Chapter 4
Exploiting 3D Medical Equipment Simulations to Support Biomedical Engineering Academic Courses:
Design Methodology and Implementation in a Small Scale National Project

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ABSTRACT

Biomedical Imaging is a rapidly evolving area, where new versions of advanced medical equipment/new methodologies based on complex physical phenomena are developed. The cost for the effective training of both academic students/company employees in real training environments is high and in many cases impossible. Most of the times, it is not possible to effectively transfer knowledge due to the limitations of these environments, which has a strong effect both on the theoretical understanding and the practical skills of students. On the other hand, the exploitation of 3D simulations enables for better knowledge acquisition by learners, although not efficiently explored yet. Several studies support that this can be achieved by maximizing the interaction with simulations. To this end, interactive 3D Medical Equipment Simulations have been developed, by exploiting open source software and delivering them through the Web and eLearning Environments. The proposed chapter aims to present the need for such Environments, the development tools, challenges, solutions and possible applications.

DOI: 10.4018/978-1-5225-1677-4.ch004

INTRODUCTION

Biomedical Imaging is a rapidly evolving area, where new advanced medical equipment and new methodologies based on complex physical phenomena are continuously being developed. A growing number of academic students or trainees in corporate environments require continuous inservice training. The authors' experience from Greece shows that there is a wide variety of both undergraduate and postgraduate academic programmes in this domain and new programs are being designed. The learners/trainees should understand concepts and acquire skills by interacting with complex phenomena and processes on which the function of medical equipment is based (Shyam et al., 2011); however, this cannot be easily covered using conventional educational means and as a consequence, the exploitation of advanced equipment in clinical practice is not optimal. By achieving this type of interaction with state-of-the-art equipment in a hands-on setting, the gap between the general theoretical concepts and the efficient usage of medical equipment can be bridged. In this way it would be possible to educate a new generation of learners/trainees, who can acquire competences (knowledge, skills and values/beliefs) regarding the latest and innovative technologies and subject matters (Hofer et al., 2013; Holzinger et al., 2009).

Student/trainee access to actual, state-of-the-art systems is often difficult due to practical restrictions. The daily workload of medical staff, safety issues and other complications apply limitations to the learning/training experience. Usually, training is limited to a small number of visits, demonstration without hands-on practice and only, in a few cases, interaction with the external parts of the medical equipment. Furthermore, a most of the latest and innovative medical equipment is only available to a selected number of hospitals, making them inaccessible to most of the learners/trainees. These problems are acknowledged in the international literature and existing studies define the basic reasons that make the design, development, and implementation of Integrated Virtual Labs e-Training Environments a necessity (Bedia et al., 2011). Other studies support the argument that the exploitation of 3D Technologies is flourishing and presents advantages (Boulos et al., 2007), including the use of simulations for other similar areas, such as medicine, nursing, physics, chemistry and others (Wiecha et al., 2011).

Specific studies (Dieckmann, 2009) (Table 1) acknowledge that the need for the design, development and implementation of Integrated Virtual Labs eLearning Environments due to:

1. The high cost of acquiring the most recent and innovative medical equipment along with the cost of the educators, which cannot be omitted, as this area is growing and changing rapidly

Table 1. Needs and objectives

Need	Type of Need	General Objectives
Reduce the high cost of buying equipment for training purposes	Economic	Cost effective eLearning Environment platform using open and widely available tools and services
Reduced need for large space to interact with medical equipment	Spatial	Design, Develop and Implement 3D Simulations of Medical Equipment providing high interaction
Provide multidisciplinary training	Training/Education	Provide Integrated 3D Simulations of Medical Equipment and Phenomena along with training material
Relate Medical Equipment with physical phenomena	Training/Education	Design and implement by combining the Medical Equipment with the corresponding physical phenomena