keywords— Accessibility, CSCW, closed caption, audio description, multimedia.

I. INTRODUCTION

THE volume of repositories of multimedia resources on the Web has increased prolifically in the last number of years. Websites such as YouTube, Photobucket or Flickr manage millions of videos and images which are uploaded by their authors, generally every-day users, and in some cases, organizations. However, these resources suffer from a defect which in today's information society has become crucial: accessibility.

Accessibility applied to audiovisual resources enables users with an auditory or visual disability to avail of alternatives for access to information in an environment equal to that of standard users. The alternatives for achieving accessible multimedia resources vary based on the characteristics of the resources [1]. The requirements for converting an image into an accessible image are not the same as the requirements necessary for making an audio file accessible. Each typology of multimedia resources has one or more associated solutions for converting the resources into being accessible, as is demonstrated below in Table 1.

The process of converting resources into accessible is

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Components affected by accessibility	Access with audio description	Access with caption
Image	Alternative text	Alternative text, use of clear and simple language
Text	Audio	Use of clear and simple language
Audio	Audio	Caption
Video	Audio description	Caption

Table. 1 Accessibility Alternatives

costly. It requires the realization of one or more additional tasks, which depending on the multimedia resource in question, can be rather extensive tasks. For example, in the case of audio description, it is necessary to determine whether the resource is suitable to be audio described, draft a script, revise the script, correct it, realize the editing and narration of the resource (usually in video format), and revise it. This is a series of steps which require a quantity of effort and time proportional to the duration and complexity of the resource. Given that it is generally the end users who publish multimedia resources on the Web in a spontaneous fashion, it is habitual that they do not consider taking the effort to make them accessible. This implies the outcome that many groups of society inevitably cannot access such resources.

The conversion of multimedia resources into accessible

resources is realized by means of various processes. These processes could be realized efficiently by a set of different users. This does not imply a reduction in the total effort required, however, a decrease in individual effort. Computer-Assisted Cooperative Work, or CSCW (particularly in Web 2.0) provides an opportunity for the conversion process, distributing the effort between various individuals, which entails both a reduction in conversion time as well as an increase in the number of accessible multimedia resources published.

The field CSCW emerged from an invited workshop organized in 1984 by Irene Greif and Paul Cashman that was intended to elaborate ''an identifiable research field focused on the role of the computer in group work'' [2].

CSCW began as an effort by technologists to learn from anyone who could help them better understand group activity and how technology could be used to support people in their work. These specialists spanned many areas of research, including economists, social psychologists, anthropologists, organizational theorists and educators [3]. Now, following the same trend of interdisciplinary focus of CSCW pointed out in [4] and followed by several authors (E.g. [5], [6], [7]), in this paper, authors propose CSCW, and more precisely, social web CSCW as a valid tool to improve accessibility in multimedia contents.

In this scenario, this work proposes a CSCW architecture for the conversion of multimedia resources into accessible. In order to achieve this objective, the work involved a study of the phases in the conversion process, determining the correct order for executing the various tasks and which tasks have the possibility to be carried out in parallel. With this information, applying established methods which have demonstrated their efficiency in CSCW, the requirements and conceptual architecture will be described at a high level.

The remainder of the paper is structured as follows. Section II presents the social web and its implications. Section III discusses techniques to provide accessibility to multimedia content. Section IV presents the architecture designed to bring CSCW support to the process of making a multimedia resource accessible. Section V concludes the paper and outlines future work.

II. SOCIAL WEB AS A SOURCE OF OPPORTUNITIES FOR COLLABORATIVE WORK

Social interactions have recently found an exceptional vehicle in the recent breed of user generated content aware technologies encompassed by the coined "Web 2.0" buzzword [8]. The Social Web is represented by a class of web sites and applications in which user participation is the primary driver of value [9]. Web 2.0 technologies as outlined in [10] are exemplified by blogs, namely easy to update websites about a particular subject where entries are written in chronological order, picture-sharing environments such as Flickr or Photobucket, social bookmarking sites such as Del.icio.us, video-sharing such as YouTube or music preferences such as Last FM. Web 2.0, social software, social computing, online communities, peer networking, immersive web... Their meanings overlap, and definitions are somewhat fluid [11]. But according to O'Reilly [8] the term Web 2.0 is slightly different in that it includes more technologies within its scope and does not bind itself closely with the social aspect. To sum up Web 2.0 can best be described as the accumulation of new Web-based collaboration technologies such as social networking sites, communication tools, and wikis [12].

The Web 2.0 phenomenon made the Web social, initiating an explosion in the number of users of the Web, thus empowering them with a huge autonomy in adding content to webpages, labeling the content, creating folksonomies of tags, and finally, leading to millions of users constructing their own webpages [13]. Logically, the result of this movement was a significant increase in the number of WebPages available. According to O'Reilly [8] a fundamental principle of Web 2.0 is that users add value by generating content through these applications, resulting in network effects among the community of users. Thus, the core characteristic of Web 2.0 is that a website is no longer a static set of pages but is a dynamic platform upon which users can generate their own content. Given this new characteristic, several works have studied de use of Web 2.0 in several industrial applications (E.g. [14], [15], [16])

Due to this new amount of information, in [17] authors pointed out that social web is a valid example of Metcalfe law. Metcalfe hypothesized that while the cost of the network grew linearly with the number of connections, the value was proportional to the square of the number of users.

Modeling multimedia content collaboratively may be seen as a second generation of multimedia metadata in which Web 2.0 environments are exploited so that users can model and share multimedia content within online communities [18]. Following the same argumentation, giving accessible content to multimedia data can also be seen as a new deal for both users (people with disabilities) and contributors.

III. AUDIOVISUAL ACCESSIBILITY IN COMPUTER SUPPORTED COLLABORATIVE WORK ENVIRONMENTS

In order to guarantee the access of people with disabilities to multimedia resources on the internet, these resources should comply with a series of standards. The Web Content Accessibility Guidelines 1.0 (WCAG 1.0) [19] is widely considered as a standard by the legislation and normative of many countries and its evolution to version 2.0 [20] has demonstrated an advance in diverse aspects which relate to accessibility. Specifically, in the field relating to multimedia content, the standard recommends: "Provide a single document that combines text versions of any media equivalents, including captions and audio descriptions, in the order in which they occur in the multimedia." It also adds, "Combining the text of audio descriptions and captions into a single text document creates a transcript of the multimedia, providing access to people who have both visual and hearing disabilities. Transcripts also provide the ability to index and search for information contained in audio/visual materials".

An overview of multimedia accessibility standards can be found in [21].

According to [21] the main techniques used to make audiovisual resources accessible are subtitling and audio description. Subtitling is defined as "a communication support service which shows the oral discourse, suprasegmental information, and sound effects produced in any audiovisual resource on the screen by means of text and graphics" [22]. De Linde and Kay [23] pointed out "there are two distinct types of subtitling: intralingual subtitling (for the deaf and hard-of-hearing) and interlingual subtitling (for foreign language films)". In the scenario of accessible multimedia content, it is always about intralingual subtitling. On the other hand, audio description is defined as "a communication support service which consists of applying a set of techniques and skills, with the objective of compensating for the lack of processing of visual content in any type of message, submitting adequate oral information which translates or explains it, in such a way that the disabled viewer perceives the same message as similarly as possible to a person with sight" [24].

The processes of subtitling and audio description are not archaic. There are regulations at both national and international level, as well as reference guides published by associations, bodies or private institutions and companies which specify what the processes consist of and how they should be realized [25], [26], [27], [28], [29]. Apart from these efforts, some other authors have shed light into referred processes in some recent and relevant works [30], [31], [32], [33], [34], [36].

Audio description process requires the realization of a determined number of tasks: generation of time codes, creation of the audio description script, expression of the contents and titles of the production, recording of the oral expressions, addition of sounds (whose process includes the insertion of the narration in the sound track of the production, joining the oral expressions and the sound track, and the master copy) [25].These tasks are realized by specific roles which have concrete tasks assigned to them: the analyst, who determines if the work is appropriate, the audio descriptor, who drafts the script, the narrator, who realizes the narration in the presence of the images; the film editor, who mixes image and voice, comparing volumes; and the reviser, who revises the whole set. These tasks and profiles should be supported by the audio description system and are the base for the defining of this system. Table 2 displays the activities necessary for the realization of the audio description task according to the AENOR norm previously described.

In a parallel way, subtitling is a known process and defined as being formed by a series of activities which are executed sequentially. The regulation in relation to subtitling makes reference to technical aspects which refer to, for example, how and where the subtitles should appear and how they should be drafted; however, it does not make reference to how to carry out the subtitling process. This is in contrast to audio description, where this aspect is clearly described. The activities are analogous except for the aspects in relation to the narration and sound, which are substituted by the insertion of subtitles in defined time segments

The definition of these two processes demonstrates the grade of user participation permitted in each of the activities, divided into two types; single user or multiple users, as well as the profile which is required to be developed. Obviously the division of tasks generates intrinsic problems for CSCW systems, related to the sharing of information, communication and coordination [35], [36]. This has a series of implications at the moment of defining a CSCW architecture, such as resolving coordination and collaboration issues [37], negotiation and discrepancies among the members of the work group [38], member control [39] or the control of work flows [40].

Besides what has been previously described, it should be mentioned that the motivation for the current work has been based on the extension of the cooperative concept entitled Web 2.0. However, realizing subtitling or audio description in a cooperative way, which is the result of the formation of an uncontrolled group of users, implies a new set of problems which must be resolved. The reliability of the participants during the conversion process is the most obvious problem. This is particularly because the conversion is not performed in an obligatory fashion by professionals in the field. This provokes the requirement to dispose of mechanisms which guarantee the quality of the work, and avoid inconsistencies, even if they are the result of voluntary actions or accidental.

The architecture proposed in this work has to comply with all of the requirements from the point of view of accessibility and the subtitling and audio description of the resources, as well as deal with intrinsic problems of CSCW environments.

The objectives or challenges faced by the architecture, are, in summary, the following: permit the conversion process of multimedia resources into accessible, in a cooperative manner; manage the sharing of tasks, avoid the emergence of conflicts as a result of concurrent Access to information, and control the work flow; and obtain a reasonable grade of reliability of the work in an uncontrolled work environment.

IV. AN ARCHITECTURE FOR COOPERATIVE AUDIO

Users	Activity	Rol
One	Set resources to perform audio description	Analyst
Group	Time codes generation	Audio descriptor
Group	Script generation	Audio descriptor
Group	Script revision	Revisor
One	Locucion	Announcer
One	Audio edition	Editor

Table. 2 Audio description activities

DESCRIPTION USING SOCIAL WEB

The objectives pursued in the process of converting a non-accessible resource in a resource accessible are the same regardless of the mechanisms used. In the case of audiodescription is intended to replace the image with the sound, for, among other things, help people with visual disabilities, generating thus a product in audio format. Subtitling helps those with hearing disabilities, replacing the sound on visual information, generating a product expressed in text format. Thus, subtitling and audiodescription processes are very similar, despite the fact that each of them generates a product expressed in a different format:

- Both processes require the development of a script: in the case of subtitling, the script corresponds to the film itself. Sometimes this script may not be interpreted literally due to the impossibility of making a proper presentation of the subtitles. In the case of the audio description, sprint must be developed *ex profeso* and contain explanations of what is being viewed on the image and that dialogue and the soundtrack does not transmit in an explicit or implicit way.
- Either audiodescription or subtitles must be reviewed in order to check if the script complies with the original and meets the requirements for each of the accessibility tools.
- For the realization of both processes is necessary to specify the exact time frame in which a piece of audiodescription or a subtitle must be placed. In the case of subtitling, the code must correspond with the time instants in which it is playing the sound that corresponds to the caption. On the other hand, the audiodescription will be located in the white noise space, which will fit the voice so as not to overlap with those sounds of the action or dialogue that users need to listen.
- In the case of audiodescription, there is a specific activity called Locution. In it, an announcer's script plays the audio.
- The speech will be recorded and assembled over the multimedia resource in Edition activity.

The last two areas are similar in the process of subtitling. This activity is named Assembly. During this activity, subtitles are transcribed, located together with the information in the temporary segments and checked, making the necessary adjustments so that the overall result is consistent and useful. Some of these activities can be undertaken in a cooperative manner, and this opens the door to new opportunities to convert into accessible multimedia resources in less time and with less individual effort.

Given the analogy between the subtitling and audio description processes, audio description will be used as an example. Only audio description can demonstrate the solution proposed, as it will be similar to that for subtitling, containing essentially the same concepts.

As shown in Table 2, based on a single multimedia resource, there is a series of activities to realize to convert it into accessible by means of audio description, which has the following characteristics: the activities should be realized in a sequential manner; each activity will be realized for a determined role; each activity can be divided, and each division realized in parallel by various users. Thus, the existence of a task work flow is required which manages the correct realization of the activities.

The CSCW system capable of giving support to the conversion into accessible of multimedia resources is comprised of the following repositories and process models (Figure 1):
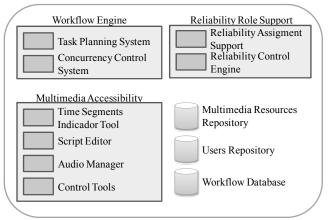

Fig. 1 Architecture

- Multimedia Resources Repository. This repository contains the multimedia resources, whether they are accessible or not. It also contains the elements which are complementary to accessibility; the information which converts a multimedia resource into accessible, including the corresponding support information necessary for its use. In the case of the example, the audio description is considered as the complementary element, including the narration as well as the temporal segments in which it should be reproduced.
- Users Repository. The repository of users maintains the information of the users "actors" (those who realize the tasks for making the resource accessible). Each user will be associated with one or more roles for each of the processes supported. In the case of the example, the process is the audio description. Each process role of the user has a value, obtained from outside users or "spectators" (those who can access the accessible resources). The assignment of values is the evaluation process which enables the assignment of an acceptable reliability value with reference to the actual accessibility of the resources.
- Workflow Database. This repository is responsible for providing physical support to the information related

to the control of the conversion process of each of the resources. Each multimedia resource should be in a determined state, which implies the possibility to realize a determined activity of the conversion process from the process which makes the resource accessible. It should control the assignment of activities to users to avoid duplications or redundancy in the completion of tasks.

- Workflow Engine. This functional model is responsible for managing the correct realization of the conversion process. It is comprised of two subsystems:
  - o Task Planning System. Responsible for, based on the information contained in the Workflow Database, permit or deny the realization of activities. It controls the change in state of the resources, determining when the next activity can be commenced.
  - o Concurrency Control System. System responsible for avoiding audience-related problems. Its basic functionality consists of avoiding the assignment of one activity to distinct users.
- Reliability Role Support. Module responsible for establishing the control of the reliability of the process of making the resources accessible. It is comprised of two subsystems:
  - o Reliability Assignment Support. System which will give support to the "audience" users to allow them to determine the reliability of the work. The reliability of the work should be assigned based on the reliability of its activities, which indirectly represents a ranking of the "actor" users, or those who have carried out the task.
  - o Reliability Control Engine. The functionality of this system, consists of, based on the reliability assigned by the "audience" users, assigning the grade of reliability of the "actor" users, determining the reliability of a production, allowing or prohibit the "actor" users to carry out a particular role, or establish a revision strategy in the case of diffused information.
- Multimedia Accessibility Process. This module is used specifically in the context of audiovisual accessibility and will only be described briefly. It should allow the realization of all of the tasks involved in making a resource accessible.
  - o Time Segments Indicator Tool. Tool for the marking of time segments.
  - o Script Editor. Allows the drafting of the script, placing it in its corresponding time segments.
  - o Audio Editor. Allows the narrator to narrate the script.
  - o Audio Manager. Provides the tools for the addition of audio to the resource, placing the narration in the corresponding time segments, also allowing adjustment of volume.
  - o Control Tools. One of the phases of the process of conversion into accessible should be supervised, as well as the entire production. Te architecture contains control tools to realize this supervision.

V. USE CASE

With the objective of describing the use of the system in a practical setting, the use case will be presented in this section. Audiodescription process starts with an assessment to determine whether its conversion is viable or not. This task is carried out by Analyst role and is basically a manual task. To this end, the analyst carries out the viewing of the video and checking that the resource requires and supports audiodescription process. Once the video is likely to be audiodescribed, it is stored in the Multimedia Resources Repository. At this time, resource activities breakdown is created and stored in Workflow Database.

Once the resource activity breakdown is stored, logged users will be able to check out that there will be a new resource available for audiodescription. Depending on their availability and will to collaborate, they may subscribe to one or more activities listed in Workflow Database.

At this point, the system using the information contained in the Users Repository and in the Reliability Control Engine will determine whether the user is qualified to perform such activities, allowing or denying his or her subscription.

Users who have been allowed to subscribe to the activity to generate the time code will access the system through the Time Segments Indicator Tool. This activity, applied to audiodescription process, is to define the segments (indicating the beginning and the end of a given segment) in which it is possible to introduce a voice-over explaining what is being viewed at that time.

This activity, conducted concurrently, presents certain inherent difficulties in CSCW working environments. The main difficulty is related to concurrency. It is necessary to prevent the segments selected by the users overlap. The Concurrency Control System will detect conflicts and determine the solution to them. The Reliability Control Engine will be responsible for completing which segment is prevalent and what discarded. This component will evaluate the assessment of users that have generated the conflict in fulfilling this role in particular to make a decision.

Once the temporary segment is set-up, to the next activity is the development of the script. This activity is performed by the same role as that which provides temporary segments: audio descriptor role. In this case, users playing this role and presenting good assessments will be able to allocate segments and then describe the script within the given segment. In this case the problems of concurrency have to do only with segments allocation process; and again Concurrency Control

System will solve these conflicts according to the classification of users in such tasks. Scripts are written using Script Editor component and stored in Multimedia Resource Repository.

According to AENOR [24], all scripts must be reviewed. Moreover, given the open and collaborative environment in which the systems operates, this review process is even more crucial. This task is performed by a specific role: Reviewer. These users may allocate segments and their corresponding scripts to check compliance with conditions specified in the guidelines of audiodescription good practices as well as audio that are faithful to the original content and meet required quality.

The next activity is to make the voice over. This activity cannot be carried out collaboratively. Recommendations for the development of audio description indicates that the voice over must be the same throughout the work, in order not to confuse the user. A user with a profile Announcer performs the speech through the Audio Manager. This user will read the script and this new information will be stored with the script.

Once the speech is ready and stored, an editor role user will edit the voice over. He or she must adjust the volume to be consistent with the rest of the work, the start and end points and the playback speed in the right way to adjust the audio of the voice over with audio from multimedia resources.

In all these activities there is a mechanism that determines when such activity has been fully completed and stops the process until this mechanism indicates the completeness of the activity. Such mechanism is implemented via Control Tools by an Editor user.

Task Planning System taking into account Workflow Database information can set new activity to be completed and generate all related tasks. However, Task Planning System is unable to determine whether an activity has been completed. Unlike other business processes, the audio description and subtitling requires some human supervision needed for quality assessment and implementation of activities and tasks. Editor will be responsible for determining, once all the activities that the audio description of the work has been completed correctly or may, instead, decide which activity or activities should be reviewed or re-perform.

Finally, end users will access Multimedia Resources Repository in order to get full accessible multimedia content. These users will evaluate the various aspects of the work through the Reliability Assignment Support. Using this tool, end users will evaluate the resource in order to determine the qualification of the users who had performed audiodescription with the final aim to feed the system by providing it with greater reliability.

VI. CONCLUSIONS AND FUTURE WORK

Integrating disabled individuals into society, with dignity, is an ancient social issue [41]. In technology scenario, the task of helping people to interact with computers has been investigated for long time and many tools, techniques, and devices have been proposed to help users with disabilities to successfully use computers [42]. Despite these efforts, the Internet is full of not accessible multimedia resources produced by the Web's own users, commercial companies or even institutions. The reasons for this reality are; ignorance, unprofitability, lack of adequate tools, or simply lack of knowledge. All of this provokes exclusion in society which should be eliminated. Permitting access to information in equal conditions to all users, regardless of whether they have a disability, is a legal and moral obligation. Unless web accessibility is supported and employed, the internet does not deliver worldwide access as it was intended [43].

One of the principal values of cooperative environments is the work effort they contribute. Web 2.0 takes this effort one step further; it is the proof that the CSCW paradigm can be successfully applied to groups of uncontrolled users to achieve a common end, even in an altruist manner. It is an opportunity to avail of the technology characteristic of cooperative environments and the active participation of the users of Web 2.0 to eliminate social barriers.

This article has proposed the first steps in the definition of a cooperative system to convert multimedia resources into accessible by uncontrolled user groups. The requirements have been identified from the point of view of conversion and from the perspective of the realization of the process in a cooperative way. Based on an analysis of previous research and studies, the problems which cooperative environments entail and should be taken into account have been discussed. It should be noted that the definition of all of the processes has been determined based on accepted norms and processes, to organize some processes which are currently not being carried out in a standard way.

This work arises from the existence of a given and controlled repository of multimedia resources. A future line of research will be to perform the same approach with external repositories. Such repositories are common on the Web, and contain a greater number of non accessible multimedia resources. In this scenario, grant access to those resources would be a great benefit to the community of users.

Currently, as a continuation of the present study, exhaustive definitions are being formulated of all of the modules and subsystems, to be able to implement a reference implementation in the future and accurately evaluate the precision and efficiency of the proposed architecture. Moreover, evaluation of multimedia content produced using proposed architecture using a formal method (E.g. [44]) must be provided in order to ensure that provided multimedia content is accessible by target users.

Undoubtedly, it can be affirmed that there are solutions to the problems presented in this paper, and that the requirements with which the proposed architecture should comply have been detected and taken into account.

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