Developing a Hybrid Educational Platform based on Virtual World Learning for Teaching Renewable Energy Domain

Ioannis Hatzilygeroudis1, Boris Stoyanov2, Zuzana Palkova3, Foteini Grivokostopoulou1, Konstantinos Kotas1, Isidoros Perikos1, Dorina Popovici4, Sorin Ionitescu4

1University of Patras, Greece (ihatz@ecei.upatras.gr)
2E-Training Solutions, Germany (boris.stoyan@gmail.com)
3Slovak University of Agriculture in Nitra, Slovakia (Zuzana.Palkova@uniag.sk)
4University “Politehnica” of Bucharest, Romania (sorin.ionitescu@gmail.com)

Abstract: AVARES Project, which runs under Leonardo Da Vinci Lifelong Learning Program, aims to develop a Virtual Reality environment, create innovative Virtual Reality learning methodologies and integrate them with traditional learning for teaching more efficiently the challenging field of Renewable Energy Sources (RES). RES domain is considered by many tutors to be a hard domain for students to deeply understand via traditional learning methods. The Hybrid Educational Platform to be developed in AVARES combines traditional learning procedures offered to students via Moodle, a very popular Virtual Learning Environment (VLE), with learning procedures delivered to students in a 3D Virtual World. The Virtual World is developed in Open Simulator (OpenSim), an open source platform for creating multi user 3D Virtual Worlds. Moodle VLE focuses on the management of the learning processes, whereas the Virtual World environment offers students the ability to interact and experiment with items and constructs in a similar way they would do in real world. So, students can get a deeper understanding of the functionality of special items such as energy machines, solar collectors, wind turbines etc. In this paper, we present a first design proposal of integrating a VLE and a Virtual Reality 3D world.

Keywords: Virtual Reality in Education, 3D Virtual Learning Environment, Teaching Renewable Energy domain, 3D Visualization, Student 3D learning scenarios

1 Introduction

The AVARES Project, which runs under Leonardo Da Vinci Lifelong Learning Program, was commenced in October 2012 and will be completed in September 2014. The aim of the project is to establish a 3D virtual learning environment and multime-
dia learning materials for vocational education and training in the field of Renewable Energy Sources (RES). More specifically, the project aims to develop a Virtual Reality environment, create innovative Virtual Reality learning methodologies and integrate them with traditional learning for teaching more efficiently the challenging field of RES. RES domain is considered by many tutors to be a hard domain for students to deeply understand. It consists of complex subjects that cannot be elucidated easily to students via traditional learning methods. The Hybrid Educational Platform developed in AVARES project for teaching RES domain will combine traditional learning procedures offered to students via Moodle, a very popular Virtual Learning Environment (VLE), with learning procedures delivered to students in a 3D Virtual World. The Virtual World is developed on Open Simulator (OpenSim), an open source platform for creating multi user 3D Virtual Worlds. Moodle VLE focuses on the management of the learning processes and can help the tutors with the course organization and administration and also the student to get the proper theoretical background on the domain of RES. On the other hand, the Virtual World environment offers a transition from the traditional book/textbook learning approaches to a new way of more interactive and efficient learning. Indeed, virtual reality offers a new, attractive and efficient way of learning where learners can have a feeling of natural presence and also learn through experimenting and interacting scenarios in the virtual world. In the Virtual World students have the ability to interact and experiment with items and constructions in a similar way they could in real world. In this way, students can get a deeper understanding of the functionality of special items such as energy machines, solar collectors, wind turbines etc. The 3D models of such items in the virtual world will present in an interactive way the parts they consist of and how they function.

A student can explore the RES domain through 5 online courses: Solar Energy, Water Energy, Wind Energy, Geothermal Energy and Energy of Biomass. The curriculum of each one of the e-courses combines traditional learning approaches with proper learning scenarios in the virtual 3D world. In this paper, we present a first design proposal for integrating a Virtual Learning Environment (VLE) and a Virtual Reality 3D world (VR).

The rest of the paper is structured as follows: In Section 2, a first design of the VLE structure is presented. In Section 3, the Virtual World, the technical aspects of it and the technologies involved are discusses. Finally, Section 4 concludes the paper.

2 The Virtual Learning Environment

A Virtual Learning Environment (VLE) has been developed based on the Moodle VLE. Moodle platform was selected because of its popularity and wide-use and also because of its open-source nature. Selecting and using Moodle as a VLE has many pros. A main advantage is that Moodle is an open source environment which is developed and supported by an international community which has more than 1,000,000 members. Also, the Moodle LMS environment has been translated to more than 75 languages and has been used with great success in different institutions all over the world. Moreover, it includes a web service layer that opens it to new technologies and also gives Moodle the ability to be integrated with service oriented architectures.
Moodle VLE focuses on the management of the learning processes and can help the tutors with the course organization and administration and also the supervision of the students’ performance. Moreover, it can help students to get the proper theoretical background on the domain of RES. Students can explore and learn about RES domain through 5 courses available in the Moodle VLE environment: Solar Energy, Water Energy, Wind Energy, Geothermal Energy and Energy of Biomass. Also, an introductory course on Green Energy is planned to be offered to the students. In Figure 1, a first proposal of the main menu presenting students the courses available in VLE is illustrated.

![Moodle VLE and the courses offered](image)

**Fig.1.** The Moodle VLE and the courses offered

A short description of the proposed course follows.

**Solar Energy Course:** Introduces students to the basic theoretical concepts regarding solar energy production. The students learn how solar energy can be generated and how radiant light heat from the sun is harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaic, solar thermal electricity, solar architecture and artificial photosynthesis.

**Water Energy Course:** Hydroelectricity is the term referring to electricity generated by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water. The Water Energy course provides students the proper theoretical background of how hydropower generation systems operate and how hydropower energy is produced.
**Wind Energy Course:** During this course the students learn how wind power is generated. More specifically, they learn how the wind is converted into a useful form of energy, and also the way this is made by using, for example, wind turbines to make electrical power, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships.

**Geothermal Energy Course:** Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%).

![Fig. 2. A presentation during the Biomass course in the VLE](image)

**Energy of Biomass Course:** As a renewable energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods, broadly classified into: thermal, chemical, and biochemical methods.

A student can register to the VLE platform and create a personal account. After that, he/she can anytime assess the platform with his/her credentials. In the VLE developed the student can register and participate in any course he/she wants and gain access to the course’s educational content. The course material mainly consists of presentations that the student can download and study on his/her own pace. Learning material also includes textbooks, web-pages, animations and videos. In Figure 2, an proposed example presentation during the course of biomass is illustrated.
During a course the students are requested to fulfill different assignments. The assignments consist of different type of exercises such as fill-in-the-blank exercises, multiple choice exercises and open answer ones. The student after having answered their assignments can submit their answers for grading. Finally, the VLE platform offers various ways of communication between trainers and trainees including: News and Announcements, Discussion Forum, Instant Messaging / Chat, Files Sharing.

As mentioned above the aim of the courses offered by the Moodle VLE is to help the students get the proper theoretical background on course’s concepts. After a student has covered the basic theoretical topics, he/she can access the Virtual World, where he/she can get the proper practical training thought different learning scenarios.

3 The Avares Virtual World

As technology evolves it changes the human society. Over the past decades technology has changed the education domain as well. Indeed, the way that learning procedures are structured and delivered to students has changed completely, shifting from traditional blackboard approaches to more engaging and interactive ones. Recent approaches for more efficient and intensive learning are via digital, 3D Virtual Reality environments. A Virtual World environment offers to the student the ability to interact and experiment with items and constructions in a similar way he/she would do in the real world. Over the last years, more and more universities use virtual worlds to create teaching programs and learning activities that emulate their real equivalents.

There are various Virtual World platforms developed to offer the ability to create Virtual Worlds. A very popular platform is the Open Simulator (OpenSim) platform. It is currently one of the most popular and mature multi-user virtual world platforms and is being used very successfully in many domains and especially in education. The Virtual World developed empowers the students to move around the areas of the virtual word, to talk with other students, to gesture, to manipulate items and constructions in a very natural way. In Figure 3, a part of the proposed Virtual World developed is presented.

The main objective of the Virtual World is to present the learning material for each learning topic stored in the VLE, in corresponding areas inside the world. It offers 3D models of the presented machineries and devices that will help students understand the way they function. Furthermore, it offers more assessment possibilities by tracking the avatar interactions in the Virtual World and also more ways for communication of trainers and trainees.
Inside the virtual world, trainers and trainees can communicate with instant messages. It is possible for teachers to create groups and invite their students to create working groups. OpenSim can also embed suitable communication software, such as the FreeSWITCH server, to allow voice communication. This communication can be in the form of the trainer speaking and being heard by any avatars that are near to him, or in the form of private calls with selected avatars or groups in the world.
3.1 The Virtual World Facilities/Constructions

The Avaras Virtual Word is proposed to consist of:

**The 3D Auditorium:** Trainers giving lectures in the 3D Auditorium will be able to load specific presentations from the VLE or even upload their own slides.

**Sub-Areas dedicated to each course:** For each one of the five main learning topics (Solar, Water, Wind, Geothermal, and Biomass) there will be a designated area inside the world. Each area will host the corresponding training material along with interactive 3D models that will help them comprehend the presented topics.

**Classrooms/ Meeting Rooms:** These rooms can serve both as meeting areas for project partners and as classrooms for small groups of students.

3.2 Connecting the Virtual World with the VLE

The learning material stored in the VLE will be also available in the Virtual World. More specifically by visiting the 3D Library, users will have access to the textbooks and will have the option of opening them in browser windows inside the Virtual World or following external links to the VLE. Specific textbooks and presentations will be visible as posters or boards, at various areas of the Virtual World. For example inside the 3D Virtual Park, adjacent to 3D models representing RES systems, users will be able to read the corresponding learning material from the VLE. Trainers giving lectures in the 3D Auditorium will be able to load specific presentations from the VLE or even upload their own slides.

![A classroom in the Virtual World.](image)

SLOODLE [4] is a Moodle plug-in that has been developed to facilitate the integration of Moodle with Seconlife or Opensim. Using SLOODLE avatars will be able to participate in the exercises stored in the VLE by sitting on corresponding “test chairs”. Their answers will be stored and automatically evaluated by the VLE. A
Scoreboard connected with the VLE can present their assessment in the 3D world. Communication of users inside the virtual world will be stored inside the VLE as well. It will also be possible to use “enrolment booths” in the Virtual World to automatically register and enroll users in the VLE. This will also be necessary to connect a student account in the VLE with the corresponding avatar. OpenSim can embed suitable software such as wifi for offering an avatar account management system. This allows users to create and manage an avatar account for the virtual world. The administrator of the system can also use this tool to remotely manage avatar accounts and groups of avatars, to assign specific roles and grant permissions. It also allows using a number of default avatars (e.g., male, female) for users to select during the avatar creation. This system can finally be used in parallel with the Moodle registration module to allow the automatic creation of the avatar during the registration of the user in the VLE.

4 Conclusion

In this paper, a hybrid educational platform that is being developed to assist in teaching the challenging domain of Renewable Energy Sources is presented. We propose two main components, a traditional Virtual Learning Environment and a 3D Virtual World and the method implemented to combine these two together in an efficient way. Main focus of the paper is to present the underlying technologies we use and the functionalities they offer. The 3D Virtual World can support traditional learning environments by offering new ways of communicating and delivering learning material. The platform is expected to be completed and available by September 2014 and we hope it will provide a useful supporting activity for RES classes.

5 References