A MEDICAL INFORMATION SYSTEM BASED ON ORACLE TECHNOLOGIES

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Abstract: The paper presents an information system based on Oracle technologies (Oracle Database, Oracle *inter*Media and Oracle JDeveloper) dedicated for managing and querying medical multimedia databases. The database contains images related to the internal medicine area. This on-line application allows creation of complex medical files of patients that can be viewed and updated both by internist and general practitioner. The main functions of the application are: managing patients contact information, examinations, imagery and content-based visual query using color, texture and shape characteristics. It can be used in individual offices, laboratories or in the hospital clinics and departments. The application provides security and confidentiality for patient's data.

1 INTRODUCTION

The information systems that are used in many areas (financial, government, education, medical, etc) are dealing nowadays with an increased demand for managing efficiently not only the traditional information, but also the multimedia content. The management of multimedia data has a series of unique aspects because multimedia objects are large, relatively unstructured and in a variety of formats. The indexing of the multimedia content is necessary in order to have an efficient search.

One of the areas where both alphanumerical information and multimedia data (images, video) is necessary is the medical domain. For establishing the diagnosis and treating the patients, the specialist completes medical records with treatment, analyses and other investigations, most of them of imagistic nature. A big part of the medical devices uses the DICOM standard, the result being a file with a standard structure including alphanumeric information, images or video data.

One of the database systems that provide extended capabilities for managing multimedia content is Oracle Database with Oracle *inter*Media.

This system was chosen to implement the medical information software that is presented in this paper.

Oracle *inter*Media is part of the Oracle Database 11g, being thus possible the managing of multimedia content (image, audio, video) in an integrated fashion with the traditional information. Oracle *inter*Media component extends to the multimedia content the possibility offered by Oracle Database to manage data in an efficient, secure and precise way (Oracle 2007, Chigrik, 2007).

The paper presents a medical information system based on Oracle that has as main scope to manage both traditional information and images. It is also studied the speed and quality of the content-based visual query process that is done using Oracle *inter*Media. This type of query needs to select an image representing the query image and to find all the similar images in the database taking into account the color, texture and shape characteristics (Del Bimbo, 2001, Faloutsos, 2005, Khoshafian, 1996, Smith, 1997). The tests were effectuated on a database with 540 medical images from the digestive tract representing patients having the next diagnoses: ulcer, colitis, polyps, ulcerous tumor and esophagitis.

2 THE INFORMATION SYSTEM DESCRIPTION

2.1 Necessity

Internal medicine can be considered as basics for many specialties and needs large amounts of paraclinical explorations performed by different devices that generates visual and numerical data (radiology, echography, endoscopies, tomography, electrocardiogram, MRI, histological cups etc.) used for diagnosis and for follow-up of treatment or evolution. Numerical information is given by functional and biological assays while various imagistic devices provide image data. That is why internal medicine departments usually accumulates huge quantities of medical data, including thousands of image files, millions of numerical values and thousands of written reports. As a result, a complex application to manage and query a database containing information and images from medical domain is needed.

Oracle has been chosen because of the qualities and the functions that it provides. The application was developed under Oracle Jdeveloper. It provides a completely integrated Java environment for development, implementation and execution of the multilevel Internet applications. JDeveloper gives the possibility to build applications integrated with the Oracle Databases servers. The Java applications can be executed on all the 3 levels of the Internet Computing architecture: client, application server and databases server (Oracle Application Development Framework, 2006).

2.2 The Database Structure

Applying the normalization process (Elmasri, 1994), the database proposed for this on-line application will be described further on. The database contains a number of tables created when installing the application. The tables contain a series of codes that makes easier the work of updating patient information and the investigations. These tables are: medical units, users groups and users.

The data confidentiality is ensured by user name and password that are provided separately for each unit. In order to increase the data security, the password is encrypted. Each doctor has access to information regarding his own patients, but he can share some data that can be seen by other specialists. He can also access both statistical and scientific data regarding all patients in database but in this case the identification data about patients is hidden and the ID number, name and address are blinded. At information management level, anonimizing all information concerning clinical data ensures confidentiality; diagnosis, paraclinical information, treatments are also blinded and only statistical data can be viewed. On the other hand, the office secretary can see personal information about patients and referring doctors, but no diagnosis and treatment elements are accessible. Other tables are:

- Diagnosis table.
- Analyses table codifies paraclinical and biological data.
- Clinical examination table.
- Patient groups table.

The following tables are the most important in the database because they store information about patients, examinations, investigations and results:

- Patients table is used for storing information about patient's visits: personal ID number, name, doctor, county, city, address, phone/fax number, email and program – if any.
- A patient might have several examinations, for each of them storing in the Consulting Table, the diagnosis, date and treatment. Each examination might contain one or several clinical examinations (it is stored code, description, a series of analyses identified by code and obtained value).
- Images table stores information about still images that were obtained from a patient during his whole disease history.

This table has two special fields in order to store the images and to realize the content based visual query: image, having ORDSYS.ORDIMAGE type and image_sign, having the ORDSYS. ORDIMAGESIGNATURE type. *Inter*Media uses objects to describe multimedia databases: ORDAudio for audio data; ORDImage static images; ORDVideo for video sequences and ORDDoc for heterogeneous data (Oracle, 2007). At the insertion in the database of the multimedia data using *inter*Media, the metadata for still images is automatically extracted (Oracle, 2007).

2.3 The Main Functions

2.3.1 Patient's Information Management

This function is one of the main functions in the application, and the information about patients has the following organization:

a) Contact information

This option refers to the information for patient identification: personal ID number, name, address, phone, fax, email, category and National License Number of the examining doctor.

b) Examinations

The management of this information is implemented in a window that contains several secondary windows. The first secondary window contains a record for each patient examination with the following information: examination date, diagnosis and results of the visit (solved/unsolved). This window is associated with four secondary ones, having the following functions:
1. Collecting data from clinical examination.
2. Collecting numerical data from laboratories.
3. Storing, as descriptive text, the results of various investigations.
4. Storing treatment recommendations and prescriptions resulting from diagnosis.

c) Imagery

This option gives access to all the functions of the application concerning the imagistic data for a specific patient and provided by different devices (echograph, endoscope, MRI, CT, etc). For storing in the database, these images can be loaded from saved files or can be imported directly from medical devices using a real time acquisition system. Viewing an image stored in the database implies not only displaying the image, but also viewing the metadata attached to it. Oracle Multimedia provides a set of server-based manipulation functions: scaling and cropping, arbitrary rotation, flip, mirror, gamma correction, contrast enhancement, re-quantization and alpha channel (Oracle, 2007). A part of these processing functions used for enhancing the image, were also implemented in this system.

2.3.2 Content-Based Image Query

The directions of the medical field where content-based visual queries methods can be used are well known (Müller et al, 2005, Lehmann et al, 2006). As a result, we implemented in the application content-based visual query methods using color and texture characteristics. Generally speaking, there are two methods to find images:
- Using information that was manually introduced in tables
- Using the images characteristics that are automatically extracted

*Inter*Media gives the possibility to combine these 2 possibilities: there are used text type data to describe the semantic of the image, and ORDImageSignature data type for content-based queries that uses main attributes of the image.

The search criteria used by *Inter*Media are color, texture and shape. Coordinates represent the locations of these visual attributes inside the image. These coordinates are not used independently to recognize shapes, but along with one of these three visual attributes. Once the image is inserted in the database, it is analysed and stored as a characteristics vector representing a compact representation of the content. This vector is called the image signature. The OrdImageSignature type has methods for image comparison. The image signature is extracted by segmenting the image based on the color spots that compose the image.

In the content-based visual query process each image from the database is compared with a query image that can be another image from database, or an external image.

In the retrieval process it is assigned a weight to each visual attribute. The similarity between two images is calculated for each attribute as a distance (score) between images. The score of the whole image is a number between 0 (there is no difference) – 100 (maximum possible difference). It represents the sum of all the scores, taking into consideration the attributes' weights. In the retrieval process it is used a threshold value. If the sum is smaller than the specified threshold value, the images are considered to be similar, otherwise not.

To execute this process, the user must select an image from the database and activate the Compare Signature button. In the new window, the user has the possibility to setup the parameters needed for the retrieval (color, texture, shape and location). In figure 1, the window that implements all the operations described above is presented.
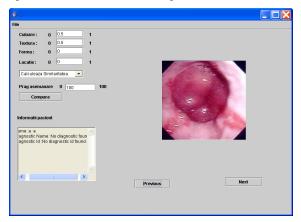

Figure 1: The window for content-based visual query.

3 EXPERIMENTS AND RESULTS

The experiments were performed in the following conditions. It was created a database with 540 color images from the digestive area. The images were taken from patients having the following diagnoses: polyps, ulcer, esophagites, colitis and ulcerous tumor. For each patient there are more images of the same ill area, made from different angles.

In order to execute the query procedure the following steps are necessary:

- a query image is chosen
- the similarity between the query image and every target image from the database is computed
- the images are displayed in ascending order of the computed distance

Table 1: Experimental results.

Query	Nr. of relevant images	Nr. of relevant images retrieved in the first 5
Polyps	208	4
Colitis	88	4
Ulcer	140	4
Ulcerous Tumor	40	3
Esophagitis	64	3

For each query, the relevant images have been established. Each of the relevant images has become in its turn a query image, and the final results for a query are an average of these individual results. These experiments have considered the color and texture attributes of the medical images, each of them having equal weights (0.5). The motivation of this choice is bound by the nature of medical images from digestive area with different diagnosis that generates changes both in color and texture of the ill tissue. In this case the shape parameter is less important. The experimental results are summarized in table 1.

4 CONCLUSIONS AND FUTURE WORK

This paper presents the main functions of an information system based on the newest Oracle technology (Oracle Database, *inter*Media and Jdeveloper). A special attention is provided to study the content-based visual query process using Oracle *inter*Media. There have been presented the experimental results of this process that used a database with 540 medical images from the digestive tract. The queries are based on two attributes: color and texture. The results are satisfactory and motivates next studies in the following directions:

- The experiments will include a database with much more medical images
- There will be tested more combinations for color and texture weights, taking into consideration the doctors recommendations: there are cases where the variations in color represent a sign of a ill tissue and cases where changes in texture are important
- It will be analyzed the quality of the content-based visual query process when there are used images from different parts of the body, not only from digestive area.

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