Research Article

DESIGNING OF DATA EXCHANGE PROTOCOL BY INTEGRATING DICOM USING HL7 STANDARD TO DEVELOP DATA EXCHANGE GATEWAY TO SUPPORT SECURES DATA FLOW

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ABSRACT

Health care has become one of the most important services. Hospitals, physicians, insurers, and managed-care firms are networking, merging, and forming integrated organizations to finance and deliver health care. This paper mainly does some research on the problem of secure data flow. Data access is enabled via internet browser technology. Relevant patient and image acquisition information is extracted from the DICOM images and stored into a relational database. Patient information such as radiological findings are transferred from the Radiological Information System (RIS) into the database. Image data is accessed viewer. Since data security mechanisms either by a fast preview tool , a DICOM encryption of sensitive patient data is implemented. The method allows a dynamic selection of the data to be encrypted.

INTRODUCTION

Hospitals, doctors, and other healthcare centres around the world require the ability to send and receive healthcare data, including patient information and various lab reports. Means that vast amounts of healthcare information are exchanged on a daily basis. However, medical data can be extremely complicated due to the abundance of clinical terminology, as well as the structural complexity in the formation of the presented information. Thus, this information must be presented in a standardized format in order to ensure that the data is universally understood and organized. All healthcare information must be sent in a specialized healthcare language. The language that has been developed to overcome these obstacles is HL7. This interface protocols define the rules by which two applications will exchange data in an orderly and secured way. Owing economical requirements, patient data increasingly have to be handled with digital hospital information systems (HIS). During the past few years, high-performance networks have, therefore, been installed in hospitals. Technically, these networks may also provide image data transfer between different

departments. The overall transfer time of the huge data amounts depends on the network capacity, the data access method, and the protocols used. To achieve a high compliance of the medical users, easy, unified, and fast data access and data transfer must be provided. The problems most often encountered include historically grown heterogeneous hard and software infrastructures, the difficulty of providing unified access to data, the costly dependence on vendor-specific solutions for long-term data storage, and changing demands of medical users that require the adaptation of data server capabilities. The DICOM standard offers the highest potential for a standardized exchange of image data. To achieve platform independence and to provide an economical and unified access to patient and image data, a DICOM image server was implemented. However, DICOM has the disadvantage of lacking standardized security mechanisms. To enable data transfer over insecure networks and secure long-term storage on low-cost CD-Recordable (CDR), DICOM-conform security methods had to be developed. The very secure but restrictive and expensive complete isolation of sensitive hospital networks from internet based networks as required by some national data security laws was not considered because it would have necessitated the installation of specialized hardware environments. Instead, solutions were implemented for hospitals where access to public networks was allowed but restricted by firewalls. In clinical practice, time-consuming transfer and encryption methods for data exchange will usually lead to the reduced compliance of medical users, thereby hindering telemedicine applications. Hence, only fast und user-friendly methods were applied. A pilot installation proved the applicability of the concept.

METHODOLOGY

In this paper, formal methodology is data exchange between PACS and HIS to merge the patient data and image information of the patient. The DICOM server is installed on a PC with a dual Pentium processor in the Department of Radiology and Nuclear Medicine. The operating system is Windows Vista. Four image acquisition modalities are connected to the server. Images are transferred manually per DICOM protocol from two magnetic resonance

tomography (MR) scanners. One computed tomography (CT) scanner allowed both automatic and manual DICOM transfer. A second CT scanner provides images only in a vendor-specific format. Therefore, a software tool is developed to convert the original data into DICOM format. The proprietary image data is accessed and transferred automatically using a self-developed macro. After conversion of the images into DICOM format using self developed software, the data is automatically transferred to the image server using the DICOM protocol. The relational database is accessed via middleware. Selected patient data (name, birth date, local image ID-number, examination date, etc.) is also extracted from the DICOM images and stored in the relational database (Fig1).

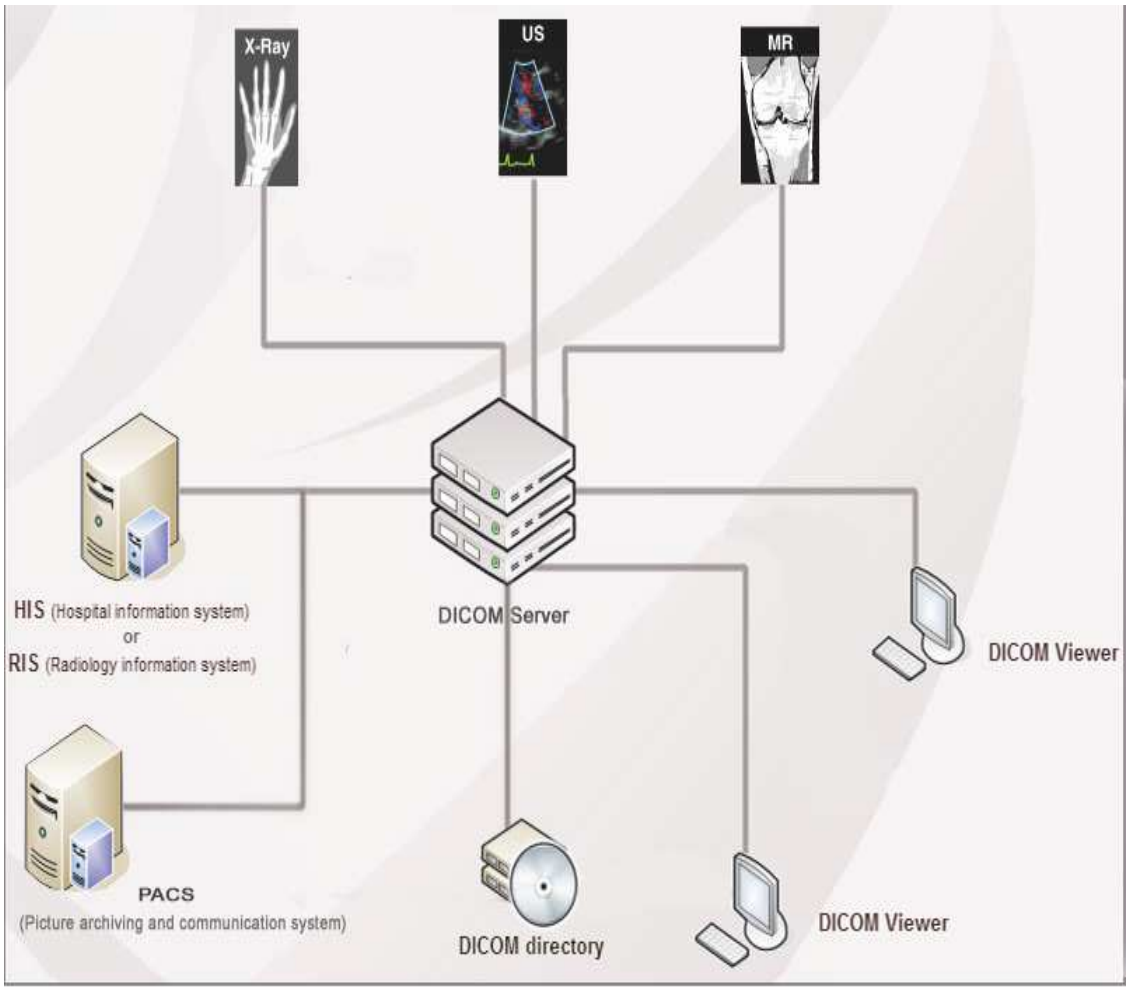

Fig1 : Principle of data exchange between DICOM server and DICOM viewer

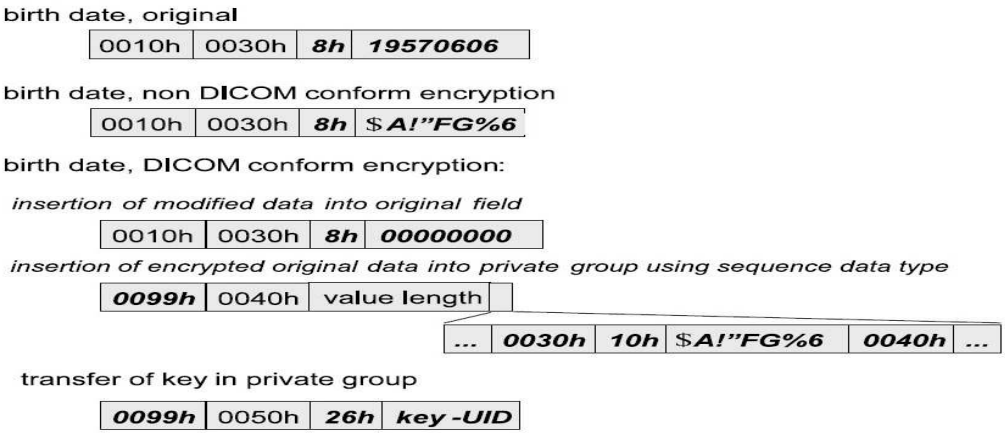

Fig. 2: DICOM-conform partial encryption using private groups for encryption keys and encrypted data. The example shows how the encryption of standardized data yields data that may not be allowed by the DICOM standard.

Images were additionally converted into compressed GIF or JPEG icons. Additional information, such as the department that requested the examination is also extracted and entered into the database. A user management tool allowed the administration of users with respect to different authorization levels for accessing image data and findings. For DICOM-conform data encryption (Fig 2), a new concept is developed that enabled high-speed, secure data transfer as well as secure long-term storage on external devices. The basic problem to be overcome with encrypting DICOM images is the fact that the DICOM structure contains fields that have to be filled in a standardized way. For instance, applying an encryption algorithm to the characters of a standardized field such as the birth date will usually result in special characters that are not defined in the DICOM standard (Fig 2). Fields may not be left empty as specific fields have to be filled with the appropriate information according to the DICOM standard . In the proposed solution, the patient-relevant fields are filled with permissible but meaningless information, and the original information is encrypted and stored into so called private groups using the data type sequence. The amount of information to be encrypted could be adapted flexibly, ranging from the

patient ID up to only to the complete data set including pixel data. Keys are stored at the application site and identified by a unique identifier (UID). Data is encrypted using symmetric methods; key exchange was achieved by asymmetric methods. The key UID was transferred into a second private group. The security software is integrated into the graphic user interface of the image browser.

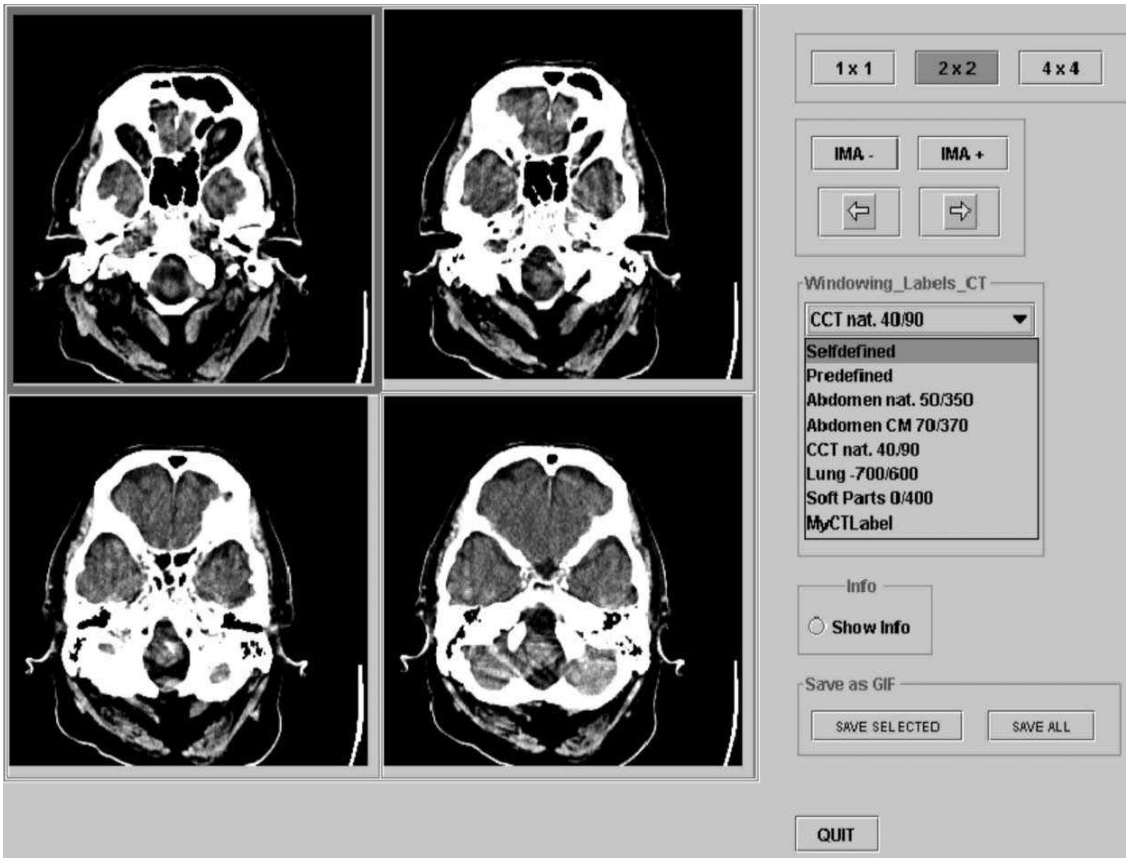

Fig.3: DICOM viewer allowing basic image manipulation such as scrolling, zooming, or windowing.

RESULTS

Data access via internet browser is controlled by password, department and different authorization levels depending on the status of the findings and whether the examination is requested by the according department. All image data and findings are accessible to radiologists irrespective of which department had requested the examination and whether the examination findings are already final. All other users have access to images

only if the findings are final, if the examination is initiated by their department or by related departments (e.g. Neurology and Neurosurgery had one data access level), or if the patient is transferred from another department to their department. Otherwise, a message is displayed informing the user that the examination is performed but the findings are either not yet available or not accessible. In an emergency, these restrictions can be removed by an authorized person, thereby providing access to all image data. For legal reasons, the person requesting the emergency information, the date, and the department are logged. To reduce network load, viewers can preview compressed images that are stored as GIF or JPEG icons in the database (Fig.3).

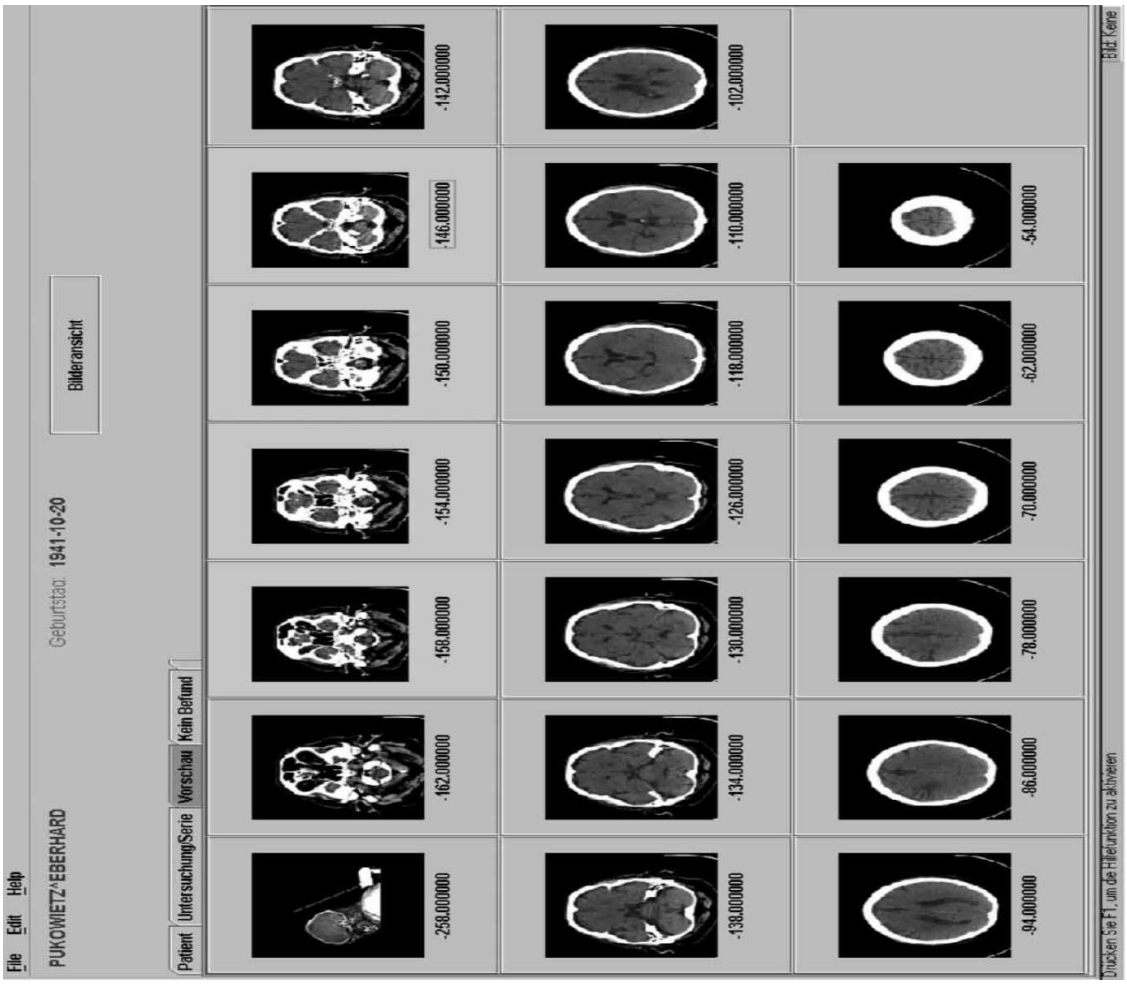

Fig. 4: Images may be zoomed; the contrast may be changed by selecting different window settings

Basic image manipulations such as zooming or setting different contrasts by adapting window and threshold can be performed on the icons. In many cases, the information required can be gained in this manner. However, if the full image information is necessary, the original DICOM images corresponding to the selected icons can be transferred to the DICOM viewer (Fig. 4) with similar image manipulation. Findings are stored to allow the patient's clinical history to be traced. Image data are deleted after four weeks. If required, data can be stored on CD-R. Stored image data is marked as such in the database (with reference to the corresponding storage disk) and then deleted from the hard disk. For encryption, either single images, a series, or all series of a patient can be selected. In a two-step procedure, the findings server module is introduced first. The departments are connected stepwise by defining the user authorization rights and naming a contact person. The image server is tested successfully and has recently entered the evaluation phase in cooperation with the neurological department. More patient's information such as laboratory data and neurological findings will be included in the database in the near future can be chosen interactively. The target for the transfer of the encrypted patient data can be selected as a directory.

CONCLUSION

New platform-independent solutions using DICOM can be implemented to realize an economical transfer of DICOM images and patient data. The use of graded authorization procedures guaranteed the differentiated access to images and patient data. A procedure has to be implemented to allow access to all patient information in emergency situations. Network load can be efficiently reduced by implementing a preview tool displaying compressed GIF or JPEG images. To access full image information, a DICOM viewer is necessary. For optimum encryption speed, data have to be encrypted using symmetric methods while the key exchange should be implemented with asymmetric methods to guarantee high security. With this method, access to stored data is provided only to authorized users.

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