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UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

FONDO DI ATENEO PER LA RICERCA ANNO 2016
PROGETTO DI RICERCA DI DIPARTIMENTO

1.Titolo del Progetto di Ricerca

On designing a system to improve the effectiveness of video lectures

2. MacroSettore ERC del progetto

PE6 (Computer Science and Informatics)

Sottosettori ERC di riferimento

PE6-10 (Web and information systems, database systems, information retrieval and digital libraries, data fusion)

3.Parole Chiave (MASSIMO 5)

Video lecture, Distance Learning, Video indexing, Students collaboration.

4.Responsabile Progetto (P.I.) (ricercatore a tempo indeterminato e ricercatore a tempo determinato ex art. 24 L.240/2010, lettera a) e lettera b), professore associato o professore ordinario)

COGNOME: FURINI

NOME: MARCO

Data di nascita: 11/01/1970

Qualifica: RICERCATORE INF/01

Dipartimento: Comunicazione ed Economia

(telefono): 0522.523156

(E-mail): marco.furini@unimore.it

5.Sottosettore ERC del PI

PE6-10 (Web and information systems, database systems, information retrieval and digital libraries, data fusion)
PE6-8 (Computer graphics, computer vision, multi media, computer games)

6.Elenco dei docenti e dei ricercatori (strutturati e non strutturati) partecipanti, appartenenti esclusivamente all'Università di Modena e Reggio Emilia

NOME	COGNOME	DIPARTIMENTO	RUOLO/ Tipologia di rapporto
MARCO	FURINI	Comunicazione ed Economia	Principal Investigator

7. Principali pubblicazioni del P.I. e dei componenti il gruppo di ricerca negli ultimi 5 anni 2012-2016 (max 10), con eventuali indici bibliometrici:

1. M. Furini, F. Mandreoli, R. Martoglia, M. Montangero, "IoT: Science Fiction or real revolution?'', Proceedings of the Goodtechs Conference, Venice, Italy, November 30, December 1 2016. Springer Press.
2. M. Furini, M. Montangero "TSsentiment: On Gamifying Twitter Sentiment Analysis'', Proceedings of the IEEE Symposium on Computers and Communications (ISCC 2016) - DENVECT 2016, Messina, Italy, 27 June 2016. IEEE Press. Best paper Award
3. N. Dusi, I. Ferretti, M. Furini, "PlayTheCityRE: a Visual Storytelling System That Transforms Recorded Film Memories Into Visual History'', Proceedings of the IEEE Symposium on Computers and Communications (ISCC 2016) - DENVECT 2016, Messina, Italy, 27 June 2016. IEEE Press.
4. M. Furini, "On Gamifying the transcription of Digital Lectures'', Entertainment Computing, ISSN: 1875-9521. Elsevier. DOI: doi:10.1016/j.entcom.2015.08.002. 2016
5. M. Furini, C. Pitzalis "Smart Cart: when Food enters the IoT scenario'', Internet of Things, December 2016. Springer-Verlag in the Lecture Notes of ICST (LNICST).
6. M. Furini, V. Tamanini "Location privacy and public metadata in social media platforms: attitudes, behaviors and opinions'', Multimedia Tools and Applications, November 2015. ISSN: 1380-7501 (print). ISSN: 1573-7721 (online). Springer US. DOI: 10.1007/s11042-014-2151-7
7. M. Furini, "ViMood: using social emotions to improve video indexing'', Proceedings of the 12th International IEEE Consumer Communications and Networking Conference (CCNC2015), Las Vegas, Nevada, USA, 9-12 January 2015. IEEE Press.
8. M. Montangero, M. Furini, "TRank: ranking Twitter users according to specific topics'', Proceedings of the 12th International IEEE Consumer Communications and Networking Conference (CCNC2015), Las Vegas, Nevada, USA, 9-12 January 2015. IEEE Press. Best paper runner up
9. M. Furini, "Users Behavior in Location-aware Services: Digital Natives vs Digital Immigrants'', Advances in Human-Computer Interaction, Volume 2014 (2014), Article ID 678165. ISSN: 1687-5893
10. M. Furini, M. Federico, "An Automatic Caption Alignment Mechanism for off-the-shelf Speech Recognition Technologies''", Multimedia Tools and Applications Journal, Vol. 72, n. 1, pages 21-40, September 2014. Springer US. ISSN: 1380-7501

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8.Curriculum scientifico del P.I. (Max 3000 caratteri, spazi inclusi)

Marco Furini received the Ph.D degree and the Laurea degree in computer science from the University of Bologna, Italy, in 2001 and 1995, respectively. Since 2008 he is a researcher at the Department of Communication and Economics at the University of Modena and Reggio Emilia. Since 2013 he is member of the Ph.D. program organized by the Marco Biagi Foundation and the University of Modena and Reggio Emilia. Previously, he has been a researcher at Department of Computer Science, University of Piemonte Orientale in Alessandria (2001-2008) and he has been visiting scientist at the Computer Science Department, University of Massachusetts in Amherst, USA (1998-1999).

His research focuses on:

- **Social computing.** The research focuses on advanced data analysis to identify trends and influential users on specific topics, on privacy issues in the social media scenario, on the development of architectures for the reuse of computational resources used for selfish purposes by users;
- **Multimedia computing.** The research focuses on the analysis and distribution of digital contents in a distributed environment, on the design, analysis and development of heuristics for the production of audio/video streams temporarily reduced, on the analysis and design of protocols to support video streaming applications, and on the design of mechanisms to improve the effectiveness of video lectures with a special focus on impaired people.

In these fields, he authored more than 55 journal and conference papers, 2 books, and 1 USA patent. He also authored chapters for international books and encyclopedia. His studies have been cited in 24 international patents owned by big ICT companies like Apple, Sony, Microsoft, Nokia, British telecom and Myspace.
He is associate editor of the Multimedia Tools and Applications journal (since 2009), of the international journal of Computer and Applications (since 2006) and of the international journal of Communications (since 2012). Furthermore, he has been involved in the technical committee of more than 100 international conferences and workshops.
He participated to research projects and he maintains scientific collaborations with the "Quantum Information Processing Institute" of the University of Ulm, "Istituto di Informatica e Telematica" of the CNR-Pisa, "Dipartimento di Informatica: scienza e ingegneria" of the University of Bologna, "Istituto di Informatica" dell'Università del Piemonte Orientale, "Math Department" of the University of Padova. He has been member of the Scientific Advisory Board of BAtlas, a BPER (Banca Popolare Emilia Romagna) business innovation project (2014). In the field of video lecture multimedia computing, he was principal investigator of two projects funded by the "Centro Disabili Unimore" (from 2011 to 2013).

9.Abstract del progetto di ricerca (max 2000 caratteri, spazi inclusi)

Many educational institutes use video lectures to support distance-learning students and/or alternative teaching methods. However, the naïve use of video lecture layouts and the poor performance of the search&retrieval process might jeopardize the effectiveness of video lectures. Indeed, although the layout of a video lecture directly affects its effectiveness, many video lecture producers use some video editing application default templates to produce video lectures. This is why, in video archives, we find videos with different layouts: just the teacher's face, or just the slideshow, the blackboard or the classroom. Similarly, the importance of the search&retrieval process is usually underestimated by video lecture producers. Indeed, most processes index videos according to few textual information (e.g., course title, teacher's name) and return a list of full-length video lectures. Since the requested information is

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often covered in few minutes of the video lecture, the process is far from being efficient. Indeed, it is often cumbersome for students to search through an entire video, or across many videos, to find what they are looking for. The problem is exacerbated if students are not familiar with the area, if the topic is very specific, or if they access by means of assistive technologies.

In this project, we propose an innovative video lecture system able to:

1. Generate on-the-fly layouts in order to satisfy any student's preferences;
2. Improve the search&retrieval process by designing ad-hoc video indexing algorithms;
3. Involve students in the production and enrichment of video lecture contents;
4. Help teachers in the process of video lecture production by collecting metadata produced by students when playing a video lecture.

By using up-to-date technologies and by designing novel algorithms and methodologies, students and video lecture providers will likely appreciate the proposed system, as it will improve the effectiveness of video lectures.

10.Stato dell'arte (max 3000 caratteri, spazi inclusi)

In the literature, many researches focused on video lectures: some considered the technological point of view (e.g., network distribution, audio-video coding), some focused on the learning management systems (e.g., Sharable Content Object Reference Model), some on the accessibility of the educational contents (e.g., development of educational contents for ear and/or sight impaired people).

Recently, given the huge amount of videos within video lecture archives, researchers are addressing three important challenges to improve the effectiveness of video lectures [1-5]:

i) find the appropriate video lecture within a large video lecture archive;
ii) provide a general picture of the contents of a video lecture;
iii) find the segment of the video that covers a particular topic.

To meet the first challenge, the most common approach is to use textual metadata (e.g., course title, teacher's name, etc.), but this approach is not very efficient as it is too general to be useful [1]. Approaches that are more recent pose strict constraints on the video lecture layout and use OCR and audio technologies to transform visual and aural data into textual data in order to increase the number of textual metadata associated to a video lecture [2,3].
To meet the second challenge, a summarization of the video contents is necessary. Unfortunately, most of the effective video summarization techniques proposed in literature fail when applied to the video lecture scenario because a video lesson does not contain enough low-level video features differences to produce a useful summary [4].
To meet the third challenge, many systems provide VCR-like controls (play, fast-forward, rewind and pause), but the act of browsing an entire video lecture with simple VCR-like controls is time consuming and not practical [5].
To improve the effectiveness of video lecture systems, we think it is necessary to avoid constraints on the video lecture layout and to improve the performance of the search&retrieval process.

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References

[1] Hijung Valentina Shin, Floraine Berthouzoz, Wilmot Li, and Fredo Durand. Visual transcripts: Lecture notes from blackboard-style lecture videos. ACM Transactions on Graphics. October 2015.
[2] Haojin Yang and Christoph Meinel. Content based lecture video retrieval using speech and video text information. IEEE Transactions on Learning Technologies. April 2014.
[3] Vijaya Kumar Kamabathula and Sridhar Iyer. Automated tagging to enable fine-grained browsing of lecture videos. In Proc. of the IEEE International Conference on Technology for Education. July 2011.
[4] Marco Furini, Filippo Geraci, Manuela Montangero, and Marco Pellegrini. STIMO: Still and moving video storyboard for the web scenario. Multimedia Tools and Applications. January 2010.
[5]. Azzam Sleit, Moaath Hajaya, and Farhan Obisat. Video powersearcher: A text-based indexing e-learning system. In Proc. of the International Conference on Intelligent Semantic Web-Services and Applications. June 2010.

11.Ipotesi, obiettivi, metodologia e risultati attesi (max 8000 caratteri, spazi inclusi)

The advances in networking and multimedia technologies have led to the widespread use and availability of digital video lectures. Indeed, many educational institutes use video lectures in the attempt to improve the effectiveness of teaching in and out of classrooms, to support distance-learning students and to support alternative teaching methods. For instance, the so-called “flip-learning” is a different style of education in which students watch video lectures at home before attending the classroom lessons and teachers use the class time for additional learning-based interactive activities. However, it is to note that the achievement of the goals described above is not trivial. Briefly, there are two main problems: i) the naïve use of content layout and ii) the poor performance of the video retrieval process when dealing with large video archives.

The layout of a video lecture is closely linked to its effectiveness. Unfortunately, in most cases the producers of video lectures do not give the right importance to the video layout and use some default video editing application templates to produce video lectures. This leads to problems, as the live classroom scenario is very different from the video-based remote scenario: the performances differ, just as the written language is different from spoken language. The naïve use of layouts and the idea of recording the classroom to improve the effectiveness of teaching in and out of classrooms, to support distance-learning students and to support alternative teaching methods is the first step towards the production of non-effective contents. Unfortunately, video lecture archives are full of lessons recorded with many different layouts. For instance, we can identify four popular layouts, as shown in Figure 1: layout (a) is extremely popular in scientific courses, layout (b) is generally used for distance learning, layout (c) is very common in humanistic courses and layout (d) is the one provided by those educational institutes that simply record classroom lessons and put them in a video lecture archive.

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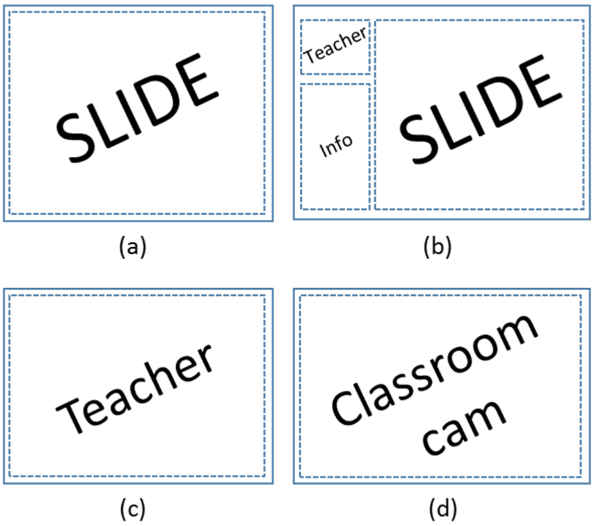

Fig. 1. Most common video lecture layouts.

The retrieval of specific video lectures within a large video archive is a fundamental and critical process in a distance learning system and is one of the challenges that need to be addressed by video lecture providers. Currently, most of the systems index video material according to few textual information like course title, teacher's name and keywords, and the retrieval process provides students with a list of full-length (e.g., 60 or 90 minutes) video lectures. Since the requested information is often covered in few minutes of the video lecture, it is often cumbersome for students to search through an entire video, or across many videos, to find what they are looking for. The problem is exacerbated if students are not familiar with the area, or if the topic is very specific, or if they access by means of assistive technologies, in particular screen readers and screen magnifiers or if they need captions.

Project's goals and research methodology

To address the challenges of the content layout design and of the retrieval of specific video lectures within a large video archive, in this project we aim to:

1. **Design a layout generator mechanism** able to automatically provide the most appropriate layout for the considered scenario. Indeed, Figure 2 shows the general idea: three different streams are recorded for every topic: one stream is produced with cameras pointed at the teacher, one is produced with a screen-recorder, and one is produced with 360-degrees camera that records the scenario. The three streams will be combined according to the student's request. For instance, while using a small device, a student may prefer having a single stream, whereas while at home he/she may prefer having a combination of streams; or a student may want experience a virtual classroom with VR-enabled devices.
2. **Design of an indexing mechanism** able to find the proper lecture and the proper position inside a video lecture. The idea is to use advanced techniques to understand the contents of a video lectures (e.g., low-level audio and video features analysis like histogram colors, speech recognition, OCR, etc.) and to design indexing and retrieval algorithms to improve the search&retrieval process.

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3. **Design an interface with up-to-date technologies** that: i) involves students in the production of additional contents by allowing them to suggest links, to tag, and to rate specific portion of video lectures, and ii) records all the students' activities (e.g., playout time, VCR actions) to better understand how the lecture is perceived by students.
4. **Automatically produce additional educational contents** by exploiting the information produced with low-level feature analyses. For instance, a smart use of speech recognition technologies allows producing video lecture captions (this may bring benefits to ear-impaired people and/or to foreign students), a combination of aural and visual analyses allows producing educational material (e.g., in PDF and/or EPUB formats) and/or allows producing a wiki version of the lesson contents in order to involve students in the production of educational material.

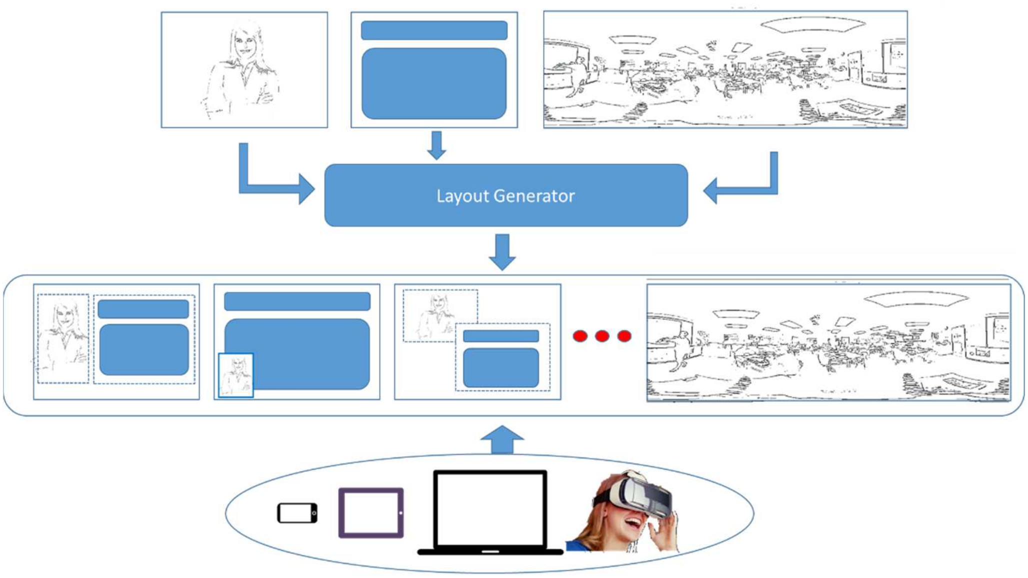

Fig. 2. Layout Generator System.

Expected results

The design and implementation of the system would bring benefits to both students and teachers. In particular, students may customize video lectures layout according to their preferences and needs. For instance, a student may prefer watching the teacher's face, whereas another may prefer watching the slideshow. Similarly, one would rather receive a combination of the two streams, whereas another may want to experience a virtual classroom using VR-enabled devices. In addition, there may be technological constraints (e.g., screen size, bandwidth consumption and speed, etc.) that may suggest the use of specific layout. Moreover, students may interact with the system and can have an active role in the learning process. For instance, they may suggest links, tags, and resources and the teacher/system may embed these suggestions into video lectures.

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Teachers may improve the produced contents by using the suggestion of the students (e.g., links to external resources, tags like "interesting" or "boring" associated to specific portion of the video), and by exploiting the amount of metadata produced by the system (e.g., number of visualization, unique viewers, playout time, bouncing time, etc.). Furthermore, the system may help teachers in the production of additional contents. For instance, the OCR analysis of the video track combined with the ASR analysis of the audio track may produce a rough transcription of the contents organized in chapters. Although this textual content is far from being a well-written educational material (we recall here that the written language is very different from spoken language), it can be an interesting basis for a social editing of the contents (e.g., the text can be the input of a wiki system, where students can collaborate to produce reasonable and readable educational material). Needless to say, this material can be automatically transformed into PDF or EPUB documents for easier reading. In general, we expect the system to improve the effectiveness of video lectures.

12.Eventuali potenzialità applicative e impatto scientifico e/o tecnologico e/o socio-economico (max 3000 caratteri spazi inclusi)

Potential Application

1. The system will enable innovative and relevant applications in the area of distance learning. It will change the role of students, moving them from passive to active. In this way, they will contribute to the development and enchantment of educational material. We recall here that one of the reasons that drives users to collaborate to the Wikipedia platform is the production and dissemination of information material to raise awareness of people and thus to improve the entire society.
2. The analysis of the students' behaviors, when dealing with the system, will be crucial to devise appropriate strategies to improve the effectiveness of video lectures. Teachers will have a feedback for their activities: for instance, they can know the subjects that students consider less attractive, less clear, verbose or complex. The novelty is that the feedback will not be based on questionnaire or survey, but on real-data, extracted by system by collecting metadata about the students' behaviors when they interact with the system.

Scientific impact

1. Novel models and algorithms to improve the effectiveness of video lectures In particular, these algorithms will be based on different sources of information like low-level audio and video features, students' suggestions and metadata automatically produced by analyzing the students' behaviors when playing video lectures.

2. The search&retrieval process in video lecture archives is currently a research topic of high interest, given the scope and magnitude of its potential societal consequences. We believe this project represents an important opportunity to advance the knowledge in the field.

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13.Costo complessivo del progetto articolato per voci di costo:

	Costo	Descrizione Max. 2.000 caratteri spazi inclusi
Eventuale cofinanziamento (certificato dal dipartimento)		
Costo dei contratti del personale da reclutare		
Attrezzature, strumentazioni e prodotti software	2750	• Computer Server • Hardware to collect, manage, process, and visualize lecture • Software to collect, manage, process, and visualize lecture
Servizi di consulenza e simili		
Altri costi di esercizio (missioni, partecipazioni a convegni, attività di disseminazione dei risultati, pubblicazioni, organizzazione convegni, seminari, materiale di consumo, ecc)	1000	Costs for publication and dissemination (e.g., conference fee and/or journal charge and/or travel expenses)
Totale	3750	

Data: 07 Novembre 2016

Firma del Responsabile scientifico
Marco Furini