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Design and development of a secure DICOM-Network Attached Server

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ABSTRACT

It is not easy to connect a web-based server with an existing DICOM server, and using a web-based server on the INTERNET has risks. In this study, we designed and developed the secure DICOM-Network Attached Server (DICOM-NAS) through which the DICOM server in a hospital-Local Area Network (LAN) was connected to the INTERNET. After receiving a Client's image export request, the DICOM-NAS sent it to the DICOM server with DICOM protocol. The server then provided DICOM images to the DICOM-NAS, which transferred them to the Client using HTTP. The DICOM-NAS plays an important role between DICOM protocol and HTTP, and only temporarily stores the requested images. The DICOM server keeps all of the original DICOM images. When unwanted outsiders attempt to get into the DICOM-NAS, they cannot access any medical images because these images are not stored in the DICOM-NAS. Therefore, the DICOM-NAS does not require large storage, but can greatly improve information security.

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1. Introduction

In recent years, many hospitals have installed high-tech medical equipment, including Computed Radiology (CR), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) [1]. Researchers and developers have attempted to combine this equipment with information technology (IT) to improve the quality of medical care. Web-based servers, which have enabled us to display patients' medical images on computers using Internet Explorer, have been especially developed. This allows medical physicians and other researchers to easily share and view these medical images anywhere when needed. However, the use of web-based servers also brings many problems [2–13].

Since most servers were originally designed for vender-customized DICOM servers, their versatilities are not very good. Therefore, users must install a web-based server combined with a particular DICOM server for medical use. This is sometimes not feasible because of technical and financial reasons. On the other hand, in order to distribute the medical images, patients' information must be stored in the servers at all times. Therefore, the misusage risk of patients' information becomes higher.

The present study developed a web-based server called the DICOM-Network Attached Server (DICOM-NAS), which can be easily installed and adjusted to DICOM protocol and HTTP. The DICOM servers in a hospital-LAN are connected to the INTERNET through the DICOM-NAS, and the patients' medical images and information are only kept temporarily in the DICOM-NAS when eligible Clients need them. Since the patients' medical images are not stored there at all times, it greatly improves information security.

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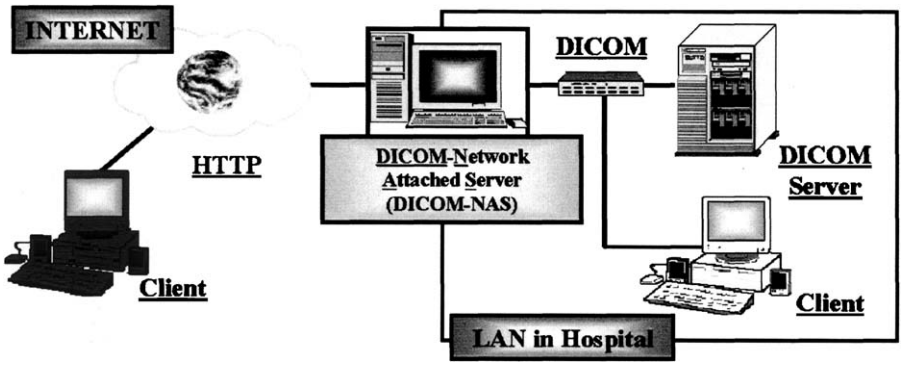

Fig. 1 – Scheme of DICOM-Network Attached Server.

2. DICOM-Network Attached Server

2.1. *Scheme of DICOM-NAS*

The DICOM-NAS scheme is illustrated in Fig. 1. It communicates with the DICOM server by using the DICOM protocol when it is attached to the Local Area Network (LAN). An IP address, AE title, host name, and port number were assigned to the DICOM-NAS. In order to view the DICOM images, the Client can use the browser in any computer to connect to the LAN, the INTERNET, and then to the DICOM-NAS.

2.2. *System configuration of DICOM-NAS and data flow*

Fig. 2 demonstrates the system configuration of the DICOM-NAS and the data flow. The DICOM-NAS can work with Internet Information Server (IIS) 5.0 on Microsoft Windows 2000 or XP and consists of Java Applets, Java Servlets, and DCMTK. The Java Servlets work with application servers Tomcat 4.0.1 and IIS 5.0 to provide a highly reliable, manageable, and scalable web application infrastructure for all versions of Windows 2000 and XP. The IIS can increase website and application availability and lower the system administration costs. Java Servlets provide a component-based and platform-independent method for building web-based applications without CGI program performance limitations. Java Servlets can access the entire Java API family, including JDBC API, to access enterprise databases and a library of HTTP-specific calls. They have all of the benefits of mature Java language, including portability, performance, reusability, and crash protection. Tomcat 4.0.1 is the servlet container that can improve performance and memory efficiency. DCMTK [14] is a collection of libraries and applications that implement large parts of the DICOM standard. It includes software for examining, constructing, and converting DICOM image files, as well as sending and receiving images over a network connection.

In this DICOM-NAS system, the Java Applets are the interfaces between the Client and the Java Servlets. The Java Servlets communicate with the DCMTK and the Diagnosis report database based on the information obtained from the Java Applets. The DICOM-NAS communicates with the DICOM servers using two applications, including DCMTK, which has the C-FIND and C-MOVE functions.

When a Client wishes to access the medical images of a patient, the Client should first connect to the DICOM-NAS using Internet Explorer and request a patient name or a patient name list, which is stored in the DICOM server. After receiving the request, the DICOM-NAS generates query keys related to the request and sends them to the DICOM server

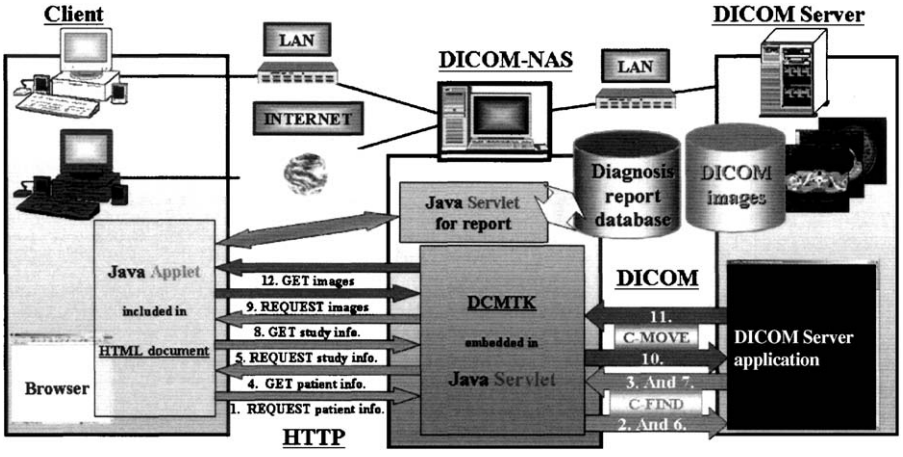

Fig. 2 – System configuration of DICOM-NAS, and data flow after downloading Java Applet that have the functions of Query/Retrieve and display of DICOM images from DICOM-NAS.

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