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Fingerprint verification on medical image reporting system☆

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ABSTRACT

The healthcare industry is recently going through extensive changes, through adoption of robust, interoperable healthcare information technology by means of electronic medical records (EMR). However, a major concern of EMR is adequate confidentiality of the individual records being managed electronically. Multiple access points over an open network like the Internet increases possible patient data interception. The obligation is on healthcare providers to procure information security solutions that do not hamper patient care while still providing the confidentiality of patient information. Medical images are also part of the EMR which need to be protected from unauthorized users. This study integrates the techniques of fingerprint verification, DICOM object, digital signature and digital envelope in order to ensure that access to the hospital Picture Archiving and Communication System (PACS) or radiology information system (RIS) is only by certified parties.

1. Introduction

New imaging and information technologies have urge healthcare facilities everywhere to implement electronic medical records (EMR), computerized physician order entry (CPOE), wireless technologies and Picture Archiving and Communication System (PACS) to enhance patient care and improve workflow. Although modern solutions certainly benefit healthcare providers and their patients, there are some significant technology gaps, such as the know-how of information security, that need to be closed to more fully realize their potential [1,2].

PACS are computers or networks devoted to the storage, retrieval, distribution and presentation of medical images which are stored in an independent format known as digital imaging and communications in medicine (DICOM). PACS handle images from various medical imaging instruments, including X-rays, ultrasound, mammograms, computed tomography, magnetic resonance, positron emission tomography (PET) and endoscopy.

Currently, most large-scale hospitals in Taiwan have begun to implement digitalized medical image system. PACS replaces hard-copy film archives and provides capabilities of off-site viewing and reporting (tele-diagnosis). It also enables prac-

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titioners at various physical locations to access the same information simultaneously (teleradiology). Typically a PACS network consists of a central server that stores a database containing the images connected to one or more clients via a LAN or a WAN which provide or utilize the images. The popular web-based PACS computers utilize the Internet as their means of communication, usually via virtual private network (VPN) or secure sockets layer (SSL). When medical images are to be conveyed via Internet, data security is important to prevent any modifications on the images, which can be achieved by using public key infrastructure (PKI) system and limiting access to certified users only. Authorization control includes physical identification of the users, unique identification number for each individual and auto-logout mechanism. A complete PACS structure should provide a single point of access for images and their associated data and should interface with the existing hospital information system (HIS) and radiology information system (RIS).

However, computer storage of medical images as part of the EMR may give rise to security problems: PACS computers need to be protected from unauthorized users. The need to address patient privacy concerns is driving many healthcare organizations to adopt greater security standards. Passwords and personal identification numbers (PINs) are ubiquitous, as are swipeable ID cards and tokens. Alternatively, biometric authentication involves the biological identification of a person based on the structure or action of physical characteristics such as fingerprints, hand geometry, irises, the face, voice responses and handwritten signatures. Amongst these, fingerprint verification is the most stable and proven biometric technology for one-to-one functionality, as well as the leading biometric technology in revenue generation. Implementations of computer systems incorporating fingerprint recognition expertise have been demonstrated around the world because fingerprint verification's versatility makes it ideal for both access control and network access. With well-established matching algorithms, false match and false non-match rates can be reduced to the minimum. This study integrates the techniques of fingerprint verification, DICOM object, digital signature and digital envelope in order to ensure that that access to PACS or RIS is only by certified parties.

2. System design

2.1. Load balance

Load balance is an important issue to be considered under the structure of cluster-based server. It serves to distribute assigned loading to the servers in coordination with a scheduling algorithm. There are five approaches to deal with this issue: "round robin", "weighted round robin", "least connections", "weighted least connections" and "monitored server load". Load balance is usually handled by the 4th-7th layers of the OSI reference model, which compute the undergoing real-time and dynamic distribution services for exchange among servers. For clinical 3D PET that requires extremely high computing loading, PC cluster is an excellent choice in treating 3D image segmentation. As shown in Fig. 1, PC cluster consists of a master node and several slave nodes which are connected to Ethernet or other networks. The required system resources and processing time vary with different objects to be stored. Since the performance of load balance with traditional routing distribution may not be as good as expected, radiographic imaging system can achieve a better performance of load balance by using content-specific distribution [3,4].

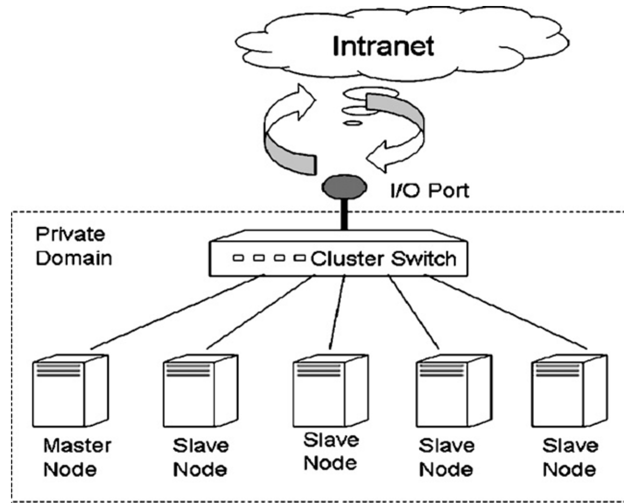

Fig. 1 – PC cluster.

2.2. Cluster PACS (CPACS)

One of the goals of our study is to speed up PACS transmission by replacing traditional single-server PACS with cluster PACS, as shown in Fig. 2. The advantages of cluster PACS include: (1) outside working model can be unified and simplified, (2) all I/O ports of slave nodes can be fully tuned and (3) traffic condition of connections can be regulated. The master node serves to determine the optimum slave nodes for this purpose. Traditional schemes of cluster load balance uses the cluster as its basic unit and is known as the inter-cluster load balance. On the other hand, CPACS uses the nodes inside a cluster as its basic units and is therefore called the intra-cluster load balance [5,6].

2.3. Master node

During system configuration, we open all I/O ports of the slave nodes for outside service in order to appraise data transmission efficiency. As shown in Fig. 3, the system's master node acts to determine the optimum slave nodes' operation condition. All medical requests will be distributed to slave nodes through the master node. The master node serves as the front-end mechanism of CPACS. When medical requests arrive, the software modules in the master node will distribute the request, according to the load condition, to different slave nodes for processing. In this scenario, practitioner at each slave node works as if he/she was connected to an independent server.