Building a neurological patient multimedia database for information retrieval

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Abstract

This paper will focus on presenting the challenges to retrieve information from medical data such as Digital Imaging stored in a multimedia database. This database will store information about patients and high resolution images scans.

The data was gathered from patients in Neuroradiology Service at UHC "Mother Teresa" in Tirana. This is a national reference center and performs more than 5000 scanned images in year. It would be very useful for the physicians to use the gathered data of different format to retrieve information about each patient or for a specific disease. The characteristics of multimedia database, technologies that can be used and the structure of the multimedia database from the gathered data to retrieve information are presented in this paper.

1. Introduction

Over the years, certain standards have been formulated for medical departments, endowed with modalities using digital technology (Ultrasonography, CT, MR etc.) and peripheral devices like laser printers. Digital Imaging and Communications in Medicine (DICOM), is one such standard, which deals with imaging equipment, printers, picture archival and communication systems (PACS), etc. It also offers assorted functions such as film printing or CD burning, which are distinctly determined by service classes. [Ind,Ver16].

Medical images are usually fused, subject to high inconsistency and composed of different minor structures. So there is a necessity for feature extraction and classification of images for easy and efficient retrieval. Content Based Image Retrieval(CBIR) is an automatic retrieval of images generally based on some particular properties such as color composition, shape and texture. Every day large volumes of different types of medical images such as dental, endoscopy, skull, MRI, ultrasound, radiology are produced in various hospitals as well as in various medical centers. Medical image retrieval has many significant applications especially in medical diagnosis, education and research fields [Ash,Man12].

Technological capabilities in the field of medical imaging contribute to the increasing use of image analysis in the diagnostic medical systems. Medical imaging is derived from a number of tomography studies, primary including radiography, ultrasonography, computed tomography and magnetic resonance imaging. The methods of collecting and storing medical images can be performed using almost any database system. However, the analysis of this type of information is a complex issue and requires advanced information technologies. The appropriate management of medical image and patient information is related to the issues concerning database design and specificity of multimedia data [Byc, Wos11].

Developing a high quality medical multimedia database will give the opportunity to compare medical images, to retrieve similar cases and to see their treatments, diagnosis. The radiology information system (RIS) is considered the core system for the electronic management of imaging departments. The electronic medical record (EMR) is the core informational system for patient management across the health-care system. Within a radiology department, major functions of the RIS can include patient scheduling, resource management, examination performance tracking, examination interpretation, results distribution, and procedure

billing. The widespread adoption of picture archiving and communication systems (PACS) requires additional practice management workflow coordination, including the creation and distribution of images within the imaging department and throughout the imaging enterprise [McE13].

2. Characteristics of Multimedia Database

Multimedia database management system (MMDBMS) is mainly used for the retrieval and storage of the multimedia data content. The development of the multimedia system depends on the process of inserting, indexing, querying and retrieving, etc. In recent years, many researchers have designed the multimedia data model, but these models have some drawbacks [GUO13]. A multimedia database is a collection of related multimedia data. Common multimedia data types that can be found in a multimedia database include the following: Text, Graphics: drawing, sketches, and illustrations, Images: color and black & white pictures, photographs, maps and paintings, Animation sequences: animated images or graphic objects, Video: a sequence of images (frames), Audio: generated from an aural recording device, Composite multimedia: a combination of two or more of the above data types [Yu, Bra11].

Multimedia databases thus should provide (1) content-based access, (2) knowledge discovery methods, (3) scalability to large data volumes, (4) scalability to high dimensionality of features, (5) good runtime performance. Multimedia database management system support facilities for the indexing, storage, retrieval and provides a suitable environment for using and managing multimedia data [Far, Nor, Yuz, Sai12].

There are several differences in the processing of multimedia data compared to traditional data which can be divided into five as follows: [Mar,Sub96]

a) Format of multimedia data.
b) Presentation of the output results.
c) Size of multimedia data.
d) Temporal characteristics of multimedia data.
e) Automatic feature extraction and indexing using advanced tools.

Content based retrieval was first introduced in the early 1980 as a new tool and is the most popular group of optimization technique. CBR uses visual content of an image as features to represent and index image to be searched from large scale image databases. It is the main motivation behind recent research in multimedia databases.

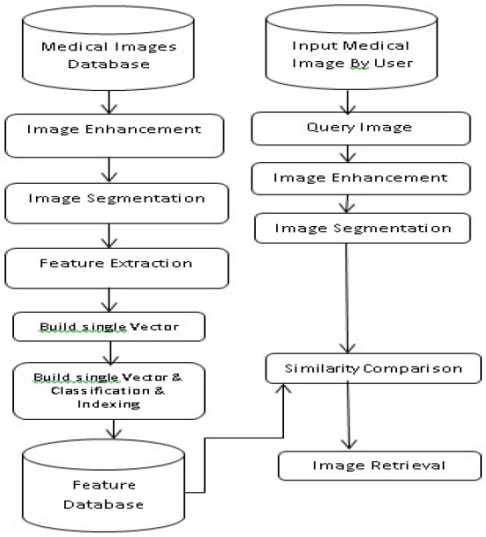

Figure 1: Architecture of CBIR systems in medical [Fat,Bal12]

Semantic based search is defined as a type of searching technique that compares the original multimedia data to a prototypical category. Compared to content based retrieval, semantic based retrieval is categorized as a high level features that implements user's perception. Semantic query uses knowledge about the domain of relations, nature of data, and constraints related to database elements. Element extracted from different modalities of a video, such as visual information, auditory information, and text in the video frames are generated to model the semantic of the video. Keyword based retrieval is considered as a traditional method to retrieve data using textual description (metadata). Metadata is defined as structured information describing characteristics that assist users to identify digital content itself. Metadata is the data or semantic information to classify the

content, quality, condition and other characteristics of the data. [Ras, Haw8]

With the increasing variety and decreasing cost of various types of sensors, there will be an increase in the use of radically different media such as infrared, motion sensor information, text in assorted formats, optical sensor data, telemetric data of various sorts (biological and satellite), transducers data, location data captured by GPS devices, spatial data, graphics and animation data. [Kan,Rui7].

Kehua Guo and Shigeng Zhang developed A Semantic Medical Multimedia Retrieval Approach Using Ontology Information Hiding. Their architecture consists of semantic annotation, ontology representation, semantic multimedia storage, and medical multimedia retrieval steps. [Keh, Shig13]

2.1Query formulation by image content

Representation of images needs to discuss which features are most useful for representing the contents of images and which approaches can effectively code the attributes of the images. Some of the Processes of Image Retrieval will include:

a) The query image and database images are compared to retrieval of very similar images to query image from the database.

b) In radiology feature Extraction, generally used image features for content-based image retrieval were color, shape and texture. If a user wants to perform a query, three parameters have to be specified: 1) the location of the idle is containing the future query image, 2) the system will give the query a number that uniquely identities the group of fragments with the same dimension (the "query index"), 3) the type of the algorithm used in the query, Content Based Image Retrieval (CBIR).

c) Providing a sample of the kind of output is desired and asking the system to retrieve further examples of the same kind. Several alternative query formulation approaches have been proposed: category browsing, simple visual feature query, feature combination query, localized feature query, query by sketch, user-dawned attribute query, object relationship query, concept query [Fat, Bal10], [Ram,Chan11], [Sim, Jom11].

3.Digital Imaging and Communications in Medicine

The Digital Imaging and Communications in Medicine (DICOM) standard was created by the National Electrical Manufacturers Association (NEMA) to aid the distribution and viewing of medical images, such as CT scans and ultrasound. New technologies such as Java should always be used as complements of the de facto standard in medical imagine, DICOM. DICOM allows the interchange of images from different modalities, archives, and workstations from different vendors. java technology can be used to build a storage system and to make this service accessible for different clients. However, this storage service should also incorporate DICOM services to store and access examination data from DICOM workstations and DICOM modalities. DICOM is the universal standard for sharing medical imaging resources between heterogeneous and multi-vendor equipments (acquisition device, workstation, storage server, patient management system, etc.). [Noo,Sam9]

DICOM Service Class is defined as a group of operations that a user wants to perform on data from a modality. Typical examples of Service Classes include Print Management Service Class that deals with printing images on film or paper printer, with flexible film formats, Storage Service Class that implies "sending" images and Query/Retrieve Service Class that deals with issues of "find", "move" and "get". SOP (Service Object Pair) Classes. While "find" is used to query for images, "move" and "get" are used to commence a transfer. Other classes of service include Verification Service Class, Media storage, Study content Notification, Print management, Patient management, Study management, Result management, Modality Performed Procedure Step Management States and Structured reporting [Ind, Ver13].

DICOM enables the integration of scanners, servers, workstations, printers, and network hardware from multiple vendors into a picture archiving and communication system (PACS).

The DICOM standard has a series of advantages: Generally, all medical equipments acquiring medical

images support this standard and communicate among them using it; DICOM can store besides the actual 2D image additional information, such as: the patient's 3D position, physical size of the objects presents in the image, slice thickness, exposure parameters, and others. These are used for a better later processing and interpretation. The DICOM files and messages support more than 2000 standardized attributes that maintain patient's medical data and images. Images are acquired and stored using parameters that are device independent. Likewise, DICOM images can be processed without taking into account the actual device used in the acquisition process.

4.The proposed multimedia database

The database used for storing information about patients will include patient information, physical examination, neurologic facts, scanned images, intervention in patients and histology. This structure of storing information will give the opportunity to group patients according to the disease, diagnosis and treatment. We will use DICOM for managing the medical images information.

Table1: Information about Patients

Basic information	Risk factors
First name	Diabetes
Last name,	High cholesterol
Date of birth	Smoke
Gender	LDL under control
Health insurance number	Allergies from penicillin
Birthplace	
Address	

Family history also plays an important role in determining the diagnoses and the treatment for a certain disease. Also it is important to store in the database the complaints of the patients and the current medication that he is attending so this database will offer the history of a patients and all the medications that he took.

Table 2: Family History and Complaints

Family History	Complaints
asthma	Eye pain
bleeding disorder	sinus pain
cancer	fever
drug addiction	acne
heart disease	diarrhea
hypertension	laceration
mental illness	pain
strokes	hoarseness
alcohol addiction	infection

Another important entity in the database is the physical examination that will include vital signs and the physical examination records by the doctor

Table 3: Physical Examinations

Vital Signs	Physical Examination
height	weight change
weight	anorexia
body temperature	heat or cold
respiratory rate	fever
systolic blood pressure	insomnia
blood glucose	change in vision
heart rate	polyuria
neurologic situation	throat
	vertigo

Another important information for the patient is the neurologic situation. First of all, in the database should be saved information if the patient has headache, seizures, incoordination, significant past history, head injury, tremors, numbness dizziness, weakness or difficulty swallowing. The neurologic

situation will include also the evaluation of the mental status, the evaluation of reflexes etc. The database with offer the opportunity to save the scale in which the patient opens the eyes, the patients give the responses, etc. The most important thing is the diagnosis in which the patient should be identified. All the diagnoses should have a unique code and the description of the diagnosis, so when the doctor will register the patient, should also register the exact diagnosis of the patient. And in the end the database should register the interventions, histology of the patient and the medications of the patient.

5. Conclusion

In this paper are described the steps for construction the medical multimedia database in neurology department in Mother Teresa Hospital. Developing the multimedia database will give the possibility to analyze diagnosis, treatments and medical images to improve the process of identifying the diagnose of patients and the disease. Medical image retrieval for diagnostic purposes is important because the historical images of different patients in medical centers have valuable information for the upcoming diagnosis with a system which retrieves similar cases, make more accurate diagnosis and decide on appropriate treatment.

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