Remote consult in radiotherapy: HEP technologies in health Physics!

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Abstract

NORMA (Network Oriented Radiological and Medical Archive) is an original project to select the best Treatment Planning in radiotherapy. It allows physicians and health physicists, working in different places, to discuss on interesting clinical cases visualizing the same diagnostic images at the same time and highlighting zones of interest (tumors and organs at risk). NORMA has a client/server architecture in order to be platform independent. Applying World Wide Web technologies, it can be easily used by people with no specific informatic knowledge and it provides a verbose help to guide the user through the right steps of execution. The client side is an applet while the server side is a Java application. In order to optimize execution the project also includes a proprietary protocol, lying over TCP/IP suite, that organizes data exchanges and control messages. Diagnostic images are retrieved from a relational database or from a standard DICOM (Digital Images and COmmunications in Medicine) PACS through the DICOM-WWW gateway allowing connection of the usual Web browsers used for the NORMA system to DICOM application using the HTTP protocol. Browser requests are sent to the gateway from the Web server through CGI (Common Gateway Interface). DICOM software translates the requests in DICOM messages and organizes the communication with the remote DICOM Application.

Keywords: Health Physics, Networking, Data Handling

1 Radiotherapy and hadrontherapy

Radiotherapy is one of the used weapons against cancer. The word cancer indicates many different tumours arising in different tissues diagnosed at various stages of development. Tumour cells usually are biologically similar to normal cells and at present the therapeutical approaches are strictly limited by this lack of specificity. In Europe at present 45% of all the patients are ”cured”, which, in this context, means that these patients have a symptom-free survival period exceeding five years. The 90% of the cured patients (i.e. 40% of the total) are cured because of loco-regional control of the primary tumour.

Improving loco-regional treatments is a must equally for at least two reasons. First, 18% of all the patients die because of their primary tumour without metastases. This implies that the percentage of cured patients could pass from 45controlled. Secondly in the long term immunochemotherapy might be extremely useful in cancer treatment. Local control of the primary tumour is so a basic prerequisite condition for cancer cure.

The successes in the loco-regional control of tumours by radiotherapy are due to the steady development of new accelerators and of better controlled treatments. Although in radiotherapy one generally aims at minimising the effect of the dose to normal tissue, that effect is still a limiting factor for the total dose that can be given to the tumour.

The ideal situation in radiotherapy is for a large amount of energy to be deposited in the tumour volume and none outside, in the surrounding healthy tissue. With a beam of charged

hadrons one can increase the probability of curing the tumour because the absorbed dose is more concentrated in the tumour tissues than with electrons and photons. The depth-dose curves of proton beams are completely different from those because these charged particles give the highest dose near the end of their range in the tissues, giving rise to the famous Bragg peak.

Hadrontherapy should allow the increase the percentage of patients cured, destroying with millimetric precision the solid tumours found in the vicinity of critical organs (brain, eye, spinal cord, prostate, etc.) and which cannot be surgically removed, nor irradiated with photons or electrons. On the other hands millimetric precision, instead of centimetric one, requires a more accurate Treatment Planning System and needs a new tool, remote expert consultation, in order to establish the better forbetter oncological treatments suitability.

2 The NORMA Project

The NORMA Project is one of the programmes of the TERA Foundation. The TERA Foundation for Oncological Hadrotherapy (TERA stans for TERapia con Adroni) was created in Novara in 1992 in order to develop and to bring to Italy the modern toumor therapy techniques based on the use of beams of protons, neutrons and light ions and was from the beginning strongly supported by the Istituto Nazionale di Fisica Nucleare (INFN) for all the connected reasearch.

In order to do a fruitfull teleconsult NORMA has pointed out a patient's classical folder which can be transmitted with RITA (acronymous for Rete Italiana Trattamenti Adroterapici, Italian Network for Hadrontherapy Treatments) [1]. RITA provides an internet/intranet connection in order to link the National Centre of Oncological Hadrontherapy (CNAO) [2] and the centers equipped with compact proton accelerator to the hospitals, University Departments and Research Centers involved in hadron treatments.

The RITA distributed data base allows the exchange of clinical data about patients distributed through the RITA network [3] and a client-server system architectureč̃iteBerlin allows remote medical consultation, and is effective in reducing costs, improving efficiency and decreasing dead times. This is expected to be particularly true for the Hadrontherapy Project, given the novelty of the approach, the rarity of the treated diseases and the inevitable lack of shared experience in its early stages.

The database where data are stored is a standard relational database SQL developed by the Hughes Technologies čiteSQL wiyh the relation-entity achieved in collaboration with medical doctors we are collaborating with.

3 The DICOM Approach

Attempt to standatisation has been tailored to the medical domain resulting in a large number of proprietary image formats and communication methods. DICOM (Digital Imaging and COmmunication in Medicine) [6] represents the standard *de facto* for the transfer of medical images. Network access to DICOM applications like PACS (Picture Archiving and Communication System) or clinical modalities is often possible through proprietary software packages, developed for specific platforms.

We have designed a suitable tool to Consult DICOM PACS archives studies, series and images) and to display images through a DICOM Client developed for a distributed open system based on the client-server Web architecture using the HTTP protocol. Data are presented in hypertext format and clinical images may be displayed on the client computer directly by the Web browser.

The DICOM-WWW gateway interface is the core of the system implementing the main

services of the DICOM Standard 3.0 for data retrieve. It is installed on the server side of the Web communication. Browser requests are sent to the gateway from the Web server through the CGI (Common Gateway Interface).

The DICOM software translates the requests in DICOM messages and organises the communication with the remote DICOM Application. The results are formatted in hypertext Web pages and sent to the browser. In this way it is possible to navigate through patient and image information using the simple interface of an usual Web browser. Moreover the image viewer allows the visualisation of DICOM images together with related data.

The PACS used to test the DICOM connections is the Central Test Node (CTN) archive server developed by the Radiological Society of North America (RSNA) [7] installed on a Personal Computer with Linux operating system and on a Workstation with Unix operating system. CTN software contains a set of libraries which, implementing different parts of DICOM Standard, are the reference for DICOM implementors. These libraries have been used in our software.

The WWW DICOM Client software is based on the client/server technology developed for the Web and on the WWW-DICOM gateway performed with the CTN libraries and the CGI library developed by the RITA group. Software code has been written in ANSI C programming language for the core part of the gateway application and in HTML and JavaScript 1.1 to control the browser capabilities.

The application front-end is implemented by dynamic Web pages in HTML format, built on-fly by the backend part of the software, installed on the server machine. The client side of the application uses the JavaScript language, embedded inside the dynamic pages, to perform useful operations in order to reduce the data exchange through the network and control data visualisation and entry.

4 The WWW-DICOM Gateway

The software structure of the WWW-DICOM gateway is organised in four modules: the CGI Parser, the DICOM module, the HTML formatter and the Image processor.

The *Parser of CGI Requests Module* reads data using CGI library functions and divides the command part from data and calls the DICOM module.

The *DICOM Module* is the central part of the gateway performing all the needed operations for data exchange in DICOM Standard. The code is written using the library functions of the CTN software distribution. Command and data received from the CGI request parser are encoded in DICOM messages: after the negotiation of the association with the *Remote Application Entity* this software module creates an instance of the *SOP Class*[1] required and sends the DICOM queries to the remote Application. The control of every network transaction is performed until the response is received and the association is closed by the Application Entities involved in the communication.

Once the response from the remote Application Entity has been received, data are sent to the *HTML Formatting Module* which builds the dynamic HTML files and the JavaScript code for the client's browser.

The *Image Processing Module* is the core part of the DICOM image viewer. It receives the byte stream of DICOM images from the DICOM module and performs two different types of elaboration: byte manipulation related to DICOM encoding and interpretation, conversion of the elaborated image in JPEG format for the visualisation on a Web browser.

[1]The *Service Object Pair* (SOP) class is the DICOM Object Oriented Class containing the description of informations being exchanged and of operations being performed.

5 Conclusion

The work presented, using well known technologies in the HEP community, is an inovative tool to be used in a distributed network. It helps physicians to access and handle clinical images which are becoming more and more important in a modern radiotherapy department.

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