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Medical Data Archive for Prevention of Epidemics

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ABSTRACT: This web-based medical data archive system aims at building up a distributed archival system over the internet to facilitate medical workers to maintain, share, update, search, and process medical information conveniently and consistently. This data is primarily used to detect, cure and prevent the spread of infectious diseases. Our system differs from the existing systems in the sense that it not only offers a full spectrum of online communications, processing, and annotation tools, but also provides powerful multimodal search functionalities to the users. In addition, the database is always kept in real time so that the information contributed by users is periodically indexed. Whenever a case of an infection is reported in a hospital, the information is forwarded to other medical institutions in the form of notification messages. This helps the government to take initial action at an early stage. Finally, the system is concluded with the current on-going development on the prototype system.

KEYWORDS: Multimodal search, Archival system, Annotation tools, Image Indexing, Geometric Histogram, Multimedia database.

1. INTRODUCTION

This system is proposing a new paradigm of managing and archiving large scale medical data for the purpose of preventing epidemics. Specifically, this research demonstrates this new paradigm through a prototype web-based medical data archive system. This system allows storing, maintaining, sharing, updating, and retrieving medical files based on the state-of-the-art multimedia database technologies and the Internet facilities.

Medical files typically contain data in different modalities, such as text description (either in print-typing form or in handwriting form), audio recordings, image files (including Nuclear Medicine, MRI, CAT, Mammography, Ultrasound Imagery, etc.), as well as possibly video clips. Currently, even though significant progress has been made towards archiving medical data in digital forms, there are still many medical centers or hospitals archiving medical files in the physical forms. As the population of this world increases fast, and as new medical diagnostic technologies keep getting developed and applied in the clinical practice, resulting in more new modalities and increasing amount of medical data for each patient, this traditional archival system obviously exhibits several major problems in accommodating the avalanching demand for archiving and managing medical data

Problems with Current System:

- More physical space will be necessary to maintain the medical files.
- More manpower will be necessary to maintain the medical files.
- It will become less efficient and more difficult to access and retrieve a particular medical file.
- Spread of infection occurs at rapid pace. Hence, it is necessary for the data to be in real time.

Proposed system for Recovery:

Even with the digital archival systems available today, the medical files are typically inconsistent and fragmented, varying from different medical institutions or medical centers to different hospitals, and there is still a substantial effort that is necessary in order to keep the medical data archival systems consistent, efficient, and effective in storing and retrieving data.

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With the fast development of computer technologies, especially the multimedia database and Internet technologies, it is possible to archive all the medical data into a "central" system so that all the medical practitioners and/or researchers in a membership controlled community may share and access this system conveniently and consistently without all the hassle imposed by the conventional archival system.

This is the motivation of this research, as well as of the development of our prototype system. A typical scenario with the system follows. Assume that the "central" archival system is located in a computer server at New Delhi. A medical practitioner in Bangalore is reviewing medical files of a patient. He/she somehow decides to consult with the database for the previous diagnostic approaches made by his/her colleagues in the same community for those patients who happen to exhibit similar kind of symptoms. To do so, he poses a query to the system through a standard browser in his PC either at home or at the office. The query here may not necessarily just be a simple keyword based query. It may be a complicated query consisting of data in different modalities.

An extreme case is that he could send the whole set of files of this patient as the query, which includes information in possibly many symptoms. Our system not only allows the user to review all the files in different modalities by popping up different windows to present the files, but also allows the user to do online processing and /or annotation directly on top of the files, just as writing down annotation on top of the physical medical files. The user could then save the processed files and/or the original files along with the newly written annotation into his/her local folders, or contribute them to the whole community by uploading the files back to the system, so that this information will be archived in the system, and may be shared by other colleagues in the community, if he/she wished to.

With the advent of Internet, more research is reported in combining Internet technologies with multimedia research in designing and developing medical archive systems. Our system differs from the existing systems in the sense that it not only offers a full spectrum of online communications, processing, and annotation tools, but also provides powerful multimodal search functionalities to the users. In addition, the database is always kept in real time so that information contributed by users is periodically indexed. The next section describes the architecture of our system, and then is followed by a section documenting the implemented functionalities of the currently developed preliminary system.

II. SYSTEM ARCHITECTURE

The architecture of the system consists of the standard 3-tier, browser-server model. The client machine may be any machine with any operating system, as long as it is connected to the Internet, and has a standard browser. After a user logins into the system, a Java Applet is downloaded to start the communications with the server. The server consists of a middleware and a backbone database system. The middleware is implemented using Java Servlets and Java Server.

Current on-going development on the prototype system, and the backbone uses Oracle 9i database. The communication between a client Applet and the server Servlet is implemented using object serialization. The communication between the middleware and the backbone uses JDBC (Java Data Base Connectivity) and RMI (Remote Method Invocation). In the current preliminary version of our system, the middleware is J2EE compliant web server (Java Web Server) hosted on a SUN Enterprise 250. While the whole system architecture is implemented in Java, some libraries (engines) of the processing, annotation, and querying tools are implemented in C++ with the efficiency consideration.

II. SYSTEM FUNCTIONALITIES

Our system offers users the following implemented functionalities in the preliminary version:

• Data management

Users may save the browsed or annotated or processed documents into their local machines, or if they wish, they can contribute these documents to the community by uploading them into the database, which allows data sharing among their colleagues.

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• Online data processing
Users may apply tools available in the system toolboxes to do the online processing for the documents they are reviewing. The modality-dependent toolboxes are developed in close collaboration with clinicians and medical researchers. The currently available tools include zoom in and out for either global of local areas of a document, arithmetic image processing, pseudo coloring, threshold, histogram analysis, etc. The algorithms used in these functionalities are from the existing literature.

• Powerful querying capabilities
In addition to the standard SQL queries, text based and image-based queries are also available to users, and user-friendly graphical interfaces are available to allow multimodal query and retrieval. The SQL query facilities are directly provided by Oracle 9i, and are incorporated into the system. The image query functionalities are implemented using histogram indexing.

• Notification Message
Whenever a case of an infection is reported in a hospital, the information is forwarded to other medical institutions in the form of notification messages. This helps the government to take initial action at an early stage.

• Membership control
Password protected membership control to make sure that the sensitive and private information is only available to the members of the community.

IV. CURRENT WORK

While the aim of developing the preliminary system was to assemble each component using existing technologies to show the proof-of-concept for the novel archival paradigm our system represents, the current work focuses on furthering the research by upgrading the preliminary system into a real application system by improving the performance of the developed functionalities and by developing new functionalities. Specifically, the following three areas are identified for further research and improvement.

4.1 Image Indexing
Image indexing is a well-received area in multimedia research, as image related search typically is notoriously expensive, and often fails to deliver an effective retrieval (an effective retrieval refers to the fact that retrieved images are semantically related to the query posed). In this task, a number of state-of-the-art image indexing algorithm from this research community are applied and combined to replace the simple histogram based indexing. The preliminary evaluation suggests that geometric histogram has promising potential in image indexing, and therefore, is taken as a candidate image indexing algorithm in this task.
In addition to a good indexing algorithm, a “good” database organization data structure is also necessary when an efficient retrieval is desired. Several advanced spatial data structures are considered and reviewed, and the upgraded version of our system will be based on one of these structures as opposed to the simple arrays of images.

V. CONCLUSION

This system presents a new paradigm of archiving medical data based on combining the state-of-the-art multimedia research with the Internet facilities. The system-concept offers a unique solution to the medical archiving problem. It surpasses the existing systems in he commercial and in the research sectors as it provides convenient, efficient, effective, and flexible online processing, annotation and multimodal querying capabilities combined together. A preliminary version of our system is fully implemented and in evaluation that contains over 2000 medical images in different modalities along with associated annotation text for each of the images. This technology will assist medical practitioners/researchers by enabling efficient management and sharing of the medical data within or across a community without being subject to geographical restrictions and without creating problems of inconsistent and fragmented medical data.

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