Eye Learn - An interactive WEB based e-Learning Environment in Photogrammetry and Remote Sensing

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ABSTRACT:

This paper presents the e-Learning project Eye Learn. The main aim of this project is to integrate in the Bachelor courses Fundamentals of Photogrammetry (FoP) und Remote Sensing (RS) given by the Photogrammetry and Remote Sensing (PRS) Group, a WEB-based interactive e-Learning environment. These courses are compulsory and introductory, forming the base for many more courses at the Master level. The e-Learning framework and tools that will be developed based on the content of each course will allow the lecturers to communicate information in a more engaging and effective way to the students. Rich media and efficient didactic methods will be employed. Interactive processes, dynamic objects and virtual experiments will stimulate understanding through a number of learning objects. The learning objects will include in addition to text, images, videos, WEB-links with an associated Assistant, interactive quizzes, simple on-line programs and possibility to use own data, acronyms and glossaries of used terminology, cross-links between the different learning objects, related literature and case studies. Emphasis will be given to the understanding of theory through own problem-solving oriented work. Evaluation and self-evaluation procedures will allow better control of what is learnt and how well and will allow a refinement of the e-Learning environment. This project will be exploited as a base for using similar techniques in the other courses of our Group and to introduce e-Learning technologies to all teaching personnel.

1. INTRODUCTION

The Photogrammetry and Remote Sensing (PRS) Group of the Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology has currently initiated the integration of a WEB-based e-learning environment in the two Bachelor courses, Fundamentals of Photogrammetry (FoP) and Remote Sensing (RS). The focus in this paper is to present the aims and concept of the e-learning framework, the target audience, the methods and tools that will be utilized and their adaptation to the current structure of these courses, the didactic scenaria and interactive media utilised, and the evaluation methods. The term Eye Learn has been adopted as the name of the e-learning environment, where the word Eye is used to point out the extensive use of visual media and methods and the strong relation of both courses to images and vision.

In the sciences of Photogrammetry and Remote Sensing a number of tutorials, on-line courses and exercises exist but in most of the cases are not transparent and have poor structure, are very static (including usually only text and images) or targeted for high-level students or have a very broad content. An example is the WEB tutorial of NASA on remote sensing (http://rst.gsfc.nasa.gov/Front/overview.html) which includes a large amount of information but without exploiting the use of interactive tools and without being transparent. The last period some academic institutes have started to integrate e-Learning tools in teaching and learning in Photogrammetry and Remote Sensing courses. Some of these developments are listed below with some remarks on their weaknesses and strengths.

The on-line course for Photogrammetry, Remote Sensing and Digital image processing from TU Berlin (http://www.fpk.tu-berlin.de/wbt/fernerkundung/) is transparent, but covers a small part of the course contents and has limited interactivity (quizzes). Tokai University, Japan has developed a Remote Sensing tutorial which includes a set of interactive experiments, for which the correct answers are found by a trial and error approach (http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/RS-fun). Intermap Technologies Corporation, Canada, has presented recently a professional tutorial on interferometric SAR, which apart from images and script includes also a narrator. Promising on-line courses have been developed from the University of Hannover (Haig et al. 2004, http://ipi.uni-hannover.de/elan) and the University of Vechta (http://www.fzg.uni-vechta.de/airlaser/) and include apart from the course material also a set of interactive exercises, in an informative and transparent way. However, the exercises are restricted only to interactive quizzes. There are several other related developments (notably at the University of Stuttgart and several N. American universities), which can not be mentioned here due to lack of space. Some work refers to nationwide teaching and learning activities, e.g. the project GITTA in Switzerland (Bleisch and Nebiker, 2004). In other cases, e-Learning material has been developed by professional organizations, e.g. the courses of EuroSDR on Digital Cameras and Data Fusion, Co-ordinate Reference Systems, etc (EuroSDR, 2005).

In this project, we built upon and exploit already performed work on e-Learning, especially in similar courses but we intend to expand on used didactic forms and teaching material in the various aspects (see section 3). Most of existing e-Learning material is developed to cover specific course requirements at an institution, thus they are not directly transferable to course of other institutions, which have a different structure.

2. AIMS OF EYE LEARN

2.1 Current situation and motivation

FoP and RS are included in the curriculum of Bachelor studies in Geomatics Engineering and Planning and are both introductory courses in the sciences of Photogrammetry and Remote Sensing respectively. Within these courses, the basic theoretical

principles are taught and the core knowledge in the respective scientific field is acquired, which serves as a basis for several courses of master studies in the fields of Photogrammetry, Remote Sensing and GIS. FoP and RS are related and have a certain overlap regarding the taught data processing methods and algorithms. Both courses deal heavily with image processing, analysis and mensuration, thus are strongly visually oriented and well suited for multimedia teaching approaches. They include sometimes complicated processes that are difficult to understand, if not practically working with them. The course material, especially in Remote Sensing is too much, thus often it can not be covered fully, while time restrictions do not allow exercises and labs to a sufficient extent. Furthermore, the course contents are subject to frequent changes due to rapid technological changes (e.g. new satellites and sensors). The students taking the courses have often different background (e.g. RS is taken by environmental engineers or students of other departments who have not taken first the FoP course). Although teaching material is made available on the WEB and first steps towards e-Learning have been explored, the current scheme of the learning methodology follows mostly the traditional lecturing approach, with its known deficiencies.

FoP consists of a theoretical part and a set of exercises. Based on the theory that is taught in the classroom the students have to use the acquired knowledge to perform some exercises in the lab. Most of the exercises are place-dependent, namely performed only in the lab, and for a number of them the students have to use complex commercial software. As a result, it is difficult to repeat the exercises outside the lab at the own pace and improve understanding based on the student's individual learning style. Furthermore, since the number of available software licenses and workstations is limited and the students have multiple obligations, the labs have to be performed at specific time slots, with multiple students working per workstation, some of which watch passively, while a colleague works.

RS is divided in thematic modules, a number of which is taught by different specialists. While students profit from the information provided by the different specialists, the drawback is that the students need to adapt themselves to different teaching and script styles. Exercises using data and programs have not been yet integrated in the course program, due to the following difficulties: (a) the students would have to use existing commercial packages for remote sensing applications to perform simple tasks. However, these software packages include hundreds of functions, are relative complex and require investment of significant time to learn them; (b) the number of hours of this course is too low and time spent outside lectures is not allowed to exceed half of the total number of teaching hours.

2.2 Aims

The main aim of this project is to improve the teaching and learning methods in these fundamental courses by developing an interactive WEB-based, place- and time-independent, e-Learning environment. A secondary aim is to exploit the work of this project as a base for using similar techniques in the other courses of the PRS Group and to introduce e-Learning technologies to all teaching personnel, so that e-Learning becomes a permanent part of teaching and learning, leading to an increase of the learning amount and learning rate at lower costs.

Regarding the main aim, our work will have the following characteristics:

a) Improved structure of the teaching material and division in thematic modules, easier update of it, and more homogenization for RS.
b) Avoidance of overlaps and double development effort between FoP and RS, by developing one thematic module and using it in both courses where necessary.
c) Enrichment of the teaching material with additional information, e.g. glossaries[1], list of acronyms[2], data sources and project cases.
d) Cross-linking of various information sources (e.g. between thematic modules, literature links etc.) and enabling of rollback (retrieval and refresh of material previously learned) and parallel learning (simultaneous learning of multiple information, as opposed to sequential learning).
e) Selection of important WEB links (e.g. tutorials, data etc.) and establishment of a WEB-Link Assistant. This tool will provide critical metadata information on the content and quality of the WEB links and their relation to the courses, speeding up considerably the selection of suitable information for a certain purpose.
f) Possibility for the students to use the material anytime, anywhere via Internet or CD.
g) Increased interactivity and use of dynamic objects (implemented using Macromedia Flash and Java) with visual or numerical feedback, so that students can work independently, try different scenaria (e.g. variable processing parameters) in labs and quizzes, understand better processes etc.
h) Increased use of media, especially images, videos and graphics.
i) More capabilities for doing practical work and learning-by-doing by providing simple easy-to-use programs and test data, possibility to do practical work alone (and learn more) and repeat it if needed, thus increasing the knowledge acquired but also the student motivation and making clearer the practical relevance of the learned methods.
j) The above aim will be supported also by setting up an ensemble of interesting case studies and projects (there, also project work of our group and research results will be embedded).
k) Choice freedom, which increases motivation and interest, in using the images and the application of interest to each student, although the problem to solve is common (e.g. when teaching students how to generate a 3D model from two stereo images, a student interested in architecture may use her own camera to image a nice architectural object, while another student may use other images).
l) Procedures for better control and self-control regarding what has been learnt and how well, providing mechanisms for self-evaluation. Latter will be achieved among others by a feedback, including explanations on frequently made errors, which we will initially set up based on experience and will refine as years go by, and proposals for alternative correct solutions.
m) Higher flexibility for the students on how much to learn, e.g. for students with gaps in prerequisite knowledge some introductory modules can be set up, while for students with higher interest and ambitions higher-level optional modules can be offered.

[1] Since there are some multilingual dictionaries in Photogrammetry and Remote Sensing we will try to make use of them, for providing the terms (and maybe also their explanation) in English, German, French and Italian.
[2] This is very important for Remote Sensing where hundreds of confusing acronyms are used.

n) Higher flexibility for the students on when to learn (enabling of asynchronous learning) and how, and revisiting capability of the learning material (recall of information).
o) Support of the students to show more initiative, be more self-confident and curious (exploratory learning), and closer to the conditions they will face in their professional life.

The approach we will follow is realistic and will use mainly existing technologies and software packages. The advantages of each of the above aspects for the students will be carefully monitored through evaluation procedures and necessary amendments will be made.

2.3 Target audience

The main target group will be students taking the FoP and RS courses. They are compulsary and are taught in the 4th and 6th semester with 4h and 2h per week respectively. The students do not include only ones that follow the Bachelor in Geomatics Engineering and Planning (their expected number is more than 30) but also other students who take these courses as elective ones, e.g. environmental engineers but also from other departments, including Master and Ph.D. students. Thus, the pre-existing knowledge of the students vary and also their interests. Although both courses are introductory, they partly rely on pre-existing knowledge and additionally since FoP comes first, RS partly relies on it. Regarding Master students, since at the Master level we expect to have students with different background and also outside ETHZ, this work for the two basic Bachelor courses, could be used by them to cover quickly knowledge gaps and thus better and faster follow the more advanced Master courses of Photogrammetry and Remote Sensing. This material can be further distributed to other institutions, especially in developing countries, within the framework of ISPRS, where our Group is very active on education, training, capacity building, international cooperation and technology transfer.

3. DETAILED DESCRIPTION OF THE PROJECT

3.1 Didactic scenaria

Although lectures, even in their classical frontal teaching form will not be totally replaced, the Eye Learn environment will enable learning processes mainly outside the classroom.
Our didactic concepts include:

- Extensive use of rich media able to convey easier and/or faster information.
- Increase of the motivation, personal activity, interaction and responsibility of the students.
- Adaptation to the different backgrounds, interests and learning styles of the students.
- Better understanding of theory through closer linkage to applications and projects, and extensive use of learning-by-doing and problem-solving oriented methods.
- Better integration of research (including our own) into teaching.
- Provision of tools for self-evaluation, search for correct answers and development of a critical attitude.

The WEB environment can be used by the students before and after the lecture and for exam preparation. The advantages for the course lecturers are that they can better communicate the course information, control the performance of the students and improve the course quality. We believe that such an e-Learning environment will be also a motivation for the lecturers to increase their engagement in their courses.

3.2 Use of media

Currently, mostly Powerpoint presentations and material on the WEB (incl. the existing dedicated WEB page of each course) are used to communicate the material of the lesson. The new media elements to be used include:

- Extensive use of images, videos and graphics which are essential for both courses. These will be used in all learning approaches (teaching, exercises and quizzes, case studies and project examples etc.). These media will be made available on the WEB but partly they will be also acquired by the students themselves, e.g. taking images with their cameras. Videos will be used for showing dynamic processes (e.g. different techniques of image acquisition) and visualisation of geodata and results, e.g. fly-throughs over 3D terrain models, walk-throughs in 3D city models etc., simulation and animation.
- The presentations will be enhanced with the integration of dynamic objects and interactive examples, which will be used on-line especially by the students themselves (e.g. in quizzes) but also by the lecturers for teaching and demonstration purposes. E.g. a student can change the flying height of satellite and see in real-time the effect of this change on the area imaged, the image scale and resolution etc.
- We will further explore the possibility to use existing technologies (e.g. similar to the MS Messenger) to use audio and video for communication between lecturers and students, in addition to the classical email.
- CDs and DVDs will be used to enable (a) access of material when the students have no Internet access and (b) for distribution and use on the own computer of programs and datasets that would be too slow to run via Internet. This material can be further distributed to other institutions, especially in developing countries, with poor or non-existent Internet access.

3.3 New elements of the project

Eye Learn (see also Figure 1) builts upon and exploits already performed work on e-Learning, especially in similar courses but also includes new aspects regarding used didactic forms and teaching:

- Development of simple, easy-to-use, stand-alone programs with associated instructions.
- Development of a WEB Links Assistant which will ease making efficient use of the plethora of the existing WEB material.
- Extensive use of dynamic interactive objects.
- Freedom in selecting (or even collecting) own data (images) to be used for a given exercise and lab.
- Support of self-evaluation, not just by a right/wrong answer or providing the correct answer but also by developing a list of frequently made errors and guiding the students to explore alternative solutions.

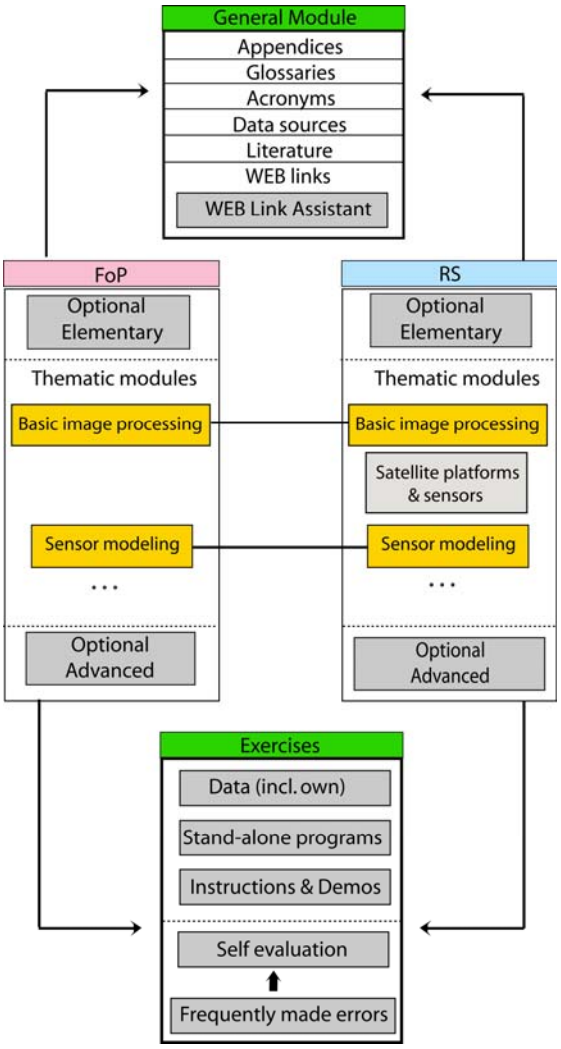

Figure 1. Structure of the e-Learning environment. The general module is used by both FoP and RS. Both courses included optional elementary and advanced modules and the exercises are built upon the same concept.

3.4 Expected life of the e-learning material

The used methods and technologies will be selected such that:

(a) They are as much as possible long lasting, using common, standard IT tools and being supported by many WEB browsers (and their versions) and operating systems ;
(b) They allow integration of new teaching and learning modes and media and easy change of the scientific content, by using a modular software concept with a decoupling of the software material from the course content.

Regarding data (images, video, graphics etc.), we will use formats that are stable and de facto standards. Furthermore, the contents and the technologies of the teaching environment will be related to content management systems, thus enabling easier change of the used technologies. Content management systems, like OpenCMS (2005) and Silva (2005) , facilitate the easy and cost efficient management and update of the structure and content (text, images, videos, etc.) using pre-defined templates. Although clearly we have no control over rapidly changing technologies, we expect the e-Learning environment to be usable for several years without major modifications.

3.5 Evaluation methods

The evaluation procedures and the data to be collected will be decided right at the beginning of the project, so that the necessary data can be collected throughout the duration of the project. The main evaluation is planned after the learning environment is implemented for each course. Questionnaires will be distributed to the students, and will include specific and targeted questions on learning methods and content developed within the project. The questionnaires will be set-up in cooperation with DiZ (didactic center of ETHZ), which will be also invited to contribute, using its own evaluation methods. The questionnaires will be evaluated and the results will be discussed with the students. Furthermore, we will track using standard WEB statistics collecting tools how often each student is using each of the WEB pages and downloads files, as a measure of related interest. An indirect method of evaluation that we will use is the number of students that perform a Bachelor thesis in Photogrammetry and Remote Sensing and continue to take such courses in the master studies.

4. SUMMARY AND CONCLUSIONS

We have presented the project Eye Learn, a WEB-based interactive e-Learning environment for basic courses in Photogrammetry and Remote Sensing. Eye Learn will utilize rich media and efficient didactic methods, while interactive processes, dynamic objects and virtual experiments will stimulate understanding through a number of learning objects. Emphasis will be given to the understanding of theory through own problem-solving oriented work. Evaluation and self-evaluation procedures will allow better control of what is learnt and how well and will allow a refinement of the e-Learning environment.

The developed e-Learning environment will very probably be used by students of the Master in Geomatics Engineering and Planning, but maybe also students of other departments of ETHZ and outside institutions, especially in developing countries, as already mentioned. We will also advertise the courses to related Swiss professional societies, as there is a great need for life-long and continuing education, especially in disciplines of rapid technological changes. The material will also become publicly available. For such users, a registration and log-in via username and password would be required for statistics and security purposes. Through involvement and training of assistants for all courses given by our Group, it is expected that this project will have positive influence on other courses as well and that modern e-Learning methods will become a permanent tool in teaching.

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