Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird
Annals of DAAAM International

EXPERIMENTAL MEDICAL RESEARCH DATABASE SYSTEM AND ITS EXAMPLES OF USE

POLIVKA, J[iri]; MAULE, P[etr] & KLECKOVA, J[ana]

Abstract: *This article describes our upcoming scientific database medical system together with the two examples of its application. The idea of the experimental system is to process and store the amount of heterogeneous multimedia data objects for particular real neurological case studies with brain vascular diseases specialization and others, which can be used for the future medical research activities. The concept of the multilevel database structure is presented together with some present common data types and standards often used in medical applications (DICOM, DASTA and HL7). The article contains examples of system application in our biomedical research, the brain infarction core evaluation and the liver´s vascular tree extraction .*
Key words: *Medical Database, DICOM, HL7, Infarction Core*

1. INTRODUCTION

In current health care, there are also more often used modern diagnostic instruments and procedures, which help doctors to determine the cause of the patient's difficulties. Diagnostics and treatment of neurological disorders are based on continuous evaluation of the amount of clinical data and their various characteristics. The right interpretation of the huge quantity of medical information is very essential for the treatment of the current patient.

We try to develop new experimental database medical system which should help researchers in the medical domain for their future investigation. The idea of the experimental system is to process and store the amount of heterogeneous multimedia data objects for particular real neurological case studies with brain vascular diseases specialization and also for the other specializations, for example the research of the liver vascular network problems. Our extended medical data warehouse should help researchers to test new hypothesis and make statistics over the stored heterogenous data.

Following parts briefly describe existing types of examination data and storing formats than the concept of the database structure as well as the multilevel database architecture is presented. The last part of the article brings two examples of the application of our system in the particular biomedical and biomechanical research.

2. MEDICAL DATA TYPES AND STANDARDS

The next part of this article describes some of the basic data types and standards which are used nowadays in the medical applications and which can represent the large medical data heterogeneity.

2.1 DICOM, DASTA and HL7 standards

At the present time many standards are existing for the medical data representation. In the visual representation domain, the leading standard is DICOM, which provides the same format for many imaging modalities. The unified structures for others heterogenous medical data representation were formed, frequently making use of the XML. Mostly used XML-based standards are HL7 and especially in the Czech Republic DASTA standard. In our system we will support DICOM standard as well as DASTA standard with future plan for HL7 standard implementation.

2.1.1 DICOM Standard

The Digital Imaging and Communications in Medicine (DICOM) standard begins in 1983 when The American College of Radiology (ACR) and National Electrical Manufacturers Association (NEMA) formed a committee to develop standard unifying digital information interoperability. Majority of producers of diagnostic apparatus already use DICOM standard. Many parts of the medical imaging information interoperability is respected by the DICOM standard. DICOM enables to preserve visual data together with other supporting information about the type of enshrined examinations, comments and so on.

2.2.2 DASTA Standard

The data standard DASTA (DS) was established by the Ministry of Health of the Czech Republic. It is the Czech national standard for the medical data representation and for transferring important data among various medical information systems in the university hospitals as well as in smaller medical facilities.

The DASTA standard enables to represent wide amount of the medical information, such as the patient identification data, urgent information (allergy, diagnosis), health insurance company information, anamnesis, patient medicaments, persistent and acute diagnosis, vaccinations or special data blocks.

2.2.3 HL7 Standard

The HL7 is another international standard for the representation of the clinical and administrative medical data. It was developed by Health Level Seven Inc. organization, which is accredited by ANSI (American National Standards Institute) as a SDO (Standards Developing Organization).

HL7 is the messaging protocol that enable to share and exchange sets of clinical and administrative data among unrelated health care applications and facilities. The HL7 message content is enveloped by the XML protocol, which increases system efficiency. The HL7 is still human-readable because of the text-based messages, although it is usually interpreted by machines and medical software.

The support of the main medical information standards in our experimental database medical system is essential (DICOM, DASTA and in future also HL7).

3. THE DATABASE STRUCTURE

The main purpose of our experimental database system is to provide the robust medical data background for the future experimental activity. This data warehouse will be used for verification of new hypothesis and for the statistics over the stored data. It is necessary to preserve all the relationships among the originally jointed medical data. The concept of storing the real but anonymized clinical cases with all the relationships ensure this information comprehensiveness.

3.1 The levels of stored data and information

The presented database system provides the possibility to store the data and their relationships from the real clinical cases. It is in fact the basic level of information in our experimental system. But the database structure allows definition of the superior information level. The researchers and the other users of our database will have the opportunity to define their own dependences and data structures which can be used in the further experimental work.

The mentioned approach to the database design makes possible to create and store new specific data structures called attributes. Each attribute has defined the relationships to the set of original clinical case data or to the other attributes. The two level system is schematically shown in the Figure 1. Each clinical case can include all medical data types as written above.

If the researchers want to test the new hypothesis and they need some special data for their algorithms, the first step is to create suitable attributes over the original data. Each attribute includes its definition, which provides its unique identification among the others attributes. Then the definition of the attribute value must be selected (mm, g, mm^3 etc.). The last step is to specify the data relationships. It means the set of original data, which are used by the particular attribute. All defined attributes form the higher database level are stored together with the original data.

4. SYSTEM APPLICATION

4.1. Brain infarction core evaluation

The example of the system application can be shown on the evaluation of brain infarction core problem. This study is still under progress and our system will be important part for the method correctness evaluation. The method can be simply described as a statistical analysis of subtraction of angiography and corresponding non-contrast examinations. Result of the method will be new kind of volumetric maps which should provide similar information as a cerebral blood volume (CBV) maps.

The role of our system is an environment which will supply and store all inputs and outputs. The database will store anonymous CT examinations delivered by our partners. Such examinations will be anonymous but it is possible to track all examinations belonging to one patient. Additional information will be stored in Attributes. Attributes will hold information about type of the computed tomography examination like CTA (Computed Tomography Angiography) or NCCT (Non Contrast Computed Tomography). Another attribute can contain date of data acquisition, etc. The brain infarction core evaluation method implementation can find all suitable pairs by simple querying the database system with conditions of one CTA examination, one NCCT examination belonging to the same patient and acquired in the same day. Method will be run on all suitable pairs which will provide number of results which can be further statistically verified.

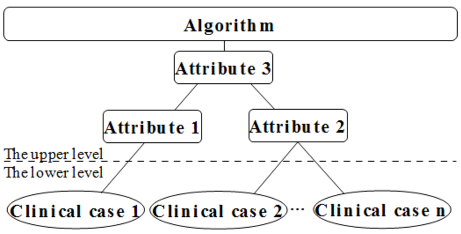

Fig. 1. The approach to the two level architecture

The benefit of the system (not only for this method) is that once implementation of the method is loaded into the system, the system will automatically execute the method with desired input data. As far as the system is filled with new data, the method will be run again and again providing a large number of results with no need of user interaction.

4.2 The liver´s portal vein network extraction

Another use of the system could be presented in connection with our contemporary biomechanical research. We try to extract and store the liver´s vascular tree for each medical subject, which will be used in the further biomechanical model of the liver. The method for the liver´s vascular network semi-automatic segmentation was presented (see references). It uses CT angiography examinations stored in DICOM format for each medical case. These CT examinations are stored in the database system as a several medical cases. The result from the segmentation and vascular extraction method for one medical case represents the geometry of the liver´s portal vein, which can be used in the further mathematical modeling.

The vascular tree is stored as a mesh of rectangles, where each mesh face has its own position in the 3D coordinate system (4 different x, y and z coordinate numbers for the four face vortexes). The generated mesh can be saved as a complex attribute (3D array) in our database system, over each medical case, together with many others important information about the subject. Then the further biomechanics model of the liver and its algorithms will work over this database system and profit from the complex medical information, which can be stored in the database together with their mutual relations.

5. CONCLUSIONS

In our contemporary research we are dealing with the experimental database system for medical application. The main purpose of our work is to provide the robust medical data background for the future research activities. This article briefly described the important data types which are often use in medical applications than the concept of the multilevel database structure was presented with two examples of the system application on the up-to-date biomechanics research work. The way how to preserve the important medical data relationshhips was also mentioned. We will use these findings in our future research work.

6. REFERENCES

Maule P.; Polivka J.; Kleckova J. (2010). *Experimental database medical system, data acquisition backgroung and features.* International Joint Conference on Biomedical Engineering Systems and Technologies. INSTICC Press

Vcelak P.; Polivka J.; Maule P.; Kratochvil P. & Kleckova J. (2009). *Experimental database system for the vascular brain diseases research*. Frontiers in Neuroinformatics. Conference Abstract: 2nd INCF Congress of Neuroinformatics. doi: 10.3389/conf.neuro.11.2009.08.002

Maule P.; Polivka J.; Kleckova J. (2010). V*ascular network SEMI-AUTOMATIC segmentation, USING COMPUTED TOMOGRAPHY ANGIOGRAPHY.* 5th International Conference on Software and Data Technologies. INSTICC Press

*** http://ciselniky.dasta.mzcr.cz - Data Standard MZČR, *Accessed on:* 2010 - 07 - 10

*** http://www.hl7.org, 08.2010 - Health Level, *Accessed on:* 2010 - 07 - 10

*** http://dicom.nema.org, 08.2010 - The DICOM Standard, *Accessed on:* 2010 - 07 - 10