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PRONET Services for Distance Learning in Mammographic Image Processing

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Abstract. The potential of telematics services is investigated with respect to learning needs of medical physicists and biomedical engineers. Telematics services are integrated into a system, the PRONET, which evolves around multimedia computer based courses and distance tutoring support. In addition, information database access and special interest group support are offered. System architecture is based on a component integration approach. The services are delivered in three modes: LAN, ISDN and Internet. Mammographic image processing is selected as an example content area.

1. Introduction

Due to the rapid evolution in methods and technological innovations in medical imaging and the poor representation of medical image processing in clinical routine [1], the need for medical physicist's and biomedical engineer's training is increasing. The advantages of computer based learning methods have been exploited in stand alone learning systems in medicine [2-4]. The evolution of these systems to distance learning systems with the use of telematics technology constitutes a current methodological trend in learning [5-7].

PRONET involves the development and demonstration of an integrated training and support service for professionals, using innovative technologies, as telematics.

In this paper PRONET services relative to medical physicists and biomedical engineers and to some extend radiologists distance learning need are presented, in the domain of mammographic image processing.

2. Materials and Methods

2.1. User Needs

One of the first phases of PRONET was the collection of user requirements concerning services that will best meet user needs. Figure 1 summarises the medical physics and biomedical engineering user group preferences.

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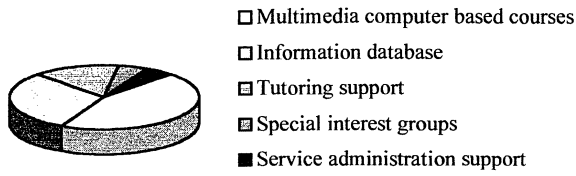

Figure 1: Top ranking of services clearly indicate an increased need for multimedia computer based courses, followed by access to an information database.

2.2. Architecture

To meet the above stated user requirements PRONET provides a series of training sessions. The sessions are implemented using multimedia technologies over the Internet. These sessions are based on interactive multimedia courses and on-line tutoring support through video/audio conferencing, white-board and electronic e-mail facilities. This functionality is based on a four-level architecture presented in figure 2.
The PRONET system architecture is based on an integration and customisation approach of components. These components are developed using commercial products, that are market proven. The main benefits of this design are: (i) reduced development time, (ii) system modularity which allows easy system modification to satisfy future needs and (iii) compliance with existing standards.

2.3. The PRONET Services

The PRONET service is being released on the World Wide Web, using HTML, CGI, Perl and Java facilities, as well as multimedia authoring tools and relational databases for the courseware creation. The user environment consists of a PC, an Internet connection, a Windows environment and a Netscape browser.

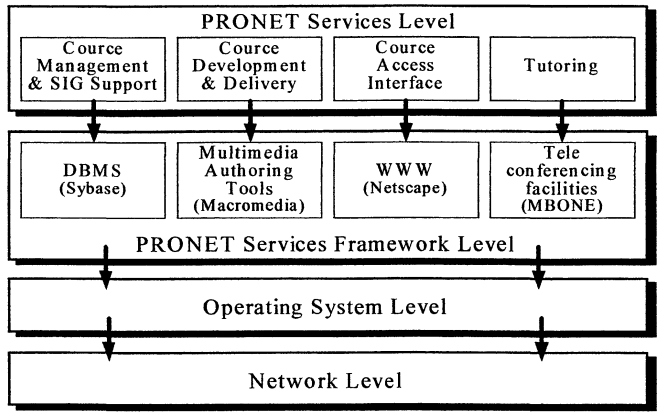

Figure 2: The functionality of the system is presented as a four-level architecture, the PRONET service, the PRONET service framework, the operating system and the network.

PRONET forms a network which is currently composed of three nodes. These nodes are named Access Service Points (ASPs) and contain all the necessary hardware, software and networking infrastructure to support the service. Such a network offers improved effectiveness of information access, since ASP nodes function as 'one stop' information shops for PRONET users.

PRONET services are adapted with respect to the available bandwidth of the end user. The access modes provided are: LAN (high speed access), ISDN (via local ISDN connections) and Internet access.

Users may use personal workstations (appropriately equipped) and basic Internet services in order to access the PRONET service.

2.4. Multimedia Course Structure

Three courses (10 hours in total duration) addressing different medical physics and biomedical engineering subjects are developed. The course structure is hierarchical, composed of units and chapters, schematically presented in figure 3.

2.5. The Database Contents

The PRONET service includes access to an information database supporting medical physics and biomedical engineering scientific/professional needs. This information base provides access to resources such as: scientific/professional organisations, european universities offering courses and programs, european organisations responsible for directives and recommendations, planned conferences and events in Europe and technical reports.

3. Results and Discussion

Mammographic image processing has been selected as it represents a functionality directly supporting image information extraction, which is related to diagnosis.

Content is organised to reflect both theoretical and case-oriented approaches. The theoretical approach consists of image enhancement concept definition and methods description such as wavelet based contrast enhancement, Difference Of Gaussians (DOG) and Gabor filtering [8-10].

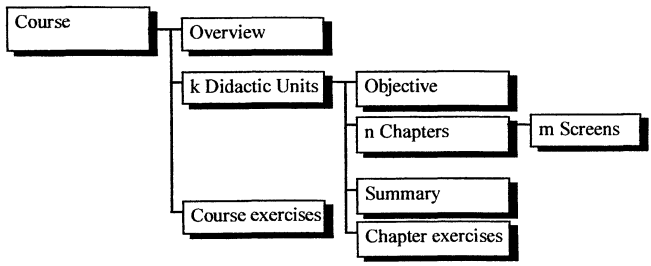

Figure 3: The structure of a multimedia course. The course structure allows the definition of general description templates, that are of generic character and are used for course development.

In describing the methods, emphasis is given to the presentation of the effects of key input parameters to processed images, which is offered as an additional functionality enriching the interactive character of the course.

Clinical images originated from the department of radiology of the university hospital of Patras and digitised (ScanJet II cx/T, HP). Images have been off-line processed using scripts (MATLAB v4.2) or original C++ code. Public domain routines have also been used (Wavelab Toolkit and Wave 2).

As an example two characteristic screens are presented in figures 4 and 5. In the first screen the structure and the key steps of a dyadic wavelet based algorithm is presented. In the second screen, an example of the application of the same algorithm on a mammogram is presented. The case is designed to visually convey the effect of different input parameters of the algorithm on the reconstructed image.

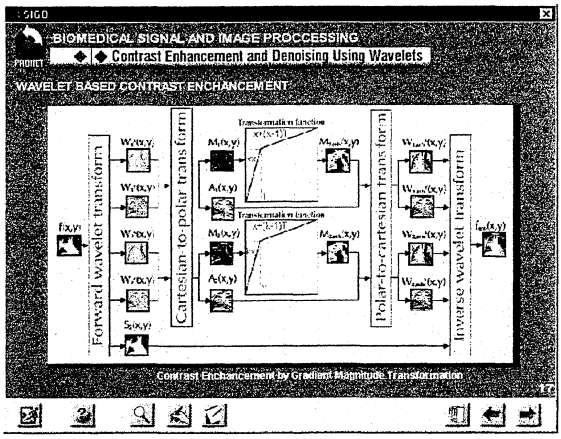

Figure 4: Wavelet based contrast enhancement. The effect of the algorithm is presented by means of an artificial object (phantom). The icons correspond to full scale grey level images at intermediate «key» steps of the algorithm.

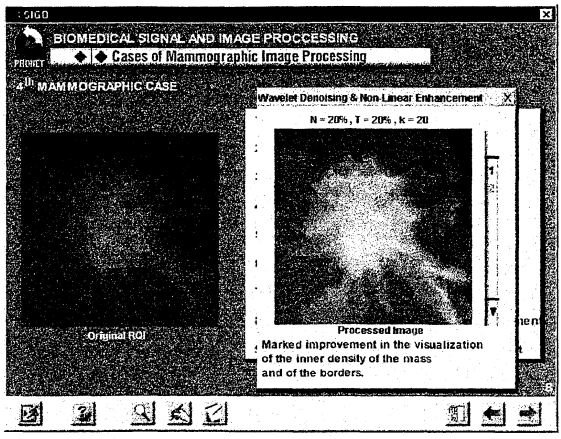

Figure 5: The effect of a selected wavelet enhancement method and its N, k, T parameters on a mammogram. Contrast enhancement is qualitatively assessed by radiologists.

The distance learning scenario of PRONET is based on exploratory learning, offered by the interactive multimedia courses, complemented by distance tutoring services following course attendance. Tutoring support services rely on real or differed time tutor-learner communication, depending on available bandwidth. Thus for LAN or ISDN accessed ASPs, the tutoring scenario relies on video-conferencing, where as for Internet access ASPs wide board technologies and e-mail are used.

Both interactive multimedia courses and tutoring services are accessed through an integrated uniform client environment, currently under development. This environment also incorporates access to the information database and special interest groups.

Finally, the effectiveness of the distance learning services offered, with respect to mammographic image processing, will be evaluated in a designed and planed evaluation phase, following the full scale implementation of PRONET.

Acknowledgement

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