DATABASE USED IN ULTRASONIC MEDICAL INVESTIGATIONS

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Abstract:

Modern medicine uses new powerful tools based on image processing and database handling for the medical information obtained through ultrasonic investigation analysis.

This paper presents the database conceptual model designed to store echographic images containing tumor structures, as well as other medical information. Tracking the image of the tumor in angiogenesis phenomenon before and after chemotherapy helps the physician establish the diagnosis correctly. Database application is being developed within the ANGIODOP project, contract no. 220, financed by the VIASAN Romanian National Research & Development program. The paper presents the database managing application and its facilities.

Key words:

medical database including images, image searching, echography examination protocol, telemedicine

1. INTRODUCTION

The progress of the information technologies has a spectacular impact on the health care field. In the case of medical imaging, traditional solutions are gradually being replaced by digital imaging techniques.

Medical imaging using ultrasounds is an important diagnosis tool in some of the most significant medical fields, especially because it allows examinations by means of non-invasive techniques.

This paper provides a complex approach as to the design and development of an image database, included into a computer-based system for tumor diagnosis. The medical examination methods used in this system are color and power Doppler echography, which allows the gathering of valuable information on tumor vascularization.

The database contains digital images (still images and video sequences), as well as relevant textual data. This data set includes the appropriate medical information for each patient and examination.

The database is an important tool in identifying patients with tumor structures and therefore it plays a significant part in decreasing the relapse rate, as it facilitates the search, the classification and the comparative display of echographic images and medical information.

Throughout the developing stage of the medical database application, one has to take into account the fact that this database would contain hundreds or thousands of still images, documents, comments, video sequences etc. Managing all this information depends on the structure and data content modeling.

A problem arises from the conflict between the database implementation techniques and the recovery of the information algorithms. Data content modeling is not a problem in the database systems, as the data has a rigid structure. In addition, information searching consists of document's context modeling (through relevant words, indexes, semantic networks etc.). As for the images and the video segments, the searching process originates a few problems.

Performance is another problem. For applications involving databases with simple documents and text, performance constraints are subjective and mainly determined by users. In the case of image databases, there are some physical restrictions to be considered (the disk space necessary for image storing, as well as the time required for the image transfer from the database server to the client application).

2. THE CONCEPTUAL MODEL OF THE DATABASE

Requirements concerning the amount of heterogeneous information to be stored, the problems as to the information archiving and consistence, as well as tele-assistance, tele-diagnosis and tele-education were considered in designing the logical and physical structure of the database.

In order to meet the tele-education and tele-diagnosis requirements, the medical recordings of the patient and the related images must be arranged so that the physician be able to access the database relying on the echography examination history of a certain patient. Furthermore, the medical student has the possibility to access the database relying on anatomical structure characteristics. To this purpose, there has been adopted a methodology concerning the organization of medical information and associated images within the medical information packages, focusing on the patient and sustained by an echographic examination, as well as and an explanatory protocol on the examined anatomical structures.

A frequently used method regarding the database designing, called entity-relation modeling (E-R), has been considered. In the E-R modeling context, an entity is similar to a relational table (including data describing connected activities set).

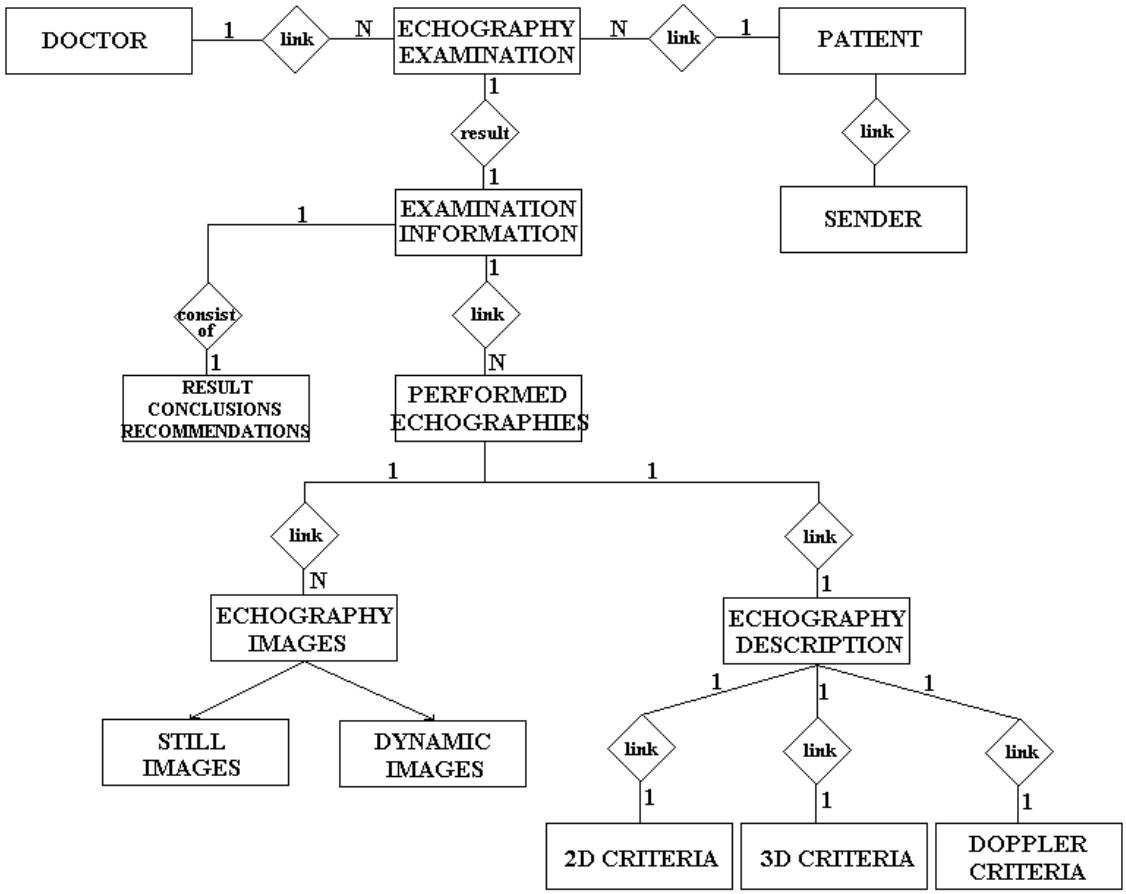

Figure 1 - Entity-relation (ER) diagram of images database

The database is a relational database, implemented in Microsoft SQL Server 2000 and stored on a database SQL Server. The image files are stored separately, on an image file server. Only the information necessary for the identification of the files (file name, archiving place) is stored in the database.

3. DATABASE MANAGEMENT APPLICATION

The application that manages the records is implemented under Microsoft Visual FoxPro environment and provides a user-friendly interface for data control. Thus, the user can easily handle different types of data stored in the database, such as: still images, video sequences and textual information.

The main functions provided by the application are:

- Echographic examinations management

This enables the management of all information concerning a specific echographic examination: patient identifier, examination date, doctor identifier, result, conclusions drawn, recommendations, types of echographies performed, still and video images.

Each echography type (endovaginal, endoabdominal) can be determined by a specific protocol that describes the anatomic structures under examination. There are

four different patterns for each of the following methods of ultrasound investigation: 2D, 2D Doppler, 3D, 3D Doppler, as illustrated in Figure 2.

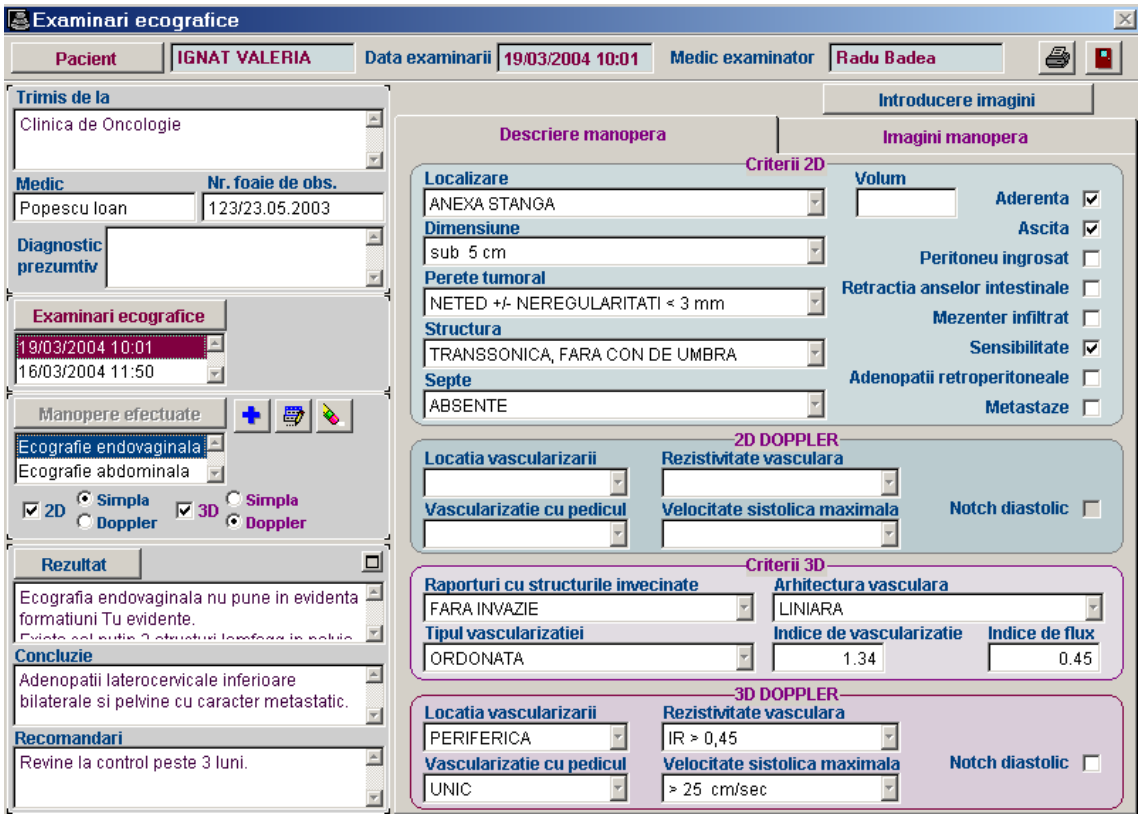

Figure 2 - Echographic examination interface – examination protocol

Each image record consists of the following fields: image type (video sequence or still image), path, image file name, image format, echography type, and ultrasound examination method. Figure 3 shows the image display window.

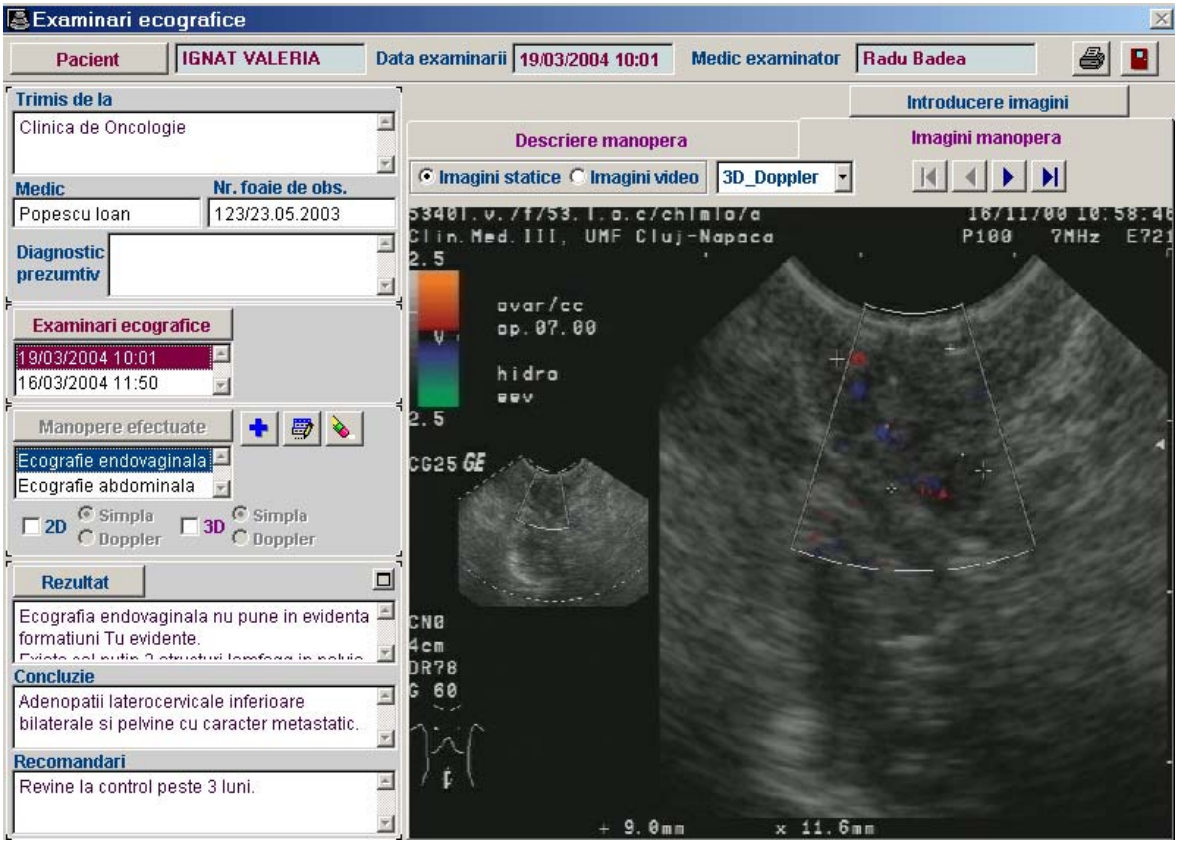

Figure 3 - Echographic examination interface – image display

Moreover, the application automatically creates an echographic report that can be printed after the medical examination.

- Patient and medical personnel management

  Allows the recording and the management of information about:
  - the patient - personal data (name, date of birth, sex, residence), antecedents, record date, medical card number;
  - the doctor: name, clinic, department, specialty, scientific title.
- Possibility of integrating image processing and analysis applications
  - color Doppler image segmentation, for color quantification within a user-defined region of interest and velocity estimation regarding the color scale provided by the echograph;
  - video processing, after the administration of contrast agents, for plotting the mean intensity within a region of interest vs. time – drawing the wash-in wash-out curve;
  - saving new patterns and loading some previously used for region definition, so the different image analysis be more coherent.
- Synthesis creation

  Allows classification and retrieval of images based on description fields of anatomical regions and examination criteria. Facilities provided:
  - image search, based on user-selected criteria;
  - parallel display of images of current and older examinations, for a specific patient;

- processed images display (and other results stored after image processing, such as the wash-in wash-out curve).

By requiring a password at the startup, the application protects the patient data confidentiality.

4. CONCLUSIONS

By meeting the tele-diagnosis and tele-education requirements, the image database could be successfully integrated within a more complex tele-medical system.

Automatic manipulation of textual data and images, obtained after the ultrasonic medical investigations, allows a faster acquisition of medical data, with an important part in the early detection of angio-tumoral structures, as well as in the identification of the factors that may cause these types of affections.

In addition to its main monitoring purpose, the database is an important source of complex medical information, used as a starting point for various statistics and didactic studies.

5. REFERENCES

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