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Review of Interactive Video–Romanian Project Proposal

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Abstract

In the recent years, the globalization and massification of video education offer involved more and more eLearning scenarios within universities. This article refers to interactive video and proposes an overview of it. We analyze the background information, regarding the eLearning campus used in virtual universities around the world, the MOOC movement in the last year, and the related interactive video platforms in the (education) field. At the same time, we pay particular attention to technical aspects of the interactive video: defining concept, types of video metadata, media fragments and types of annotations, as primordial elements that bring interactivity. We tested some free and commercial interactive web application. We gathered all the ideas. We propose a framework for an interactive system web based on the main modules: video resource management (production, transcoding and storage), annotations, Linked Open Data, distribution medium, player interface, data analytics and recommendation system. On the way, we offer our findings, together with our recommendations for an annotation interface and player module. It is our idea for Politehnica University Timisoara, either as a standalone solution or a complement to actual virtual campus (http://cv.upt.ro) depending on future development plans and financial aspects.

Keywords: annotation, fragment, interactive, metadata, player, transcoding, video

1. Introduction

1.1 Digital Native

Advancement in science, eLearning field and technology has gradually changed our personal life and society. “Today’s students are no longer the people our educational system was designed to teach” (Prensky, 2001). Students have unlimited and unrestricted access to information and a different approach to work and learning (Tapscott, 1999). They were born in a digital age and technologies are an integral part of their lives. They acquire information in a faster manner, using multiple sources. They are surrounded by digital technologies and spend a lot of their time watching television, surfing the Internet, playing games, using mobile phones, etc. (Yong & Gates, 2014). The literature classifies students in Generation Y or Digital Natives, birth years 1977-1994 and Generation Z or Net Generation, birth years 1995-Present (Kinash, Wood, & Knight, 2013). They have a “hypertext mind”, “leap around” (Prensky, 2001), “parallel cognitive structure and not sequential” (Yong & Gates, 2014). They are characterized as multitask, openness to share content (Oblinger & Oblinger, 2005), random access, function best when networked (Yong & Gates, 2014), constant connectivity, speed in delivery of information (Prensky, 2001), unique attitude towards education (Corrin, Bennett, & Lockyer, 2010). There are many approaches; each one differs in the manner researchers use it. Nevertheless, in generals terms are used interchangeably (Jones & Shao, 2011). In according to students’ needs, teachers must know how to grasp students’ attention and interest in and after the classroom. Digital native students spent over thousands of hours watching television and communicating through emails, cell phones and instant messaging, and less to reading books (Prensky, 2001). Students are both consumers and creators of electronic media material (Torres & Ross, 2014). Understanding this is “vitally important” (Teo, 2013) to allow teachers to build new materials, to improve their skills, to use new technologies (Yong & Gates, 2014). Modern educational concepts and universities must align to these goals, which is why the learning program and online infrastructure were been improved since their first appearance until present days. Contemporary eLearning involve virtual educational environments, (interactive) video lectures and new (video) platforms like MOOCs or interactive based. There are used widely and seem to be well regarded (Jones & Shao, 2011).

1.2 Major ELearning Platforms

Management systems of the educational content (CMS, LMS, LCMS, and VLE) provide an interaction area for students and tutors and also methods of delivering the educational content consisting of written materials, audio recordings of lectures and video sequences. All these come to join some current technologies such as social networks, the streaming, podcasting, audio-video conferences, forum and blogs (Clark & Mayer, 2011). Prestigious universities in the world have chosen the partial or full integration of these technologies on their educational platforms. The results of studies made by Ermalai (2011) and Onita (2011) reveal the major platforms used by universities:

- Blackboard in Austria (Salzburg University), in Canada (British Columbia University), in Japan (City University of Hong Kong), in **Romania** (Spiru Haret University from Bucharest, Ioan Cuza University from Iasi), in Sweden (Stockholm University), in UK (University of Manchester), in USA (University of Princeton, University of Drexel, Purdue University, University of Kent, Lesley University);
- IntraLearn in USA (Boston University);
- Moodle in Australia (Open University), in Canada (Alberta University, Athabasca University), in China (Open University), in France (Sophia-Antipolis University, Descartes University), in Finland (Helsinki University), in **Romania** (Politehnica University of Timisoara, Politehnica University of Bucharest, Technique University of Cluj-Napoca, Medicine Faculty from Timisoara, Credis University Bucharest, Carol 1 University Bucharest, Vasile Goldis Faculty from Arad, Economics Faculty from Oradea, Transilvania University of Brasov, Economics Faculty from Bucharest, Stefan Cel Mare University from Suceava, Maritime University from Constanta), in Serbia (Belgrade University), in UK (Open University), in Korea (OU Korea University), in USA (Cornell University, University of Harvard, University of California);
- Sakai in USA (University of Stanford, University of Cambridge, John Hopkins University, Massachusetts Institute of Technology, University of Yale, Berkley University);
- uPortal in USA (University of Minnesota, Duke University).

The video is an element of information, teaching and communication and it is measurably in above world universities online platforms and become the primordial factor in the new size of modern eLearning called MOOCs (Zahn, Krauskopf, Kiener, & Hesse, 2014). MOOC is an acronym for Massive Open Online Course and has characteristics like a huge number of students everywhere over the globe - scalability, anyone can participate; delivery of content is based on Web video-based platforms; the material are courses with a particular design, credits, period (Yuan & Powell, 2013). The main actors in the field are listed in Figure 1 (Onita, Mihaescu, & Vasiu, 2015).

Figure 1. MOOCs (generated with http://worditout.com)

"Measured by student numbers, the top five MOOC providers are Coursera with 10.5 million registered students, edX with 3 million, Udacity with 1.5 million, the Spanish-speaking MiriadaX at 1 million, and UK-based FutureLearn with 800,000 students. Measured by course distribution, the top MOOC providers in 2014 were Coursera, edX, Canvas Network, MiriadaX, FutureLearn, Udacity, CourseSites, iversity, Open2Study, and NovoEd. While 80% of the MOOCs were taught in English in 2014, they were also taught in 12 other languages" (Education Dive, 2014).

1.3 Romania's Online Education

We think that online education has come long away, and that is reflected in Romanian eLearning field as well. We listed some online education platforms used in Romania in above section and from Ermalai (2011) and Onita (2011) studies we complete with: AeL in Carol I University from Bucharest and West University from Timisoara; IBM Lotus Learning Space in University of Medicine and Pharmacy of Targu Mures; MEDIAEC in Al. I. Cuza University from Iasi; Microsoft in Babeş-Bolyai University from Cluj and Grigore Popa University of Medicine and Pharmacy from Iasi; NESSI in West University from Timisoara; Run CMS in National Defence Carol I University from Bucharest and SNSPA/UVA in Communication and Public Relation Faculty David Ogilvy from Bucharest. The local evolution followed the global movement: from postal correspondence study to online university courses based on (L)CMS (e.g., Moodle, AeL, Blackboard, Microsoft, Nessi, Mediaec) and MOOC incoming (Figure 2) with cautious approaches in multiple domains of interests like: basis of accounting, course for women, critical thinking in today's communication, educational archives, English for beginners, digital library, programming, hairdressing, homeopathic, mathematics, data analytics, IT, personal development, preschool education, financial, theology (Mihaescu, 2014).

Figure 2. Romanian MOOCs approaches (generated with http://worditout.com)

The general online (video) educational context offers encouraging peculiarities. The Romanian Ministry of Education "announced a national digitization initiative that will digitize all of Romania's educational content by the 2017-2018 school years" (Adkins, 2013). The first phase was started in 2014. In 2015 "the innovative teaching methods and techniques" will be introduced in 67% of Romanian institutions according to Sursock (2015) study. Adkins (2013) sustain that the (mobile) learning will grow to 50% until 2017, and the growth rate of self-paced learning will be 40% in 2015. Romanians (according to a report of the National Audiovisual Council) are large consumers of video materials (CNA, 2007). The National Strategy Digital Agenda Romania points out that interactive visual materials and additional resources from Internet will increase the learner's engagement until 2020. National Education Law no. 1/2011 known as the Virtual School Library talks about new and challenging eLearning platforms with lesson from all curricula, dynamic elements, self-evaluation test, video lesson and open educational resources. In terms of IT infrastructure, studies show that Romania is placed in the top 20 countries using an average speed Internet connection (Akamai, 2013), and the rate of penetration of the high-speed Internet connection (over 4Mbps) is over 79%. It is followed the European idea to "connect every school, ideally including connectivity to individual classrooms, to broadband, to upgrade the ICT equipment, and develop accessible, open national digital learning repositories using structural and investment funds by 2020" (Voicu, 2015). It is easy to extract the idea that Romania is well prepared in terms of an IT base and eLearning perspectives for the integration of video materials and new video platforms.

2. Interactive Video

2.1 Definitions

Collins, Neville and Bielaczyc (2000) emphasize in a study conducted in 2000 that the video predominant systems are the most attractive, convincing and engaging media elements, with much stronger impact than static images and strictly textual information. On the other half, a Cisco study reveals the fact that the transfer of video material will be 73% of all Internet traffic by 2017 (Cisco, 2013). These literature observations, the continues trend of improving video (educational) content, the infrastructure of MOOCs and world universities online campus ensure the premises of a complete video experience with a productive interaction between video itself and information related to the images, theme and concepts presented in the video. It is the way for generating interactive video elements. Literature defines interactive video as:

- One of the most exciting types of media, combining the power of moving images, the story of the video, the depth and wealth of the information enriched by interactivity (Chen, 2012);
- video or hyper video, an improved video material by various methods with interactive elements that provide a non-linear way to transmit information, similar to the World Wide Web hyperlinks (Petan & Vasiu, 2013);
- A convergence of interactive television with the Internet that brings a lot of benefits in areas like eLearning and business (Lytras, Lougos, Chozos, & Pouloudi, 2002).

In practice and from an instructional point of view, adapting a classical course material requires redesigning the course and restructures its content, leading to increased video production costs for such platforms (Jermann, Bocquet, Raimond, & Dillenbourg, 2014). Video interactivity, not widely implemented until present, come as a current, complement to the educational platform, and it provides "depth information" and diversity, the extra resources opportunity going from a central type video element. Moreover, it is noted by researchers as Zahn, Krauskopf, Kiener and Hesse (2014) or Jensen (2008) that the classical video type display will generate apathy in education, instead of active learning activities, the main purpose of digital information transmission process. Studies in the literature calls for an evolution of videos beyond "passive unidirectional TV type experience" in order to facilitate collaborative processes, directing the attention of students, questioning students online, and gradual transition from one stage of learning to another (Pea, 2006), resulting in increasing the level of interest and personal satisfaction from the student in relation to the contents (Marchioria, Blanco, Torrente, Martinez-Ortiz, & Fernandez-Manjon, 2011).

2.2 Technical Factors

Technically speaking, in the context of creation and distribution interactive video materials over the Internet, a primordial factor is video *metadata*. Metadata is structured information that "describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource" (Niso Press, 2001). This is the descriptive part of an individual video clip, in addition to a just replay of frames. It can be generated either manually by a human creator or automatically by various type of video processing. The information thus generated describes the current video material, and it can be used to identify additional information associated with the themes appearing in the video. In terms of content and concepts presented in a clip, a video material was a black box. From the point of view of the web browser, a video clip encapsulated this way within the page is completely opaque. From a technical standpoint, metadata can be stored in the video files, in particular, fields, defined by the existing standards or it can be saved in dedicated systems of management - databases. In the first case, metadata is stored in the header of the video, in the same file; the available fields for metadata are given by the structure of the video standard that is used. This option has the advantage of having metadata associated directly with the referred video, but access to metadata is slower, and it is requiring processing the video, which size is usually large. A much faster alternative is storing the metadata in dedicated management systems with faster response time to queries but having the disadvantage of being separated from the referred video files. Video materials that possess relevant descriptive metadata become visible to the user who is looking for accurate information. There are several types of metadata:

- Technical metadata–Metadata obtained through automatic analysis of the video. They are a particular type of administrative metadata describing properties of digital video, format, compression rate, audio-video codec, resolution, bitrate, file size, video length, information on the equipment used to capture material;
- Descriptive metadata–describe a resource to discover and identify, it creates a summary of the content of the video. The type of the information recorded is particular to make an interoperable collection. Metadata is manually entered by the manufacturer or by ordinary users: video title, description, category, tags, associating related videos, secondary annotations;
- Administrative metadata–provides access, stores and helps organize the digital collection. The information provided does not directly describe the resource itself but provides information to help manage it, Copyright for example.

These types of metadata are completed with accurate information of interactivity related to annotations, decisions and linking the inter-clips, as well as usability information (e.g., viewing statistics, viewed clips, chosen decisions, decisions annotations).

In the process of creating rich experiences through interactive video and adapting video to World Wide Web paradigm, the concept of correlation of additional information is impossible to avoid. A regular website usually contains hyperlinks to other sections from the same page or to other pages within the same site, and also to the web pages located at other sites and on other servers than the local one. The hyperlinks can also indicate other pages, images, Linked Data resources or multimedia materials. Similarly, an interactive video system can be considered as a video system containing references to information that is both within the same clip as well as to other video and multimedia resources managed on the same server, or towards other information from outside. In the first case, the one where the reference is made to another subsection of the same video clip we can use the notion of *video fragment* similar to a chapter of a DVD movie.

World Wide Web Consortium (W3C), a multi-organizational entity and led by the founder of WWW Tim Berners-Lee itself, aims to define the recommendations and directions for long term developing the World Wide Web. For video, one of the key specifications (W3C Consortium, 2013) defines "media pieces" (media fragments) notion. The main purpose of the specification of video pieces is addressing some subsections from the inside of videos, similar to HTML anchors. These anchors defined by adding a # followed by the anchor name, are referring to a subsection of a current page annotated as such. The media fragments term describes a portion/segment of a media object (Li, Wald, Omitola, Shadbolt, & Wills, 2012); a fact also highlighted by the name fragments + media. An example is a fragment of 30 seconds of a video clip lasting for 2 minutes. In terms of their structure, media fragments have three main components: #, t, xywh; described as:

- # - indicates that the preceding part is the physical location of the file, and the following is an excerpt from an image or a video and has two possible components - temporal and spatial dimension;
- *t* - it is the temporal dimension (W3C 2013), can have two values that represent the beginning and the end of the fragment, in second.
- *xywh* - it is the spatial dimension (W3C, 2013), has four values: the first two xy are the coordinates and wh representing the height and width of the defined fragment.

So, to uniquely identify a portion of a video the addressing of the video materials by URI has the following structure: http://www.name.ro/videoname.mp4#t=t_start,t_end&xywh=5,10,640,480. The process described above, where for a given spatial region or video segment (media fragment) the video content creator can provide additional resources to other media materials embedded within the page, hyperlinks to external resources or information obtained based on the principles of Semantic Web (Wald, Omitola, Shadbolt, & Wills, 2012) is part of video annotations. To cover all cases that may arise, annotations can be classified into:

- Conceptual–a video clip is available on a generic concept throughout the video;
- Temporal–a particular idea, object or person, second occurs between t_1 and t_2 second;
- Spatial–A portion of the image has a definite meaning;
- Temporal/spatial–combine spatial and temporal annotations;
- Subject in motion–the subject of the annotation moves in the video frame.

2.3 Major Players

The interactive video platforms serve the education and entertainment domains mostly. They are built under a free license or commercial, project collaboration, company effort or individual's approaches.

We search on the Internet the main actors for generating online interactive materials and the results are reveal in the Table 1 (platforms from Australia and India), Table 2 (platforms from USA and Canada) and Table 3 (platforms from Europe countries):

Table 1. Major players in interactive video from Australia and India

Name	Details
Australia iWeaver	It describes an interactive system that use text, images, audio and animations to explain a web programming course (Java Programming Language). It is Christian Wolf project, teacher of Faculty of Education, Language, and Community Services, RMIT University Melbourne, Australia (Wolf, 2002).
India Pad.ma	Public Access Digital Media Archive represents an online archive of text-annotated video material, primarily footage and not finished films. The Pad.ma project was initiated by a group consisting of CAMP, from Mumbai, 0x2620 from Berlin and the Alternative Law Forum from Bangalore.

Table 2. Major players in interactive video from America and Canada

Name	Details
HyperCafe	It is a Georgia Institute of Technology, School of Literature, Communication and Culture College of Computing project. It represents a virtual cafe, composed primarily of digital video clips of actors involved in fictional conversations in the café (Sawhney, Balcom & Smith, 1996).
NeXtream	It is an MIT Media Lab project at Cambridge. It represents a framework and implementation for the next generation of media consumption and TV (Martin, Santos, Shafran, Holtzman & Montpetit, 2010).
OVA	Open Video Annotation it is an interdisciplinary initiative led by HarvardX and supported by the Center for Hellenic Studies at Harvard, Office of Scholarly Communications, and the Berkman Center for Internet and the Center for Mind Informatics, Massachusetts General Hospital.
Remark	It is a collaborative video annotation, review and approval of video teams, clients, and stakeholders. The headquarters is in Austin, TX.
Youtube	Annotations are clickable text overlays on YouTube videos.
VARS	Video Annotation and Reference System, was developed by Monterey Bay Aquarium Research Institute (MBARI) in 2011 for annotating deep-sea video data.
Vatic	Researchers from the University of California, Irvine developed a free, online, interactive video annotation tool for computer vision that crowdsources work to Amazon's Mechanical Turk (Vondrick, Patterson & Ramanan, 2013).
VCode & VData	It is the result of a Ph.D. work in Department of Computer Science, the University of Illinois at Urbana-Champaign. A suite of “open source” applications create a set of valid interfaces supporting the video annotation workflow (Hagedorn, Hailpern & Karahalios, 2008)
Vertov	The project of the Concordia Digital History Lab Centre for Oral History and Digital Storytelling, Concordia University from Montreal offers a free media annotating plugin for Zotero.
VideoAnnEx	Annotating video sequences with MPEG-7 metadata (Naphade, Lin, Smith, Tseng & Basu, 2002) was developed in IBM T. J. Watson Research Center.

Viddler	It is an interactive HTML5 video player, a responsive one. The company began in 2005 as InteractiveTube when two Lehigh University students, Donna DeMarco and Rob Sandie, added interactive functionality to a TV program called Blues Clues.
VideoAnt	University of Minnesota team offers a mobile and desktop video annotation.
Wiremax	It is a result of a company work, and now the headquarters are in New York, London, and Venice. Cloud-based, the end-to-end pipeline for video ingestion, decomposition, analysis and delivery with the ability to add advanced annotations in real-time are the facilities provided.
Zaption	A San Francisco-based tech startup offers an online annotation system, details can be found in the next subchapter.

Table 3. Major players in interactive video from Europe

Name	Details
Algeria CHM	Component-based Hypervideo Model represents a practical framework that allows the design of Web-oriented hyper videos (Sadallah &Aubert, 2012).
Austria ConnectME	Connected Media Experiences was a research project of STI International, Salzburg Research, PS Media, and Yoovis GmbH. A framework and player act as a proof of concept for the semantics-based dynamic enrichment of videos based on Linked Data annotations (Nixon, Bauer & Bara, 2014).
Belgium Zentrick	It represents an online platform that drives measurable results for any video by introducing interactive elements that activate, engage and convert audiences.
France Advene	Annotate Digital Video Exchange on the Net is an ongoing project in the LIRIS Laboratory (UMR 5205 CNRS) at University Claude Bernard Lyon. It aims at providing a model and a format to share annotations about digital video documents (movies, courses and conferences), as well as tools to edit and visualize the hyper videos generated from both the annotations and the audiovisual documents (Aubert & Prie, 2005).
Germany Anvil	A professor from University Of Applied Sciences Augsburg, Germany offer an interactive media tool used in many research areas as human-computer interaction, linguistics, ethnology, anthropology, psychotherapy, embodied agents, computer animation and oceanography (Kipp, 2012).
Israel Interlude	It was founded by Israeli musician and self-proclaimed tech geek Yoni Bloch. It is targeted to music artists and personalities, as well as entertainment and consumer brands, to create interactive videos powered by Interlude technology.
Netherlands ELAN	It is software developed by The Language Archive, (Sloetjes & Wittenburg, 2008). The institute behind the project is Max Planck Institute for Psycholinguistics, The Language Archive and Nijmegen from Netherlands.
Serbia VAT	Video Annotation Tool was a Bohemie Research Project (Bootstrapping Ontology Evolution with Multimedia Information Extraction). VAT represents a tool to annotate MPEG video files manually and has already been successfully used for the annotation of sports events videos (Paliouras, Spyropoulos, & Tsatsaronis, 2011).

Sweden Cantemo	It has established a foothold in the market with broadcast household names. It is a portal extensible, future-proof, intelligent and easy to use Media Asset Management solution with multiple apps, including an Annotation Tool.
Switzerland AAV	Annotating Academic Video is a project resulted from the collaboration between Entwine team, Switch Net Services and Universität Bern, UniBE, Pädagogische Hochschule Zürich, PHZH, Université de Lausanne - UniL, Pädagogische Hochschule Thurgau, PHTG and Université de Fribourg, UniF. The project goal was to create a standardized, open and flexible tool/framework to enable Swiss University faculty, the others implied schools, staff, and students to annotate video across a mix of platforms including players, video management and learning management systems (Entwine, 2014).

2.4 Zaption Testing

For testing and verification of some theoretical principles of annotations, we choose this platform because it focuses on development and use of interactive video in education, both in Romania and worldwide. Addressed to all kind of learning cycles, Zaption wants to determine teachers, educator, trainers and publishers of content to transform video materials in an interactive and engaging experience. To use Zaption application, it is necessary to create an account. We choose for a Pro Membership Plan, $89/year. After logging, we noticed that the application offers three components: tours, videos, and groups. Video part have features like video searching on Zaption databases, own materials administration, and video uploading. Group component allows creating a new group or enrollment in an existing group. The tour elements offer the same functionalities as video part (e.g. search, add, admin), but for a new user here it is the start of the annotation itself. The beginning of the tour concurs with the video upload: local one, videos from Zaption databases or from other video sharing platform: Vimeo, PBS, National Geographic, TED, Discovery, NASA, Edutopia, Vsauce, Crashcourses, Scishow, CGP Grey etc.

The annotations are various: real-time drawing, creating an open response questions, creating a numerical answer questions, creating a multiple-choice questions, creating a cassette questions answered, create a reply to a question by drawing, discussions, users can ask questions or post comments, repeat video, skip a certain portion of the video. Position setting involves placing the annotation on the right or above the video frame. The behavior allows choosing between two actions: stop or play the video. Duration, in the name itself, sets a period during which the annotation will be displayed. After work finished, the final step includes publishing and sharing out the interactive video material. Once the tour is announced it can be a post to the Zaption Gallery for everyone to see it. Features like add a description and tag with, select one category and age level are permitted. From the technology profile and technical metadata perspective Zaption application was developed based on solutions from Table 7.

Table 4. Technology profile for zaption

Name	Solution
Nameserver Providers	Amazon Route 53
SSL Certificate	GoDaddy SSL
Hosting Providers	Amazon
Email Services	Sendgrid, Google Apps for Business, SPF
Analytics and Tracking	Mixpanel, Google Analytics, Optimizely, New Relic
JavaScript Libraries	jQuerry, Skollr

Audio/Video Media	VideoJS, Sublime Video, Youtube
Mobile	Apple Mobile Web Clips Icon, Viewport Meta
Widgets	Google Font API, Smart App Banner
Content Delivery Network	Cloud Front, Zencoder CDN, Ajax Libraries API, Vimeo CDN
Document Information	Cascading Style Sheets, Twitter Cards, HTML5 Specific Tags, Conditional Comments, Google Chrome IE Frame, Javascript, WAI-ARIA, HTML5 Video Audio Tags, Meta Description, HTML5 DocType, X-UA-Compatible, P3P Policy
Encoding	UTF-8
CSS Media Queries	Min Width, Max Width, Device Pixel Ratio
CDN Providers	Amazon Cloud Front

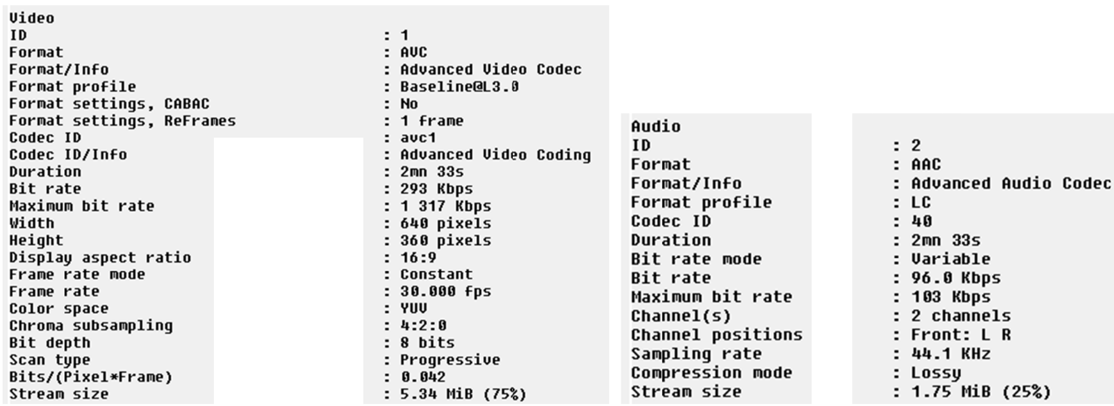

Figure 3. Zaption-video and audio technical metadata

To identify technology profile listed in Table 6, we choose the BuiltWith application–http://builtwith.com. It represents a tool for identification of technologies used in web applications. It is designed for a small group of users, including web developers and researchers. The generated results provide an overview of the complexity of technical parts required in the development process. Also, we analyzed the compression and encoding parameters characteristic of specific video content (audio video technical metadata) that plays inside the Zaption. We downloaded some video lessons (using Video DownloadHelper) on the local machine, and we extract the audio-video metadata information with MediaInfo® free software. MediaInfo has a simpler graphical interface, and it offers several different visualizations of the information that allow to user to determine what metadata are present. In Figure 3 are found values for the following components: Format profile: format/container, file size, duration; Audio parameters: audio codec, (maximum) bit rate, channel(s), sampling rate, compression mode, stream size; Video parameters: video codec, profile@level, settings (CABAC or CAVLC, GOP, M, N), video frame size, (maximum) bit rate, display aspect ratio, frame rate, color space, chroma subsampling, bit depth, scan type, Qf - bits/(pixel*frame), stream size (Onita et. al., 2015).

3. Interactive Video Project Proposal

3.1 Block Diagram for an Interactive Video Content

We collected all the ideas from case studies done on the above subchapters; we watched the trends in MOOCs video platforms and metadata field, and we managed to extract the following thought: in designing a system that allows display of interactive video content we must take into consideration (Figure 4): video framework resource management (production, transcoding and storage); a module that allows actual annotation made by the administrator or content creator; an extension of the above module for (semi)automatic (semantic) annotation; distribution area, player interface; data analytics block, recommendation system.

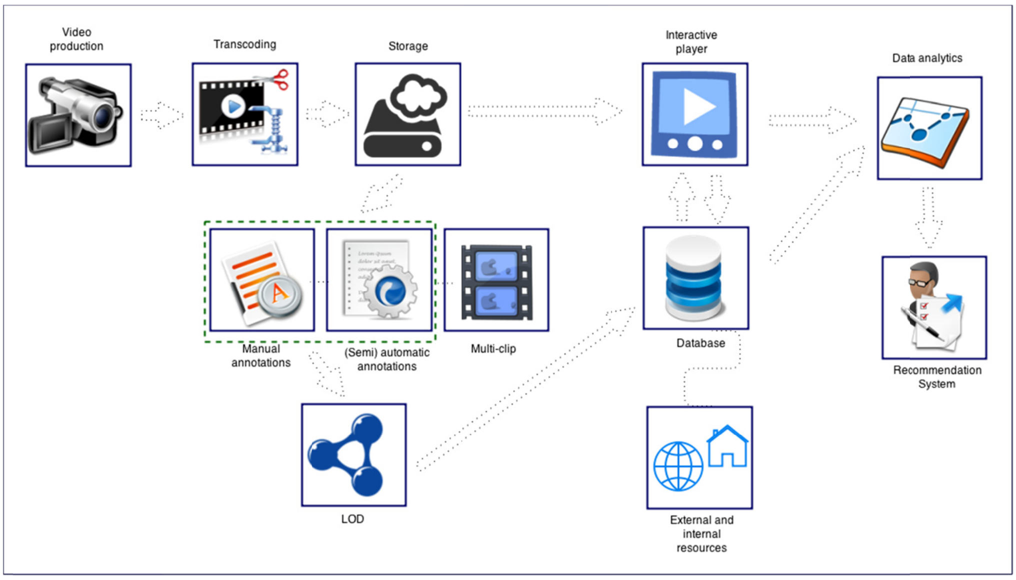

Figure 4. Block diagram proposal for interactive video content

Several devices provide the video production content: consumer, prosumer, professional and super chip Cameras; DSLR, mirrorless and compact photo-video camera; mobile gadgets. The video source may be also considered material generated with computer software support: simulation, computer-aided design or some video lectures (tutorial/demonstration, animated instructional video, voice over presentation). From the transcoding process results audio-video stream encoded in specific formats (with control of important coding parameters as shown in under construction interface revealed in Figure 5) and together with the master video is stored in a storage (cloud) system.

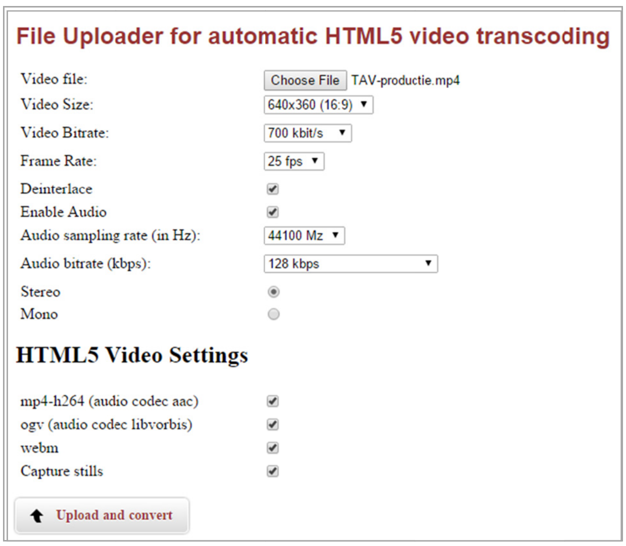

Figure 5. HTML5 video transcoding

Table 5. Scenarios for audio-video parameters (Onita et al., 2015)

Video frame size	Audio bitrate*	Codec Audio	Video bit rate**	Codec video	Container
240p, 426 x 240	196 kbps 128kbps 64kbps	MP3 Vorbis	700 Kbps 400 Kbps 300 Kbps	H.264, VP8	.mp4, .webm
360p, 640 x 360	196 kbps 128kbps 64kbps	AAC-LC Vorbis	1000 Kbps 750 Kbps 400 Kbps	H.264, VP8	.mp4, .webm
720p, 1280 x 720	512kbps 384kbps 128kbps	AAC-LC Vorbis	4000 Kbps 2500 Kbps 1500 Kbps	H.264, VP8	.mp4, .webm

*5.1, stereo, mono.

**maximum, recommended, minimum.

The content annotation can be done manually by the editor/manufacturer (Figure 6) that adds initial connections to available entities in LOD (Linked Open Data). According to W3C Consortium (2014), Linked Data appears in the Semantic Web context. “The Semantic Web is a Web of Data - of dates and titles and part numbers and chemical properties and any other data one might conceive of. The collection of Semantic Web technologies (RDF, OWL, SKOS, SPARQL, etc.) provides an environment where the application can query that data, draw inferences using vocabularies, etc. However, to make the Web of Data a reality, it is important to have the vast amount of data on the Web available in a standard format, reachable and manageable by Semantic Web tools. Furthermore, not only does the Semantic Web need access to data, but relationships among data should be made available, too, to create a Web of Data (as opposed to a sheer collection of datasets). This collection of interrelated datasets on the Web can also be referred to as Linked Open Data”.

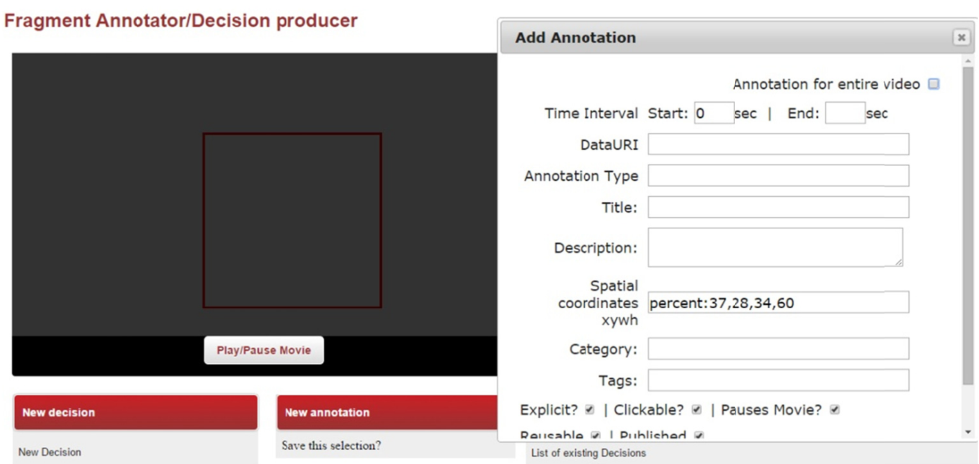

Figure 6. Spatial annotation-module proposal

Another annotation possibility is a semi-automatic one, in which case, it is applied NLP (Natural Language Processing) techniques to audio streams and video frames recognition. The system suggests the initial annotation and the editor approve them. To extract this kind of data from LOD one can use Crawling Pattern, where several data sources are covered for obtaining the necessary information. LDIF (Linked Data Integration Framework) and Apache Marmota, LMF (Linked Media Framework) part, represent solutions for this process. The data obtained is stored in a particular Triplestore, with Opened Sesame software solution. The database block is supplemented with a relational database that keeps data about video (meta)information and about user interaction with the video itself. Data analytics and a recommendation system complete the landscape. The interactive player module displays the video itself with the annotations information delivered from the database, and it can run under different scenarios. We offer some particularities on this subject in the next subchapter.

3.2 Requirements of Annotation Interface and Player Module

From the organizational point of view there are two aspects: on one hand there are the creator and publisher of the material (the "manufacturer" of annotations), on the contrary it is the one who is viewing the content. This leads to two "sides of usability and requirements" of such implementations. In the first case, the interactive part should be possible in digital video file formats via standalone or web-based interfaces. Regardless of the chosen option, the annotations system should allow all types of annotations described in Table 3, part of them or distinct combinations between them. In the Harvard (2014) proposal, the user interface should permit (Figure 7): comment or annotation of the entire video piece (1); overlays of images or videos on top of sound visualization graph (2); text associated with an annotation and overlays of user-generated graphics (3); user-defined custom annotation markers (4); automatic captioning of spoken word, used as baseline annotations-transcript (5); a time range (beginning and ending time) for each annotation (6).

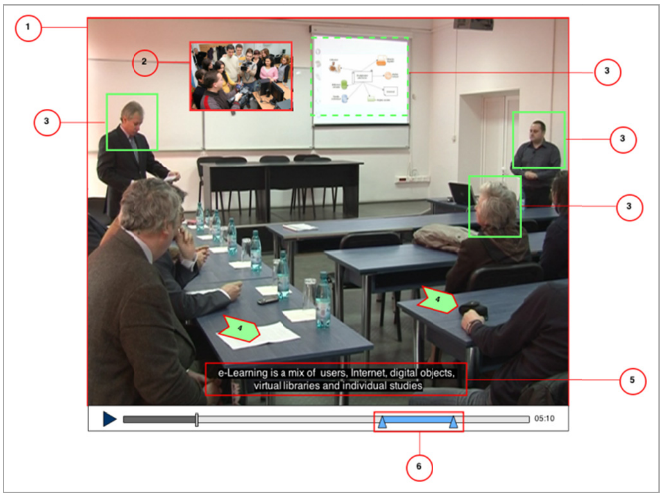

Figure 7. Requirements of a video annotation scene

The overlays area (3 in Figure 7) has some features (like the Zaption ones):

- Graphics for shapes such as lines, rectangles, ellipses, polygons and freehand shapes;
- Stroke and fill properties of graphic objects should be user defined, including color, stroke weight, and transparency;
- Short text tags with custom font weight, size, and color, including an optional highlight color and customizable background color for greater contrast;
- Placement and positioning of graphic objects should be dependent on the graphed waveform and zooming level.

In the second case, viewing and running the annotated video content involve an appropriate video, player. There are two display modes: window and full screen (Figure 8: MGI - Manually Generated Information, AGI - Automatic Generated Information). The first case belongs to web approach, where the video content appears on a part of the screen and the additional information generated by annotations is displayed in adjacent sections, not overlapping video. The full-screen case is met on smart TV-IPTV, where the adjacent information is displayed in the video. The player can be thought adaptable to different resolutions (scalable version, as Viddler model), in which case the supplementary information must be reduced in a number of blocks display.

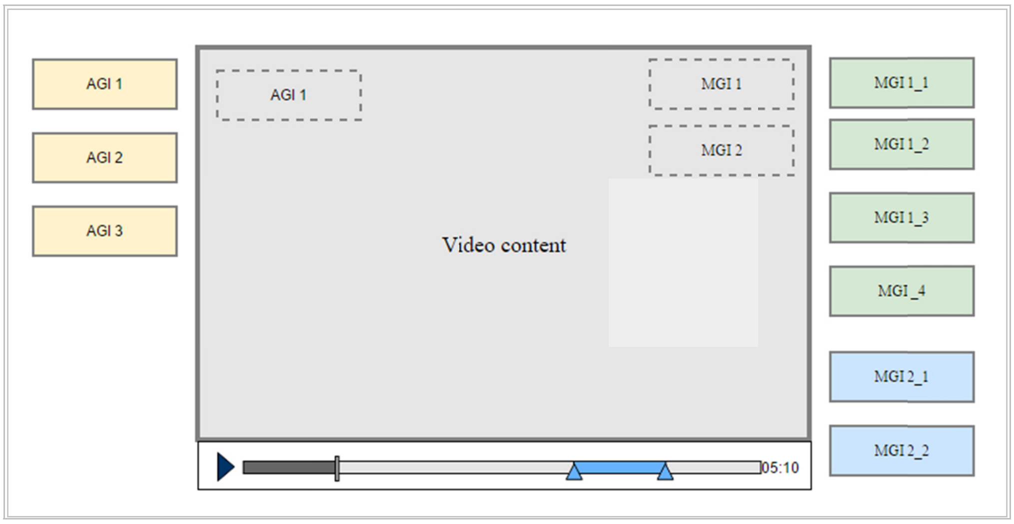

Figure 8. Video player interface, regular window and full screen

The graphical interface will have a significant role; the literature provides a list of required components (IAB Digital, 2014), (Sadallah & Aubert, 2012) for a playing module that can add value in terms of usability (Meixner, Holbling, Stegmaier, & Kosch, 2009), (Meixner, Siegel, Schultes, Lehner, & Kosch, 2013):

- Custom video player with customizable buttons, playback controls and additional buttons (mute, full screen, annotations on/off, subtitles on/off, etc.);
- Graphics and animations overlay, geometric forms, animation elements like arrow, highlighted zone that drew attention to the parts of video frame content;
- Hotspots, interactive regions with external hyperlinks;
- Overlay video subtitle;
- A timeline with the video annotations;
- Table of content;
- A key visual frame map with static image/frame from the video;
- Downloadable transcript.

At the interaction with the so-called *hotspots* containing hyperlinks, video playback must be turned off to follow that link; the resulting information can be incorporated into the hyper-video page or displayed in a new window, depending on the selected display mode. The components related to the chronological structure of the video (contents, map, timeline, transcribed text etc.) will not stop running the video and will enable the leap in the specified location. Based on MOOCs video pages and our experience in the field, we think that some additional components for such an interface can be underlined: FAQ zone, additional information area (e.g., authors, links to other materials on the same subject), multi-clip index, self-assessment quiz, homework proposals and interactive transcript (the tutor text speech which is synchronized with the video itself and with the help of keywords to allow the jump to the particular area of the material).

3.3 Managerial Implications

The performance of a University is reflected in several ways. The institute must propose itself quality and novelty. It can offer these in the educational act, with modern learning platforms and by teaching and management staff. Our study can have practical implications for the Politehnica University of Timisoara. The study indicates the necessity of a new and challenging platform based on the video (interactivity). It is a process that needs time and members to work together as a team for achieving the tasks and goals. A functional alpha version needs approximately one year of implementation and specific equipment/software in a different stage of implementation. In Table 6 we provide shorts managerial implications for each module proposed in this chapter.

Table 6. Managerial implications for alpha version of our interactive project proposal

Module	Details
Production	Equipment/Software: DSLR cameras or video professional cameras, editing software, video graphics station Number of developers: 1, Time: 3 months, 30 hours, Cost: 1000 Euros
Transcoding	Equipment/Software: VM1 (virtual machine) with FFMPEG and required libraries Number of developers: 1, Time: 3 months, 50 Hours, Cost: 600 Euros
Storage	Equipment/Software: Storage server with 1TB available space iSCSI or NFS Number of developers: 1, Time: 3 months, 50 Hours, Cost: 600 Euros
Manual annotation	Equipment/Software: VM2 configured as a web server, VM3 link data storage Number of developers: 2, Time: 1 month, 120 Hours, Cost: 1200 Euros
Automatic annotation	Equipment/Software: VM4 for image and sound processing, VM5 for automatic annotation, VM6 link data storage Number of developers: 2, Time: 3 months, 150 Hours, Cost: 1500 Euros
Distribution area	Equipment/Software: VM2 configured as a web server Number of developers: 1, Time: 3 months, 50 Hours, Cost: 500 Euros
Player interface	Equipment/Software: VM2 configured as a web server Number of developers: 1, Time: 3 months, 100 Hours, Cost: 1000 Euros
Data analytics block	Equipment/Software: VM7 for running DM algorithms (possible solutions skit-learn library for Python or Weka for JAVA) Number of developers: 2, Time: 3 months, 100 hours, Cost: 1000 Euros
Recommendation system	Equipment/Software: VM7 for running DM algorithms (possible solutions skit-learn library for Python or Weka for JAVA) Number of developers: 2, Time: 3 months, 150 Hours, Cost: 1500 Euros

The time and the cost have approximated values. The developer hour's rating is 10 Euros / Hour, 1600 Euro / Full Month. The Virtual Machines can be built on a single server machine.

4. Conclusions

The flood of popularity that accompanies video-based platforms generates more and more research opportunities. Most of this research is focused on the impact of video on Higher Education, on a new platform that offers not only a passive learning experience but way more. The video material must represent a plethora of useful information according to user wishes, followed either online, on a TV connected to the Internet or a mobile device, generating a pattern of active learning. It is the way to collaborative activities, quizzing and broad information search, effort to gain the student attention and clear objectives for learning. In terms of technology, it is the right time for interactive video, for combining elements as video production, transcoding, streaming, semantic, recommendations systems, data analytics, etc. The time has come for the educational platform to take into consideration interactivity as a "necessary". It is the moment when universities all over the world have to invest time, money and effort to improve their online video education platforms or to develop from scratch a new challenging video interactive platform. It is our idea regarding Politehnica University Timisoara, as a standalone solution or a complement to actual virtual campus (http://cv.upt.ro) depending on future development plans and financial aspects.

In order to give a proposal closer to current world needs, in this paper we highlighted: the existing educational infrastructure locally and internationally (MOOCs movement, virtual campuses for universities); the concept and the progress of video as central part for e-Learning; essential elements from technical point of view; related project in the field; platform testing (free ones and some commercial ones).

We collected all ideas and we propose a web-based system as shown in modules from Figure 4: video production, transcoding, storage, manual and (semi)automatic annotations, LOD, interactive player, databases and internal/external resources, data analytics and recommendation system. Blocks like transcoding, spatial annotation, and the interactive player was partially built by Sorin Petan for his final Ph.D. thesis, but all these pieces were put together in a discussion group in January 2015. A concrete, stable version will require at least one year of work and a team of specialists in the web developing, Semantic Web, audio video streaming, and transcoding, as a minimum start. We want to present this framework to Politehnica University Timisoara Board, to bring together the needed specialist and to work on a real scenario until the beginning of the next year, to gather feedback from our students, identify possible problems and improve user interface and overall usability.

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