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A Server Based Real Time System for Medical Image Processing Support for Doctors Analysis

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Abstract — Nowadays computerised medical databases are very widely used to take better decisions on particular diseases. Doctors can draw their opinion out of the history of previous treatment of the same or similar cases by retrieving the patients' history using the real time medical image retrieval tools. This paper describes a tool developed in Java which enables the doctors to retrieve old records of treatment of patients for the same disease using the Internet and also allowing them to view the medical images of blood slides, CT scan, X-Ray, ECG etc from medical image databases. They can mark and/or zoom important areas of the image. Implementation in Java ensures it to be a secure and multi party system.

Keywords — Image Retrieval; Medical Image Processing; Java; Applet; Multi party;

I. Introduction

Medical Image Processing plays a very important role in making diagnosis of diseases. Computerized medical data bases are used to take good decision on treatment of particular diseases. Electronic medical consultation between doctors would become more meaningful if a tool is available that not only supports verbal communication but displays medical images at their consoles with enriched features such as marking, text annotating, zooming etc [1]. Developing and implementing such a tool over the Internet is a very challenging task as it involves transfer of different type of large volume of data between the clients. Any such exchange is also threatened with the problems of data security over the network. We propose "A Server Based Real Time System for Medical Image Processing Support for Doctors Analysis", which uses the Internet as the communication infrastructure. The proposed system provides an excellent tool for Electronic medical consultation among doctors in a web based Electronic medical consultation system to facilitate discussion over medical images of the patients. We first look into the needs of such a system and its role in the diagnosis of various diseases. A description of the system is then presented highlighting its different features from user's perspective. Finally, the paper concludes with a discussion on the scope of future development.

II. Previous Related Work

Although not many systems have been reported in the literature providing aforementioned features over Internet, contributions made by a group of researchers in Sydney [1] and in Taiwan [2, 3, 4] have similar objectives. The system described in [1] used HTTP protocol to deal with online consultation of a patient's image over the Internet. However, it mentioned the use of JAI that often adds an extra overhead to the client machines. Whether more than one image can be handled simultaneously was also not clearly mentioned. The system proposed in this paper deals with pre-consultation among doctors examining medical images and other information related to a patient. When a doctor refers a case to another doctor for consultation, it would be necessary to share relevant medical images [8]. The system described in [2] used FTP as a means of communication to transfer images of a patient to the client's local machine. It has three disadvantages:

A. FTP is Blocked for Security

It used FTP for file uploading and downloading which is often blocked because of security considerations.

B. Image is Stored at the Client Site

It stores the image at the client site. Hence a suitable client tool needs to be installed for local storage management. In addition, retrieval of files and relevant image data from server as well as its storage on client side involves additional IO operations thereby increasing response time.

C. Restrictions due to Proxy

It functioned on a peer to peer basis. Peer-to-peer communication has the disadvantage that most proxies in today's environment do not allow a client to directly connect to the outside world to avoid security breaches.

III. System Description

The proposed online Graphics Communicator Processing provides an environment and platform for doctors who are not at the same place; they are remotely connected and would like to participate in an online session. During such a session, they can open patients' various medical images and perform various operations on it and if

any other assistance needed then they can open the other patient report who already procured by the same dieses. This is implemented using a Java Applet that work as client-server architecture.

IV. Features

The system proposed in this paper deals with Electronic medical consultation among doctors examining medical images and other information related to a patient. When a doctor refers a case to another doctor for consultation, it would be necessary to share relevant medical images. To undertake such sharing the following options are made available:

- To send images and medical records beforehand to all participating sites where the relevant data are saved.
- To send commands from client sites to fetch relevant image/record during a consultation. Since both these approaches tend to store the data in a stable storage (disk), additional disk access time would be involved. The proposed system addresses the data fetching and display of data in a slightly different manner. When a user (doctor/consultant) logs into the system, he/she is presented with thumbnails of relevant images. The relevant full image is fetched online, loaded into the memory directly and opened when the thumbnail is clicked. This avoids storage of image/data in the local stable storage. Images are fetched from the server to the client on-demand. Moreover, all images of the patients need not be downloaded to the client beforehand. In order to protect internal machines and databases from Internet based threats, most organizations use proxies/firewalls that implement Network Address Translation (NAT) and allow only HTTP/HTTPS traffic because of security considerations. In view of this, SBRTSFMIPSFDA has been developed and tested in a secured network where only HTTP and HTTPS are allowed and everything else is blocked. Hyper text transfer protocol secure is a protocol which provide security to the SBRTSFMIPSFDA. It helps to deploy the HTTP to SSL (Secure socket layer)/TLS (Transport layer security). HTTPS provides authentication of the web site and it is also used to protect our database with man-in-middle attack, bidirectional encryption communication between client and server, which protects from eavesdropping and tempering with or/and incoming and outgoing contents . It is assumed that images and patient records are maintained at a central web server and a client sends HTTP requests to the web server for fetching data. Images and/or messages are received as HTTP responses. The client need not install any additional software patch. SBRTSFMIPSFDA makes HTTP requests from the clients to web server only if permitted by the client. A self-signed certificate is sent to the client for its verification. Since SBRTSFMIPSFDA has been designed to help doctors who want to consult and discuss with images related to a patient, such images should not only be readable but must be presented in a user friendly manner. SBRTSFMIPSFDA enables a doctor to open any image or patient record which is also simultaneously displayed on the other terminals of the consulting parties. If a doctor writes a text on an already opened image, it is simultaneously displayed on other windows of individual machines where this image is being viewed. Besides image chatting, SBRTSFMIPSFDA supports text based chatting to start a normal discussion before actually starting a conference related to a particular patient. Some of the important functionalities of SBRTSFMIPSFDA are listed below:

- a) Open an image online during discussion.
- b) Mark on the important specified regions of the image.
- c) Zoom a whole image.
- d) Zoom selected areas in the image.
- e) Write text on the image.
- f) Write text on the zoomed image.
- g) Open specialized canvas for displaying skin patches or the different organs of the body.
- h) Write text for text-based chatting.
- i) Display the doctor's status.
- j) Perform certain mathematical operation on an image portion and display the result to other participating doctors.

View any image with any resolution. If the image is very large, it can be resized to fit into the screen. If the image is too small in resolution, the zooming facility can be used to see an enlarged image. SBRTSFMIPSFDA does not impose any restrictions on the number of users of the system, or on the number of users in a group. The number of concurrent connections would not be limited by the capabilities of the web server as we are using applet technology. There is cross platform compatibility as it is developed in Java. The application is very scalable, optimized and robust owing to the features of Java applet. Since the communicator uses HTTP requests to send and receive data over the Internet, this mode of communication enables any client to access the server irrespective of their underlying network links such as leased lines, ISDN, DSL, PSTN etc.

V. System Design and Architecture

This system is a tool of Electronic medical consultation; A Server Based Real Time System for Medical Image processing support for doctors' analysis, developed at Institute of Engineering & Technology (IET),

Alwar, Rajasthan, India. A Server Based Real Time System for Medical Image Processing Support for Doctors Analysis (SBRTSFMIPSFDA) is designed for Windows platform. It is a portal built with an intention to provide access to quality healthcare services to the remotest regions through innovative and state-of-the-art technologies. The system is developed with an objective of providing a secure electronic medical consultation platform over the Internet. A brief description of the system is being provided in the next section.

VI. The Proposed System

The system is built on a four layered architecture (shown in Figure 1). The different layers of the system are the following:

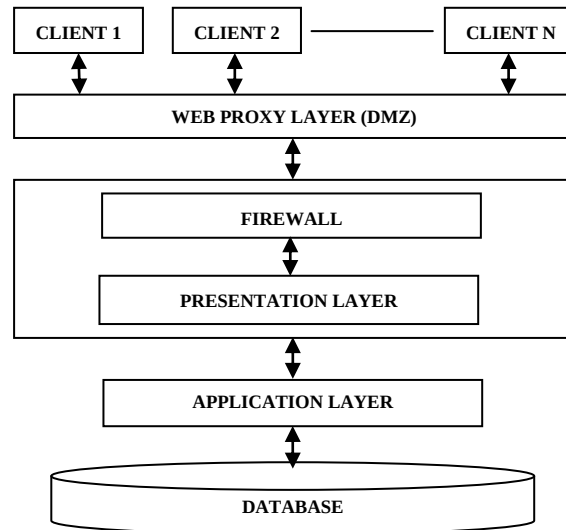


Figure 1. Architecture of the Server Based Real Time System

A. Database Layer

The Clinical Database forms the lowest layer of the application. It contains all the medical records of the patients as well as personal details of the users. The database has different logins for different types of users and the application server connects to the database authenticating the login for the current role of the user.

B. Application Layer

The Application Layer or the Business Logic Layer is the core of the application. It is responsible for all communications with the database. This layer intercepts all data requests from the presentation layer. If the current user is authorized to access the requested data, it fetches the data from the database, runs application logic on the fetched data and returns the final output to the presentation layer. Similarly data insertion and other user requests are also handled by the Application Layer.

C. Presentation Layer

This layer resides between the Application Layer and the Web Proxy Layer in the demilitarized zone (DMZ). It is the segment of the application which is responsible for organizing the data fetched by the Application Layer into a user friendly format. In the A Server Based Real Time System for Medical image processing support system, the Presentation Layer formats the data into html format for external communication.

D. Proxy Layer [6, 7]

The Web Proxy Layer is the only portion of the software that resides in the DMZ. This is the publicly accessible portion of the application which communicates with the client. Whenever a request comes from a client, this layer verifies the user and then passes the request to the Presentation Layer. After being received the output for the request it is forwarded to the same client. Apart from the Proxy Layer, all the other layers are hidden by firewalls. All the client requests and responses are captured by the proxy layer to ensure that the internal layers are not directly accessible from a public network.

E. Integration of SBRTSFMIPSFDA with the Server

The server handles critical data of patients with different diseases and problems. In the System environment, Applets are used to navigate through Web proxy Layer which in turn uses HTTPS to communicate with other layers to ensure adequate security.

SBRTSFMIPSFDA is a Java Applet, embedded in a web page. In the SBRTSFMIPSFDA architecture (See Figure 1), it resides as a tool in the Presentation Layer. When a request arrives, it is downloaded from the server to the client machine and loaded into the browser's Java Virtual Machine (JVM) for execution. Once loaded, it communicates with SBRTSFMIPSFDA is a Java Applet, embedded in a web page. In the SBRTSFMIPSFDA architecture (See Figure 1), it resides as a tool in the Presentation Layer. When requested, it is loaded on the client window and executed by the browser's Java Virtual Machine (JVM). Once loaded, it communicates with

the system (SBRTSMIPSFDA) server using the HTTP protocol. It establishes an HTTP connection to the Web Based Real Time System for Medical Image Consultation [6, 7] server and then posts HTTP requests to it when any event such as annotating or drawing a circle is activated by a user. The HTTP requests are received and forwarded by the proxy layer to the presentation layer. At the presentation layer, the request is processed and then an HTTP request is made to the application layer which fetches the required information from the database layers.

VII. Components of SBRTSMIPSFDA

The Web Based Real Time System for Medical Image Consultation [6, 7] server hosts database and ASPX9 pages for interaction with the database tables. The overall message flow between the clients and SBRTSMIPSFDA is shown in Figure 2. The following three tables are installed for storing data in the system:

- 1) User Table: This table contains data of logged-in users. When a doctor logs in, a message is posted to the server, and the table is updated. In the Figure 2, this message flow is represented by point 1.
- 2) Patient Table: It contains a list of patients assigned to individual doctors. This table is not updated by the communicator who can only fetch data from it. This is populated by the server. In the Figure 2, this message flow is represented by point 2.
- 3) Message Table: The message table is populated whenever an event is generated at the client end. In the Figure 2, this message flow is represented by point 3.

The client also checks for any new messages that are intended for it. This flow is represented by point 4 in Message Flow between Users and online Graphics communicator:

1. Login, Authenticate and Append.
2. Get assigned patients. Select patients, Get other doctor assigned.
3. Send message and update message table.
4. Check for any new message.

SBRTSMIPSFDA comprises the following two major blocks:

GetMessage Thread: GetMessage thread polls (request for new data from) the server at regular intervals to check for any new messages and on receipt of a new message, the thread updates its state as per the message.

Event Generator: When there is an event created by the connected user, a message for other clients is created and posted immediately. For example, if a user draws a line on the canvas, the message to draw the line is generated and subsequently the HTTP message is created and posted to the Server (SBRTSMIPSFDA) for Medical Image Consultation.

The system is based on event driven mechanism. For every specific event, a suitable HTTP message is generated. It is then posted to the Server for Medical Image Consultation where the message is extracted and queued up for further processing.

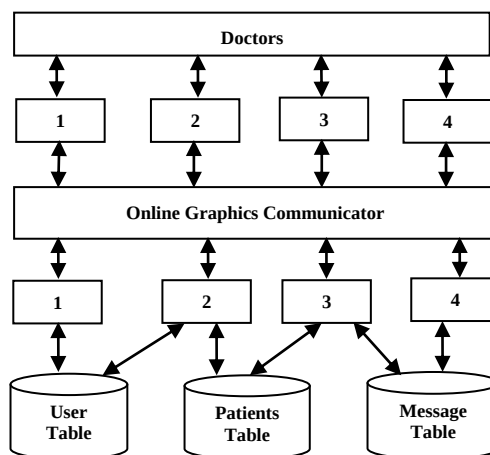


Figure 2. Message flow between Clients and Server

VIII. Conclutions and Future Work

The system presented here reflects our research work. We are in the process of developing a clean framework to implement such systems. The system design choices proposed by us, will improve the efficiency and ease of programming such techniques. This paper is based on our ongoing research of designing a new Internet and Intranet Based Real Time Medical Imaging System for Medical Image Profession. Since the research is going on, we have not included the implementation of system based on java Applet. In future we will be working on a new peer to peer system for the medical professionals.

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