

# Pyramidia – An Integrative E-learning Tool

Predrag Pale, *Member, IEEE*; Ivan Miletic, *Student Member, IEEE*;  
Zvonko Kostanjcar, *Student Member, IEEE*; Hrvoje Pandzic, *Student Member, IEEE*;  
and Branko Jeren, *Member, IEEE*

University of Zagreb, Faculty of Electrical Engineering and Computing, Zagreb, Croatia,  
e-mail: [hrvoje.pandzic@iee.org](mailto:hrvoje.pandzic@iee.org)

**Abstract**—Nowadays, students need digital, highly interactive educational materials which can be accessed at any time in their original form. In the same time, lecturing seems to remain dominant form of teaching. This combined raises the importance to video record lectures. Pyramidia was created to satisfy both the students' demands for interactive and easy-to-use material and the lecturers' time and technological limitations. It is a software package that combines PowerPoint presentation with lecture video capturing. This allows students to re-experience the lecture at any time and anywhere. Pyramidia is a descendant of previous software developments and research in ICT use in education and has been used and tested through an entire semester of lectures for several courses. Pyramidia combines two strong elements into one lecturing system. The first one being the addition of variety of content and interactivity to existing PowerPoint presentations in an easy way that does not require much computer knowledge nor lecturer's time. The second one is the video recording of a lecture, which helps students to preserve the lecture in its original form. This reduces the chance for students to miss any part of a lecture. It also significantly augments the potential audience of the lecture. This paper describes the Pyramidia application package, which helps lecturers to transfer knowledge to students, with an emphasis on lecture video capturing and combining it with additional interactive content.

**Keywords**—e-learning, lecture capture, presentation software

## I. INTRODUCTION

E-learning is a word that has found its way to most national strategies and is inevitable at any event talking about the future of education. Many researchers around the world are experimenting with technology and its implementation in education while many others are using it in their daily teaching. There are numerous ways to benefit from utilization of ICT in education [1]. Yet it is most likely that some forms of human activity will not vanish. Actually, some may get another meaning and increased demand. Although experimenting with avatars as lecturers is not new, it seems that lecturing by a human being is among most prominent "old technology" that is about to remain around for decades to come [2,3,4].

In parallel with these research activities, a majority of today's lectures are still classroom oriented, almost the same way they were in the past decades, perhaps centuries [5]. A vast majority of academic teaching is based almost entirely on lecturing [6].

With all that in mind, it is reasonable to believe that no sudden changes will occur in the academic educational

system that would alone significantly increase educational effectiveness and cause present teaching and learning systems to become obsolete and abandoned. This means that lecturers will continue to remain the dominant method of teaching.

Academic institutions are still very traditional. Making changes, both pedagogical and administrative, requires time and effort [7]. Innovative lecturing methods have to be approved and recognized by many lecturers in order to become widely adopted. All this contributes to the reason why the development of new and modern methods for advanced teaching falls behind the pace of the development of technology and products.

Surely, in recent years, lectures have modernized in various ways, mostly as a result of technological progress. However, the new ways have not been adopted by all lecturers and institutions equally. An expression "digital divide" [7], is used to describe the large gap between informatically literate people and others who have problems keeping up with all the new products and the technology that are being presented to us on a daily basis.

Students are often better versed at manipulating all kinds of digital media than their teachers. Some lecturers neither have the will nor the knowledge to prepare digital content even if it is only to digitalize or merely (digitally) publish their lectures. Their number will surely decrease but over time. Fortunately, many lecturers have already understood the benefits of digital media and have undertaken initial steps towards digital presentations. The volume of digital, synchronized multimedia presentations in education is considerably increasing [8]. The most popular software for creating and delivering digital presentations on the Windows platform is PowerPoint [9].

One problem of live lectures is that they naturally vary in quality over time and that even the best presenters have bad days. Another problem is that audience can have bad days, too. A student may be prevented of attending a lecture by reasons beyond his control. Yet another problem is that in many instances a student would benefit if he would be able to check some parts of a lecture at some later point in time. Furthermore, it is difficult to take complete notes during a lecture and concentrate on the presentation. Finally, why would a student be restricted to experience only the lecturers in his own time-space domain and denied access to lectures available to other students and at other times. For all these reasons, a video recording of a lecture is a valuable learning content.

While there is a range of free and commercial tools for video recording lectures, they all suffer from at least one problem: it is not possible to randomly navigate through the recording, only the presentation is visible at play-back

time and not the other tools used in the lecture, the lecturer's notes and scribbles during the lecture are not visible or recognizable, there is no connection with other materials not presented during the lecture, etc.

After a bit less than a decade of experiments in using video recordings and other e-learning tools in engineering education the decision was made to design and build a tool that will overcome mentioned shortcomings and that would integrate video recording with all other additional materials linked to the content of the lecture. It should also integrate classical, live education with e-learning. Finally, this tool should be very easy to use even by lecturers who have very little experience in using the technology.

## II. DESCRIPTION OF PYRAMIDIA

Pyramidia is a lecturing e-learning tool developed with purpose to improve educational effectiveness (fig. 1). The primary function of such a tool is to video record a lecture. A recorded lecture should consist of three media streams: a video and audio recording of the lecturer and a video recording of the content the lecturer is presenting to the students, i.e. the computer display presented via a LCD projector. It is important for such a tool to require as little effort and interaction as possible from the lecturer during the lecture. Thus simplicity was a key factor during the development of this tool.

Another key feature of the tool is to offer access to additional content not presented to students during the lecture, e.g. a case study, additional explanations, visualizations, simulations, links to external documents etc, which could not be presented due to the lecture's time constraint. Such additional content must be context sensitive, so (parts of) it should be presented to students at an appropriate time, i.e. while presenting a specific slide of a PowerPoint presentation.

Currently, Pyramidia has been designed to integrate all content around a PowerPoint presentation. One presentation tool had to be chosen in order to determine the source of timing information about the advancement of the lecture and to integrate additional content in a context sensitive fashion. PowerPoint has been chosen for its widespread use and popularity. Pyramidia's PowerPoint parsing system enables the author of the lecture to add extended interactive materials to existing PowerPoint presentations, in an intuitive and straightforward way via simple plug-ins for the PowerPoint tool.

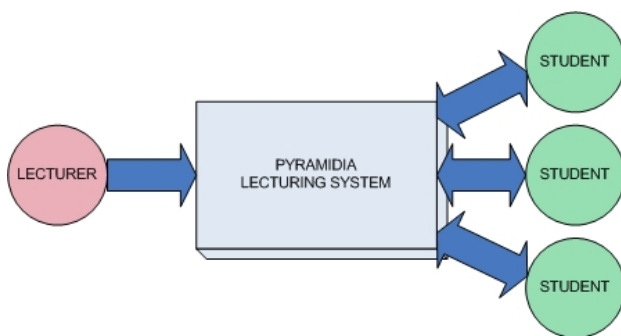


Fig. 1. Pyramidia helps the lecturer transfer knowledge to students

The lecturer interacts with the lecturing system by using the Recorder application. The Recorder application allows lecturers to record their lecture with great ease.

Students interact with the system using the Player application. It offers students full interaction with the both prepared and recorded lecture content. Students can interact with the lecturing system in various ways such as browsing and jumping through the video recording, answering multiple-choice questions, navigating the lecture and external links or searching the list of indices.

The lecturing system is composed of two main parts: the audio-video capture of the lecture itself and a PowerPoint parsing system (fig. 2).

### A. Audio-Video Capture

Not all students have the same learning capacity. Some students can process information faster than others. Even the "quick" students have their bad days, lack of concentration and other reasons for not completely understanding a lecture. Pyramidia was created to solve these important issues basically by enabling students to go over the recorded lecture as many times and at the pace they need. The purpose of this tool is not to replace "live" lectures, but to extend them.

Video capture is also of great importance to students because most lectures rely on visual communication. Body language sometimes expresses more than words themselves. Also, it is important to notice the lecturer's pronunciation and variation in volume, dynamics of sentences as well as the pitch of the lecturer's voice. This is useful for being able to distinguish the different levels of importance within specific material. Furthermore, most lectures are unique and the only way students can recall a specific lecture is to have it on video. A good lecture is composed not only of live presentation but also of printed material ("handouts") containing all the information presented so that the audience does not lose concentration hard copying spoken words. However, the best presentations are adoptive to the audience dynamic. They add or differently interpret the bare content contained in handouts.

According to past studies, students have trouble distinguishing important information "on-the-fly" and fail to record as much as 40 % of the important information throughout a typical lecture [10,11]. Another study concluded that students write down only 52 % of the important information throughout a lecture [11]. Furthermore, students record only as little as 10 % of orally delivered information and received messages are severely affected if lecturers speak too quickly, too quietly or just unintelligibly [12,13].

For all these reasons, the possibility to "post process" lectures, to go back and review unclear parts or to verify students notes, remarks, observations or thoughts during the live lecture is of high value in the process of learning. Therefore, the video recording of lectures is the primary focus of this lecturing tool. It is important to emphasize that the purpose of Pyramidia is not to completely eliminate note taking or attending lectures. In contrary, this educational tool frees students of all other activities and enables them to concentrate on following the lecturer's path of mind and to write down their own thoughts inspired by the lecture. It also allows and frees them to fully interact with the lecturer.

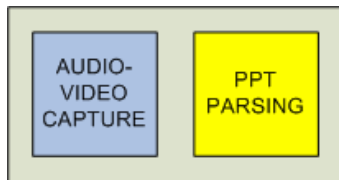


Fig. 2. Pyramidia is divided into two parts: audio-video capture and PPT parsing

In the not-so-distant future when there will be a larger pool of video recordings of similar or closely related lectures, students will have a great advantage to gain access to lectures held by experts in their field of profession and choosing the most appropriate for their cause. It also allows students to gain education from afar.

This tool has been designed to record from two separate video sources (the primary and secondary video source) and one audio source. It is recommended to use the screen of the computer on which the lecture is being held as the primary video source. This is made easy with the Pyramidia screen capture module. In this way everything that happens on lecturer's screen is captured: the presentation itself, browsing the Internet and running any other programs. The lecturer is not limited to using just PowerPoint. As the secondary video source and the audio source, it is recommended to use a camera that records the lecturer. It can also record the apparatus, if used by the lecturer, or the blackboard. Surely, all other types of video sources and their combinations can be creatively used both as primary and/or secondary video sources. The two videos are automatically synchronized and there is no running of one video ahead of the other. The primary video source is expected to provide more information than the secondary and is thus presented in the larger window at play-back time. The secondary video source is provided as additional assistance in comprehending the lecture and adding to the true lecture experience and is thus presented in the smaller window. However, students can swap the recordings among the windows on the screen whenever they need to.

### B. PowerPoint Parsing System

Having the entire lecture captured on video alone is not sufficient to create an effective e-learning material. Recent trends in learning are programs which include e-learning as a supplement to traditional classroom learning [14]. To increase the educational effectiveness of e-learning, students not only need additional material but also the ability to control the way a lecture is presented to them [15]. In order to increase the interactivity and dynamic nature of e-learning, a lecturer has to enrich the video captured lecture with additional content, questions to verify student's comprehension of the subject and similar interactive elements.

Therefore, to extend the video recording feature contained in Pyramidia while keeping it compatible with PowerPoint, the PowerPoint parsing system was developed. The parsing system is designed as a PowerPoint plug-in, which is automatically installed with the Recorder application. The plug-in is available as a toolbar in PowerPoint, as shown in fig. 3. It allows the author of the presentation to add supplemental content to a slide while composing the presentation.

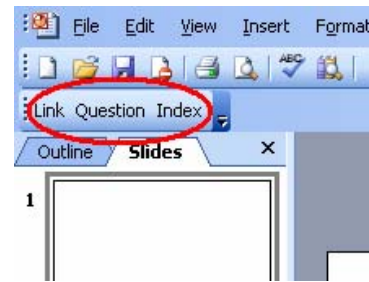


Fig. 3. Pyramidia toolbar in PowerPoint

The toolbar consists of three buttons, one for each of the three additional content types that can be added. Clicking on any of the buttons opens the plug-in dialog box which reveals an easy and intuitive interface for adding and viewing the additional content linked to that very slide. This dialog box is shown in fig. 4.

Three types of additional content are currently supported: indices, questions and links.

*Links* – external content related to the slide's content. These additional materials may be anything from a document stored in a file locally (pictures, videos, text or any other document) to an internet site (students have to have an internet connection available at viewing time to use this option). Links are defined by an URI.

*Indices* – keywords associated to a slide's content. These are usually terms being defined or explained on a slide or that would lead to the slide. After the lecture is created, indices from all of the slides are collected and used to form the lecture index, which is similar to the index of a book. The purpose of the lecture index is to allow students an easy way to navigate a lecture by key words and specific terms.

*Questions* – simple, multiple-choice questions about the subject discussed on a slide. These questions are provided for students to better understand the lecture. This allows students to evaluate their knowledge by solving simple exercises. A slide may contain many questions, which may have any number of answers. To attract the student's attention, it is best to keep questions simple and straightforward [16].

This additional content can be added both before and/or after the lecture is recorded. The lecturer has the ability to modify the additional content of a lecture even after it is recorded. This way, the lecturer can easily upgrade (correct, modify, reduce, enrich) already created lectures and does not have to deliver and record the lecture again.

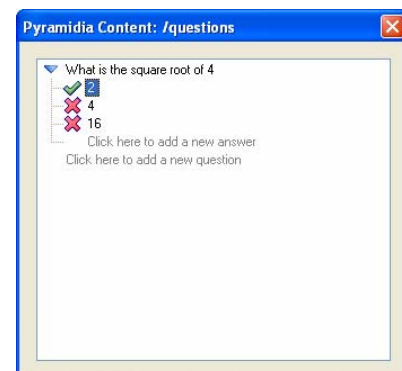


Fig. 4. Adding additional content to a slide

### III. SLIDE INFO AND LECTURE INFO

The Slide Info window presents all links, questions and indices related to the currently presented slide. This means that the Slide Info window will be dynamically updated, to reflect all of the additional material a lecturer added to the currently visible slide, as the presentation advances. Students can view context sensitive additional materials, which are opened in new windows, simply by clicking on their links in the Slide Info window. Also, students can view defined key words or indices and answer questions in this window. To assist students while answering questions, the play-back of the lecture is automatically paused whenever the mouse cursor is moved over the Slide Info window. Similarly, moving the mouse cursor outside of the window area continues the playback of the lecture.

The Lecture Info window contains the additional content (links, questions and indices) related to all of the lecture slides. In that way, all these materials are available to the student in one place, at any moment of the playback giving the student an overview of the entire lecture. The student can also see an index of terms discussed and explained in the entire lecture by taking a glance at the Lecture Info window. Clicking on any of those specific index terms, a play-back point in recorded videos is automatically adjusted to the point in time at which the slide, where that term is used and explained, was presented.

Besides being visible in the Slide Info window of an individual slide, all the questions of all the slides are accessible through the Lecture Info. Students can access and answer them without watching the entire lecture video. In addition, it is possible to solve quizzes. In that case, the Pyramidia Player randomly selects five questions from the entire lecture and students answer them one at a time. This option is can be used to ensure that students have comprehended the lecture and to recapitulate the subject of the lecture as a whole one more time.

In order to provide all these possibilities, Pyramidia records the time at which each slide was presented. If a slide is shown more than once during a lecture, all the times are saved. To avoid an unnecessary flood of saved times, for example when the lecturer navigates quickly through slides to find a specific slide, the slide occurrence times are saved only if the slide had not been changed within a “blocking interval” default value of which is three seconds. All the slide occurrence times, along with slide titles, are available in Slide Navigator of the Lecture Info to enable students an easy access to any slide of the lecture.

The concept of the Slide Info and the Lecture Info is visualized in fig. 5.

### IV. LECTURER’S VIEW – CREATING A LECTURE

In order to fully use all the possibilities this software tool offers, it is necessary to add content to the PowerPoint presentation. These changes can be made before the lecture is being held, but they can also be made afterwards as Pyramidia has an option to update the recorded lectures additional content. During the lecture, the PowerPoint Parser catches PowerPoint events which are later used to make the recorded lecture interactive and student-friendly.

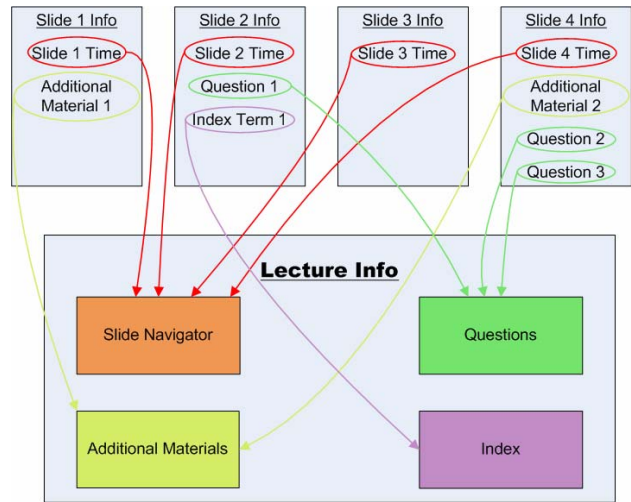


Fig. 5. The concept of creating the Lecture Info from the Slide Infos

The lecturer creates a new lecture using the Recorder, which is a simple and user-friendly application for video capturing and lecture creation. The interface of the Recorder is shown in the fig. 6.

Since the most delicate and important feature of Pyramidia is lecture capturing (video recording), the Recorder application was designed to be easy-to-use and user friendly, It only requires clicking on the record button at the beginning of the lecture and the stop button at the end of it. Therefore, most lecturers should be able to record their lectures without the aid of assistants.

Using a video camera to record lecturer requires some skills and basic knowledge: distance, angle, lighting, clothing, make-up, microphone type and position, control of the environment etc. This is neither the subject of this paper nor of the Pyramidia tool. The easiest is not to move the camera during the lecture and to set up the lens at wide-angle. It is recommendable to preset and cue video and audio equipment as well as to test sound and lighting if recording in new environment or if something essential changed in known environment [17]. The Recorder has a preview option, which allows adjustment of the angle and distance of the digital camera. If a web-cam is used, it is important not to move it because of its low resolution, in order to achieve acceptable quality of recorded video.

It is important that lecturers take into consideration that they are being filmed. This means they have to be aware of the limited walking area and avoid striped or hatched clothes. Nonverbal communication is also important because all the lecturers’ movements will be picked up by the camera.



Fig. 6. The Pyramidia Recorder application



Since the laser pointer cannot be captured on screen, lecturers should use a wireless mouse as a pointer. Usage of digital (“smart”) boards has been tested and proved to significantly contribute to the quality of recorded lecture.

After recording the lecture, it is immediately ready for distribution as a unique e-learning material via the Internet, so students only need to download the lecture (.lec) file. The recorder integrates the whole lecture into one large file with the extension .lec. The size of these files depends on the duration of the lecture and the quality of the recorded videos. One can expect about 200MB from an average 45 minute lecture. Therefore, an entire course (10 to 12 lectures) can be distributed on a single DVD.

## V. STUDENT’S VIEW – EXPERIENCING A LECTURE

To playback lectures created with Pyramidia, i.e. to open .lec files, students need the Player application (fig. 7). After opening a lecture, which can be located locally on disk (after downloading from the Internet), on DVD or any other digital storage media, the lecture videos, Slide Info and Lecture Info are loaded and ready to use.

With the Player application, students are given many options and can adjust the course of lecture to their own preferences. In addition to the usual functions found on media players, i.e. play, pause, stop, forward, back and volume control, students can swap the primary and secondary video windows at any time. More options include setting the visibility of context sensitive questions, solving quizzes and filtering the Lecture Info by specific categories. Students can also add bookmarks to remember specific locations in a lecture as well as continuing the playback of the lecture at another time.

The windows arrangement is adjustable, i.e. all windows can be moved around, and both primary and secondary windows can be resized. A screenshot of a lecture playback is shown in fig. 8.

## VI. CONCLUSIONS

While it is necessary to continue experimenting with new types of educational content [18] preserving good lectures and integrating them with other content is important thing to do. Pyramidia has been designed with that task in mind.

The project is a result of almost a decade of exploration of usage of ICT in education at the Laboratory for Systems and Signals at the Department for Electronic Systems and Information Processing at the Faculty of Electrical Engineering and Computing of Zagreb University.



Fig. 7. The Pyramidia Player application



Fig. 8. A screenshot of lecture playback: Pyramidia Player (lower left), primary video (upper left), secondary video (lower), Lecture Info (upper right) and Slide Info (lower right)

None of the tools used to video record lectures were integrating the range of materials needed, allowing free browsing through recorded material nor was their use simple enough to be used in classroom without disrupting educational process. Therefore development of a dedicated tool has been undertaken.

The whole Pyramidia software package has undergone an extensive testing phase and is already being used to record lectures of several courses at the Faculty of Electrical Engineering and Computing of Zagreb University. The experience in using this educational tool will be used as feedback to help continue improving the software as well as adding new features.

Pyramidia has been designed to be used for any type of lecturing, being it at high, middle or primary school level, in life long learning programs or public presentations. It has been specifically designed with ease of use in mind, relieving the lecturer and author of the lecture of technical activities and requiring just basic skills in using a PC. It has also been designed not to require any specific components so it can be used on any modern PC including notebooks.

It is hoped that Pyramidia would find its user base in broad audience. However, it is recognized that the extent to which it will succeed does not depend solely on the quality and ease of use of the Pyramidia but on many other social factors as well.

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