

國立交通大學

網路工程研究所

碩士論文

醫療影像維護系統

Medical Image Maintenance System

研究生：蔡本元

指導教授：謝筱齡/蔡錫鈞 教授

中華民國九十八年七月

醫療影像維護系統
Medical Image Maintenance System

研究生：蔡本元

Student : Pen-Yuan Tsai

指導教授：謝筱齡/蔡錫鈞

Advisor : Sheau-Ling Hsieh/Shi-Chun Tsai

國立交通大學

網路工程研究所

碩士論文

A Thesis
Submitted to Institute of Network Engineering
College of Computer Science
National Chiao Tung University
in partial Fulfillment of the Requirements
for the Degree of
Master
in
Computer Science

July 2009

Hsinchu, Taiwan, Republic of China

中華民國九十八年七月

醫療影像維護系統

研究生：蔡本元

指導教授：謝筱齡/蔡錫鈞

國立交通大學網路工程所 碩士班

中文摘要

本論文主要是架構於台大醫院的健康資訊系統之下，由於現在醫院都開始朝向病歷電子化的目標邁進，大部份的電子病歷都只是單純的用文字做紀錄，但往往許多紀錄是需要搭配圖片來做說明，所以這個論文主要是設計一套影像維護系統，如此台大醫院的電子病歷可以將影像紀錄也加入到其中，使電子病歷可以更加完善。

這個影像維護系統使用建構於健康資訊系統下的健康第七層通訊協定中介軟體架構做為資料傳輸的媒介、ASP.NET 作為系統的平台、C#做為開發語言、視窗應用程式做為編輯圖檔的主要工具和使用網路服務做為視窗程式和影像維護伺服器的溝通橋梁。

影像維護系統讓所有的影像資料可以全面電子化，而且醫生可以線上建立、編輯和搜尋病人影像紀錄，如此醫生在對病人的看病時可以有效利用這些資訊對病情做準確的判斷。

關鍵字：健康資訊系統、健康第七層通訊協定、電子病歷、ASP.NET、網路服務

Medical Image Maintenance System

Student : Pen-Yuan Tsai Advisor : Sheau-Ling Hsieh/Shi-Chun Tsai

Abstract

Now many hospitals are beginning to move towards the goal of electronic medical records, but most of the electronic medical records only support the text to do the records. However, a number of records need to append images. The paper designs Medical Image Maintenance System to accommodate the issue. Medical Image Maintenance System is built in Health Information System (HIS) of National Taiwan University Hospital (NTUH). The system can improve the electronic medical records in NTUH.

Medical Image Maintenance System integrated in HIS, uses HL7 as data transmission medium, ASP.NET platform, implemented in C # language. The image editing tool is established on window application. The bridge between the window application and Medical Image Maintenance System server is Web Service.

The system enables all the image data digitalized and doctors can create, edit and search patients' image records on-line. Therefore, the patient can receive treatments effectively and accurately.

Keywords: Health Information System (HIS), Health Level Seven (HL7), electronic medical record, ASP.NET, Web Service

致謝

在這研究所的兩年生活裡，在老師的諄諄教誨下學到很多做人做事的道理，而且老師對我們就像對兒子一樣的細心教導，所以能成為老師的學生真的是十分幸運，謝謝老師。

在這間實驗室的學長姐也都十分的照顧人，每當有問題時向他們請教總是能得到答案，而且在生活上也是很關照讓我們感到十分窩心，RA 學姊, 麵包學姊, Jack 學長, 小馬學長 謝謝你們~

而且在這兩年也認識了許多好朋友偉民, 昱華, 彥寧, 安勝，他們總是在課業上面幫助我許多，讓我這兩年的修課可以如此的順利，而且跟你們也有許多美好的回憶，謝謝你們~

還有一個我特別要感謝的學長就是永卿學長，永卿學長在我寫論文時真的提供我許多的意見，而且在我去台大醫院的期間對我真的十分照顧，真的十分的感謝學長 學長 謝謝你~~~



Table of Contents

中文摘要.....	i
Abstract	ii
致謝.....	iii
Table of Contents	iv
List of Figures	v
Chapter 1 Introduction	1
1.1 Motivation and Objective.....	1
1.2 Report Outline.....	2
Chapter 2 Background	3
2.1 Background.....	3
2.2 HIS System Overview.....	5
Chapter 3 Requirements	8
3.1 Requirements Overview.....	8
3.2 Requirement Analyses.....	10
Chapter 4 Design and Methodology	13
4.1 Medical Image Maintenance System Tiers.....	13
4.2 Medical Image Maintenance System Functionalities.....	15
4.2.1 Functions Design.....	16
4.2.2 Web Services.....	22
Chapter 5 Implementation and Result	25
5.1 Medical Image Maintenance System main Interface.....	26
5.1.1 Query patient medical treatment records.....	27
5.1.2 Establish patient medical image records.....	28
5.1.3 Query patient medical image records.....	30
5.1.4 Medical Image Maintenance System integration.....	31
Chapter 6 Conclusion and Discussion	33
References	35

List of Figures

Figure 2.1 HIS architecture overview	5
Figure 4.1 System Tiers	13
Figure 4.2 HL7 message flow chart	17
Figure 4.3 Establishing record flow chart.....	18
Figure 4.4 Embedding object code	19
Figure 4.5 HL7 Middleware Framework.....	23
Figure 5.1 System Architecture.....	25
Figure 5.2 System interface	26
Figure 5.3 Search patient record interface	27
Figure 5.4 editing interface	28
Figure 5.5 editing page	29
Figure 5.6 Search Image record interface	30
Figure 5.7 Medical Image Maintenance System in Surgical System	32



Chapter 1 Introduction

➤ 1.1 Motivation and Objective

Now many hospitals have begun to move towards the goal of electronic medical records, of course National Taiwan University Hospital (NTUH) is no exception. Currently, the record systems of NTUH Health Information System (HIS) can only provide a simple text record. However, many of the records need the images to assist doctors. It is necessary to design a system which can provide the medical image record and combine with the text record.

Therefore, the thesis designs and constructs Medical Image Maintenance System. The System assists all NTUH HIS record systems to record images and makes the medical records more detailed.

The system provides users to create text and image combination of medical image records and edit the image on-line. The system also allows users to find patient medical image records so significantly reduces the time to look for previously written records, make the doctors can understand the previous medical treatment situations according to the medical image records.

➤ 1.2 Report Outline

The study consists of 5 chapters. Chapter 2 introduces the background of NTUH and its HIS system.

Chapter 3 focuses on the requirements of the system and analyzes the goals of the requirements need to achieve. Chapter 4 describes how Medical Image Maintenance System is designed and to present the results. The fifth chapter consists of the conclusion and discussion of the system.



Chapter 2 Background

➤ 2.1 Background

National Taiwan University Hospital (NTUH) was established in 1895. It is a large scale healthcare center and has been operating over hundred years. NTUH has about 2,200 beds for Inpatient services and serves about 7,000 Outpatient daily in average.

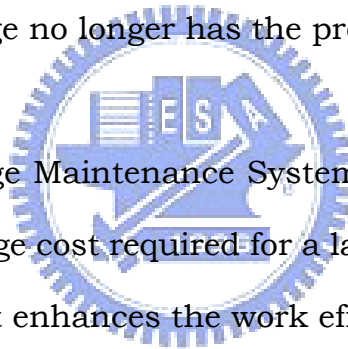
In order to deal with the such huge affairs every day, NTUH designs Healthcare Information System (HIS) to cope with the daily work of hospital, HIS has over 30 major independent systems. These systems consist of clinical information applications focused at patient care, pharmacy systems, laboratory systems, radiology systems, administrative systems, financial systems, resource management, etc. Medical Image Maintenance System is of course one of them.

NTUH in the early stage use the paper medical record to record the patient situation, such the way is not only difficult to store but also spending a lot of time to find the patient relevant medical records. And the medical record often requires the image to record together, doctors will do direct editing of these images but these images are usually only one if the image be used broken. We have to wait a period of time for images to be generated. It is often wasted a lot of time. These images are easily fade and deform so preservation of the environment too wet or dry

will shorten the life of the paper medical records. Therefore, it is very difficult to properly preserve these paper medical records.

Based on the above various reasons, I design Medical Image Maintenance System used in the HIS system at NTUH, it enables the medical image record can be electronicalize, it will do not have the issue of the preservation of the paper medical image record and doctors can quickly query the patient relevant medical image records, do not need to manually to find relevant information of patients to increase the efficiency of the implementation of NTUH. And doctors can repeat to edit the image; the image no longer has the problem of broken.

Therefore, Medical Image Maintenance System reduces the traditional medical image file storage cost required for a large number of economic and space costs. Also, it enhances the work efficiency.



➤ 2.2 HIS System Overview

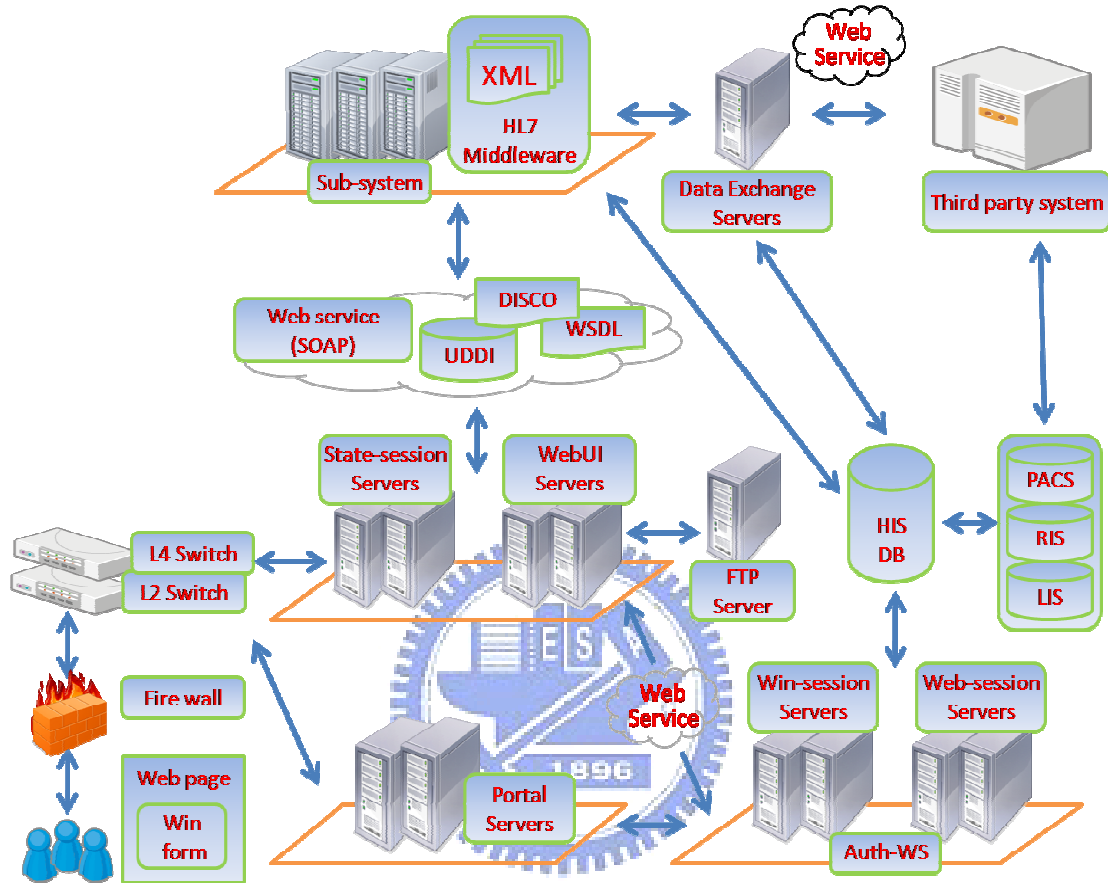


Figure 2.1 HIS architecture overview

The overview of HIS framework is depicted in Figure 2.1. In the diagram, those individual components are described as the followings. By requirement analysis, HIS choose 4-tiers infrastructure and Service-Oriented Architecture (SOA) as Healthcare Information System (HIS) developing and deploying platform.

For user friendly browsing interfaces, HIS adopts web based services. The Portal Servers and the Web User Interface (WebUI) Servers are Web

Servers.

The Portal Servers support the login process with the Single Sign on Service (SSOS) features. The servers construct dynamic web URL linkages, direct to HIS components in the architecture. To enable the SSOS features, the authentication and authorization Web Service (Auth-WS) is introduced. During the HIS operations, any validation needs to be verified through the Auth-WS. The Auth-WS integrates the Web-session Servers and Win-session Servers.

The Web-session Servers interact with all other servers in the architecture under the .NET Web Services environment. The Win-session Servers are implemented as daemons (Window Services). All established conversations, sessions are executed by the daemons including database access.

The Web User Interface (WebUI) Servers generate web-based pages for users' interactive activities. The State-session Servers store the user's web session status variables for analyzing user logic and validation. Furthermore, the ancillary Sub-systems provide the connectivity between the WebUI Servers and HIS database (HIS DB) for HIS applications. The messages communicated between the Sub-systems and WebUI Servers are exchanged via the HL7 Framework.

The HL7 Framework is the Middleware Integration Engine of the HIS architecture. It supports message management, routing, mapping, and

database access. Detailed information about the processing of each message is also automatically logged by the Engine. Moreover, the Engine glues the medical systems (or applications) together. The HL7 Middleware accesses HL7 message, embedded in XML format, over Simple Object Access Protocol (SOAP).

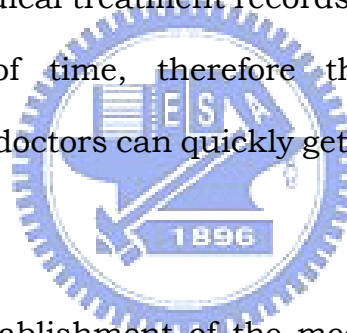
In order to achieve the data consistency, we introduce a Data Exchange Server that only receives the message sending from the HL7 Middleware. While Data Exchange server receiving messages, it will perform the data synchronization among patient demographic data in HIS, patient radiology information orders to Outsourcing Systems, i.e., RIS (Radiology Information System) database, or laboratory orders to LIS (Laboratory Information System), i.e. Legacy HIS, database. This data exchange processing can ensure all data in systems, i.e., HIS and Outsourcing Systems, are updated and consistent.

To increase the performance of the NTUH HIS, a cluster of identical servers are deployed and dispatched dynamically by introducing Layer 4 Switches and Layer 2 Switches. All the servers are configured running under load balancing as well as failover modes to ensure the system's availability and concurrency. The firewalls are also installed to enhance the security of the architecture.

Chapter 3 Requirements

➤ 3.1 Requirements Overview

Doctors see the patient sometime need to reference the past specific medical record, doctors need to know the patient medical treatment account in order to get the patient medical record, but doctors often only have patient medical record number or identity card number. At this point we have to use the medical number or identity card number to obtain patient all medical treatment records, but manually operation often spends a lot of time, therefore this query must to be programmable. So that doctors can quickly get all of the patient medical treatment records.



Traditionally in the establishment of the medical image record must spent a lot of time to generate the image file, and the process of generating the image file would generate a lot of wastewater to cause the environmental pollution, and these image files are often not easy to preserve. It often spends a lot of manpower and resources in the maintenance of these medical records, therefore we must allow all the image files can be electronicalized, making the establishment of medical image records to become a simple matter and not wasting resources.

When the doctor establishes the medical image record, doctor often needs to make the point mark on the image file, but sometime the doctor would make mistakes on the image file to lead the image file have

to be regenerated. Such editing of the image file is not only inconvenient and inaccurate, therefore we must provide users can do on-line editing of image files, allows users can do any editing on the image file, it would be no more difficult to edit the image file.

When the hospital has many patient medical image records, it is very time-consuming things to find the patient medical image records manually, therefore we must provide a function can quickly query the medical image record; the doctor could quickly understand the patient condition according to the medical image records. And the doctor could edit the medical image record for the demand, so system has to record every time modify to avoid the record will not be randomly changed.

Because Medical Image Maintenance System may be used on many record systems, the system has to be designed to easily join in other systems. Let Medical Image Maintenance System can perform its functions in the needed systems.

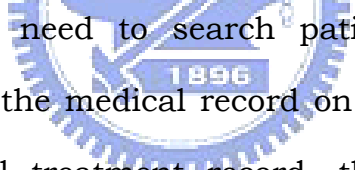
Through the requirement overview I separate the system into six main functions on the requirement functions; I will analyze every function in the next chapter.

Requirement Functions

1. Query patient medical treatment records
2. Establish patient medical image records
3. On-line image editor
4. Query and edit patient medical image records
5. Query medical image record editing history
6. Medical Image Maintenance System integration

➤ 3.2 Requirement Analyses

1. Query patient medical treatment records



Because doctors often need to search patient medical treatment account in order to do the medical record on the specific account or search specific medical treatment record, the requirement has to provide doctors can search all patient medical treatment records depending on the identity card number or medical record number. And medical treatment records must provide some information to facilitate the doctor obtains the medical treatment record he wants.

2. Establish patient medical image records

In order to electronicalize the traditional medical image paper records, the system has to design an electronic medical image record which combines with text and image, and the doctor can set the view permission on the medical records to protect the privacy of patients. On

image file part that I supply the basic medical template pictures to doctors to select as the image source or doctors can use the local side image files as the image source.

And system must automatically record some information about the uploader, the upload time, department, etc. The information can be the clues for the future investigations. When all records are electronicalized, we can reduce the manpower to maintain the paper medical records.

3. On-line image editor

The traditional editing the image directly mark the point on the image is not only inconvenient but also easy to damage image. When image files after electronicalizing, system has to provide direct on-line editing image features. Let the doctors can easily make modifications to the image, the functions of the editor must likes the functions of “Microsoft Paint”, doctors can make accurate modifications on the image, no longer be troubled by image of the damage.

4. Query and edit patient medical image records

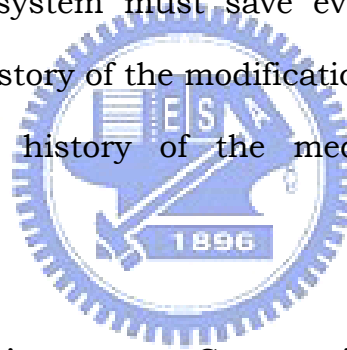
In the past, access to the medical image records of patients, not only time-consuming and laborious. However, if all files are electronicalized, we can make the work of these queries to be completed by the computer. Doctors need only enter a patient treatment account, medical record number or identity card number; the system can be based on these ID to get patient medical image records. It can improve the efficiency of

medical treatment to reduce the waste of manpower.

After doctors access the medical image records of a patient, the doctor may do additional modifications or statements to the medical image record. Therefore, the system must provide the doctor can remodify the medical image record in the future.

5. Query medical image record editing history

Because of the same medical image record may be remodified by the different doctors, the system must save every time medical image records to record the history of the modification. Let doctors be able to view the modification history of the medical image records to understand the change.



6. Medical Image Maintenance System integration

HIS system of NTUH has many record systems need to use medical image records, so Medical Image Maintenance System must has a characteristic which is that Medical Image Maintenance System can be easily established in other systems. Let capabilities of Medical Image Maintenance System can be used in various record systems.

Chapter 4 Design and Methodology

➤ 4.1 Medical Image Maintenance System

Tiers

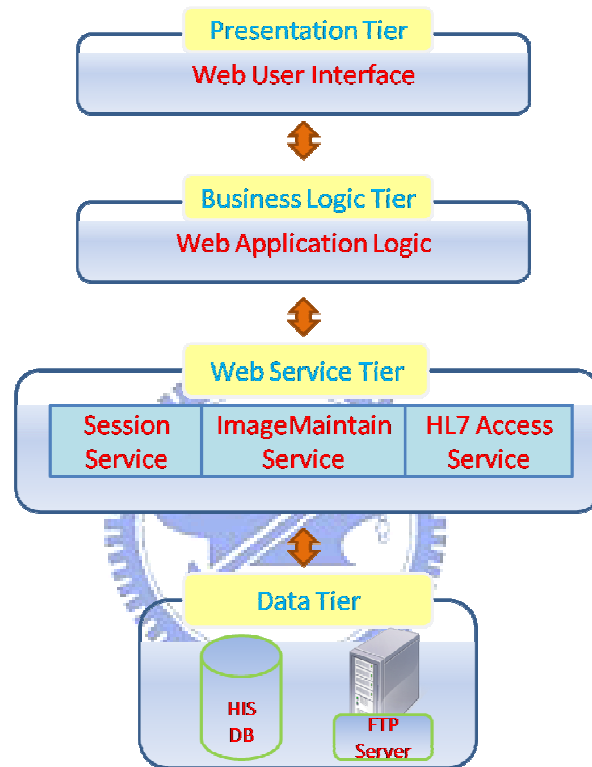


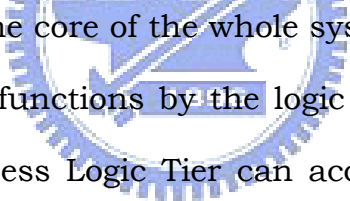
Figure 4.1 System Tiers

Medical Image Maintenance System is divided into four-tier to design this System. From Figure 4.1 we can clearly see the four Tiers are Presentation Tier, Business Logic Tier, Web Service Tier and Data Tier. Multilayer's purpose is to give each layer has its own independent responsible block so each layer could focus on its functions to implement and reduce the intervention of other layers to achieve a high degree of flexibility. In the latter part, I will describe the responsibility of each layer in detail.

1. Presentation Tier

Presentation Tier is the layer to make the interaction with users. This layer is mainly in the layout design. If the layout is properly designed, users will clearly know how to use the system at first sight. Therefore, I use a large number of functional components such as Textbox, Button, Drop Down List, etc. To make users can know the characteristics of the components and use the system very User-Friendly. This is the main responsible for this layer.

2. Business Logic Tier



Business Logic Tier is the core of the whole system. It is responsible to implement all required functions by the logic language. When a user uses the system, Business Logic Tier can access the data from Web Service Tier or Data Tier and presents to the user through Presentation Tier. Therefore, Business Logic Tier integrates all tiers' functions to complete the system.

3. Web Service Tier

Web Service Tier is responsible for communicating with Healthcare Information System's Web Services and implementing system's Web service. System under NTUH's HIS must use two major Web Services which are Session service and HL7 Access Service. Those two services I will introduce in detail in the later chapter. Medical Image Maintenance

System also has its own Web Service to provide Client-side program to use. Therefore, this tier is mainly responsible for the affairs of Web Service.

4. Data Tier

Data Tier is responsible for all information's maintenance and management. Because Medical Image Maintenance System needs to save many patient medical image records, Data Tier uses the database and FTP server to make images and text to be saved properly.

➤ **4.2 Medical Image Maintenance System Functionalities**



Through discussion and analysis of requirements, the system must be implemented six major functions and use two major Web Services on the HIS. The following is a list of it:

Requirement Functions

1. Query patient medical treatment records
2. Establish patient medical image records
3. On-line image editor
4. Query and edit patient medical image records
5. Query medical image record's editing history
6. Medical Image Maintenance System can easy join in other record systems

Healthcare Information System's Web Services

1. Session Service
2. HL7 Access Service

4.2.1 Functions Design

1. Query patient medical treatment records

On the database of HIS system, the medical treatment records of patient are distinguished into three types are inpatient, outpatient and emergency to store. And in those records store identity card (ID) number, medical record number, medical treatment account, attending doctor, and etc. Therefore, we can use ID numbers, medical record number or medical treatment account of the necessary fields does search the patient medical treatment records. Because HIS system for database access is according to Health Level Seven (HL7) standard to carry out, I use as shown in Figure 4.2 approach to search the patient medical treatment records.

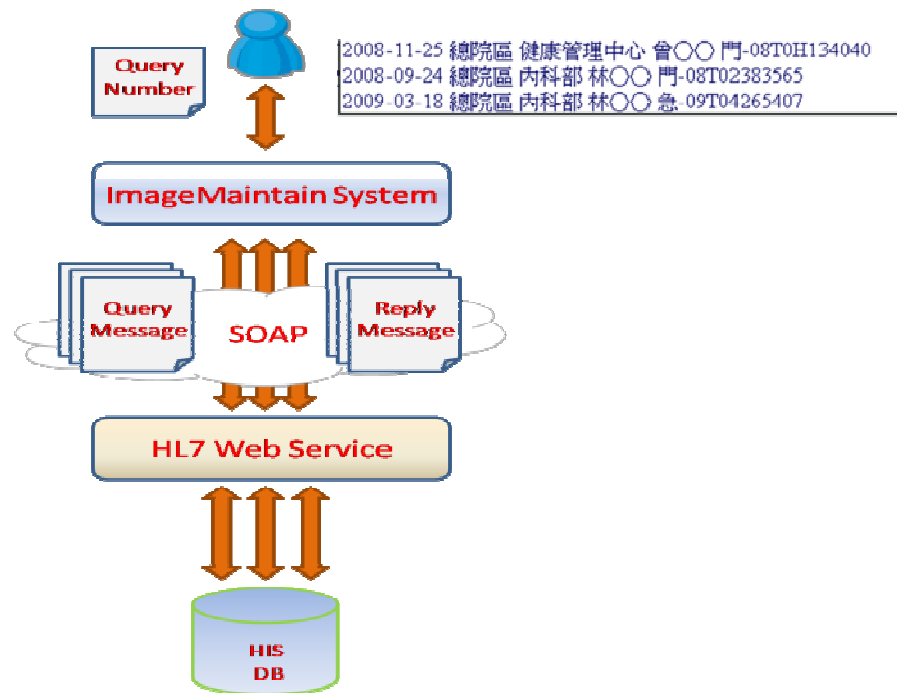


Figure 4.2 HL7 message flow chart

Because the medical treatment records of patient are distinguished into three types, when querying of patient all medical treatment record must query all medical treatment record's types. At this point we have to produce three HL7 query messages by HL7 Library and through HL7 Web Service to query different types' medical treatment records. HL7 Web Service will packet the result in the Reply Message and returns back. And I will show the medical treatment records of the patient in the drop down list to make doctors get the information they wanted.

2. Establish patient medical image records

It is very important for any record in the hospital. And in a medical image record I provide doctors can store image file, image comment, the patient ID and set the browsing permission. Of course, the system also

has to automatically record such as upload time, uploader, and the record sequence number, etc. Because each medical image record is a medical record. I have to record in detail the source of it in order to the record can be traced.

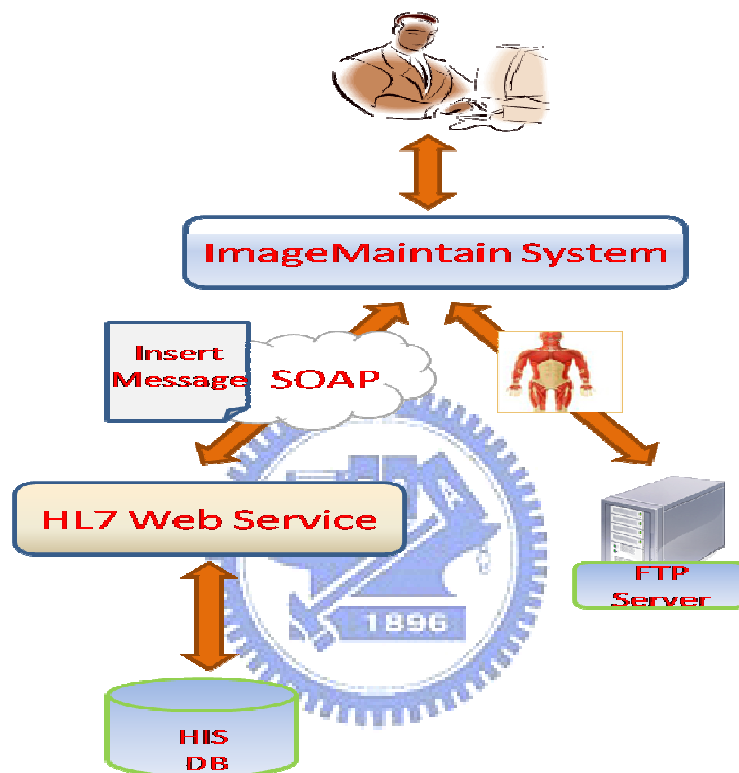


Figure 4.3 Establishing record flow chart

Figure 4.3 is the flow chart of establishing the medical image record. Because HIS system uses the HL7 to access the database, in storing the medical image record I would first convert the data into the HL7 insert message through HL7 Web Service stores in HIS database. However, the database can only save the text and image cannot be efficient saved, I use the FTP server as the Image Database to save image file. The use of database and FTP server let each record of medical image record to be stored properly.

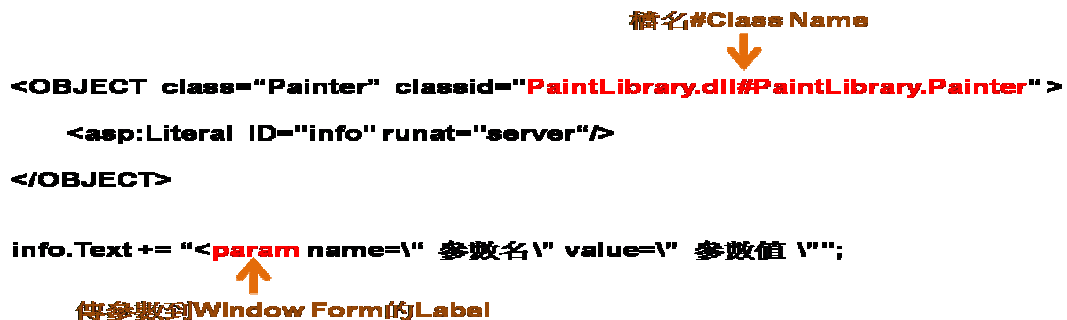
3. On-line image editor

Medical Image Maintenance System is a Web Application, so to provide a similar painting function is very difficult. But if we use Window Application, it will be easier to achieve this function.

By the survey of the plug-in technology we found out the OBJECT label, this label can combine the Active control in the Web Application. Therefore, I use this label to embed the Window Form in the Web page to achieve the functions of the on-line image editor.

Window Application and Web Application are two independent programs, so we must have a bridge to communicate both. ASP.NET provides a param label can bring parameters to the Web Application from the Window Application. And the Window Application communicates with the Web server I use the Web Service to translate data to the server. So we can reach the two-way communication of Window Application and Web Application.

Figure 4.4 is the important code of param label and Object label:



```
<OBJECT class="Painter" classid="PaintLibrary.dll#PaintLibrary.Painter" >
  <asp:Literal ID="info" runat="server"/>
</OBJECT>

info.Text += "<param name='\" 参数名 \'" value='\" 参数值 \'"\"";
```

Class Name
↓
PaintLibrary.dll#PaintLibrary.Painter

↑
传参数到 Window Form 的 Label

Figure 4.4 Embedding object code

4. Query and edit patient medical image records

When establishing the patient medical image records, I will store an identification card number, medical record number or account in the record. So I can query patient medical image record according to this information. I need to packet the query data into query message through HL7 Web Service to query HIS Database. And I could get the patient medical image record.

Editing function, I will provide the user can do delete, edit and view on the medical image record. When user deletes the medical image record, the database will mark this record then this record would prohibit users to modify and view. When the user edits the record, I will present the record's data on the editing page, and the user can reedit the medical image record. After editing is completed I use Web Service to save the record in the database. When a user views a record, I will present the record on the web page to give user to look up.

5. Query medical image record editing history

Because each medical image record is the medical treatment record of the patient, each record must be saved, even if the record is modified, the original medical image record must be properly saved.

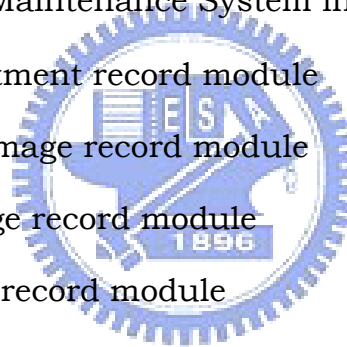
In order to record the medical image record's editing history, I design a source sequence number column in medical image record to

distinguish whether this record is a new record. This column is stored the source sequence number of the edited medical image record. If the record is a new medical image record, this column will automatically be filled with the record sequence number. In this way I can get all the edited medical image records according the same source sequence number and sort the records according the record time. We will get the medical image record's editing history to make user to refer the history.

6. Medical Image Maintenance System integration

I divide Medical Image Maintenance System into four modules :

1. Query medical treatment record module
2. Establish medical image record module
3. Query medical image record module
4. Edit medical image record module



These four modules have their own independent character, so I separate the system into four modules. Let different record systems could select modules to join.

How can the system be designed for modular. I use ASP.NET's "User Control Component" to implement the module, because the feature of the component is like an object can be easily reused.

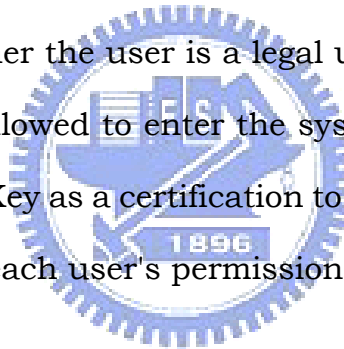
Thus, Medical Image Maintenance System can be easily used in other systems and medical image record can be applied on many record systems.

4.2.2 Web Services

1. Session Service

Session Service is responsible for controlling HIS system's users, any user of HIS system must do authentication and authorization through the Session Service and Session Service can be used to achieve the purpose of Single Sign On.

To enter HIS system of National Taiwan University Hospital must be in the portal interface to enter your account and password. Session Service will verify whether the user is a legal user, if the user is a legal user, the user will be allowed to enter the system and Session Service will generate a Session Key as a certification to give the user. By Session Service we can control each user's permissions.



2. HL7 Access Service

Health Level Seven (HL7) is an international community of healthcare subject matter experts and information scientists collaborating to create standards for the exchange, management and integration of electronic healthcare information.

HL7 promotes the use of such standards within and among healthcare organizations to increase the effectiveness and efficiency of healthcare delivery for the benefit of all.

The "Level Seven" refers to the highest level of the International

Organization for Standardization (ISO) communications model for Open Systems Interconnection (OSI) - the application level. The application level addresses definition of the data to be exchanged, the timing of the interchange, and the communication of certain errors to the application. The seventh level supports such functions as security checks, participant identification, availability checks, exchange mechanism negotiations and, most importantly data exchange structuring.

So now the National Taiwan University Hospital is using the HL7 Access Service to do the exchange of information, management and integration. This makes the transmission of information establishing on the standard structure in order to connect with international in the future.

HL7 Middleware Framework Overview is as follows:

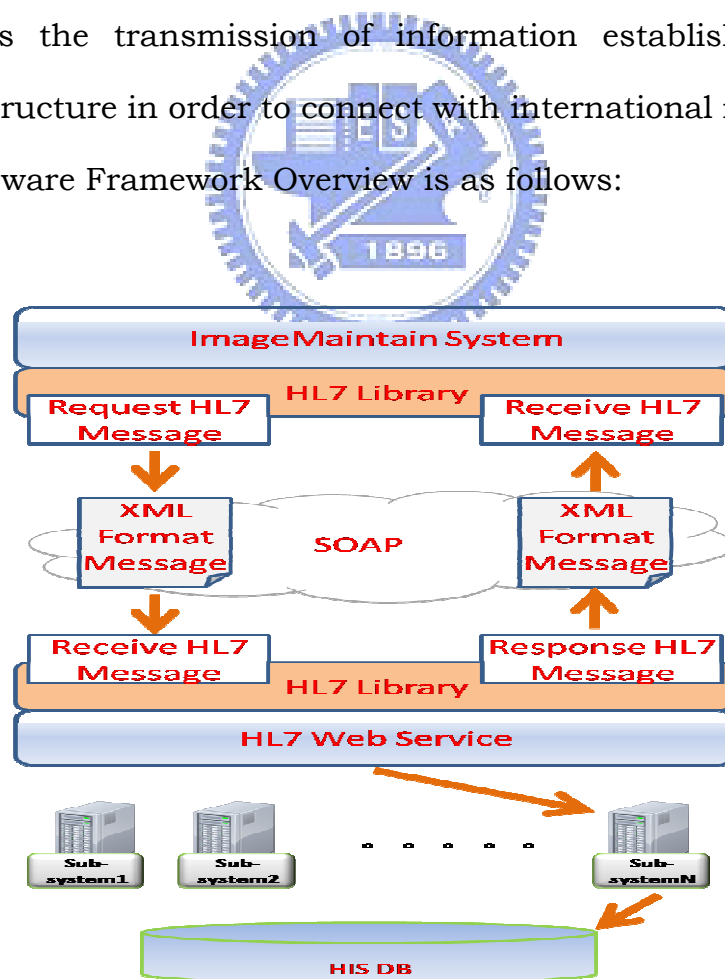
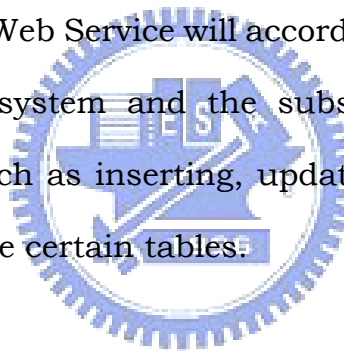


Figure 4.5 HL7 Middleware Framework

Under the HIS of National Taiwan University Hospital all the HIS database access is through the HL7 Middleware Framework to execute. When Medical Image Maintenance System accesses the database, Medical Image Maintenance System will create the Request HL7 message, and then the message will be written out as the XML format message through the HL7 library and sent over SOAP to the HL7 Web Service Server.

When the HL7 Web Service Server receives the XML format message, the HL7 library reads the XML format message and translates it into the HL7 message. The HL7 Web Service will accord to the message assign to the corresponding subsystem and the subsystem will perform the necessary processes such as inserting, updating some information or selecting data from some certain tables.



After the process, the HL7 Web Service will generate the Respond HL7 message and translate to the XML format message through the HL7 Library to Medical Image Maintenance System. Similarly, the HL7 library in Medical Image Maintenance System reads the XML format message and translates it into HL7 message.

This is the procedures of the HL7 message sending and receiving on the HL7 Middleware Framework.

Chapter 5 Implementation and Result

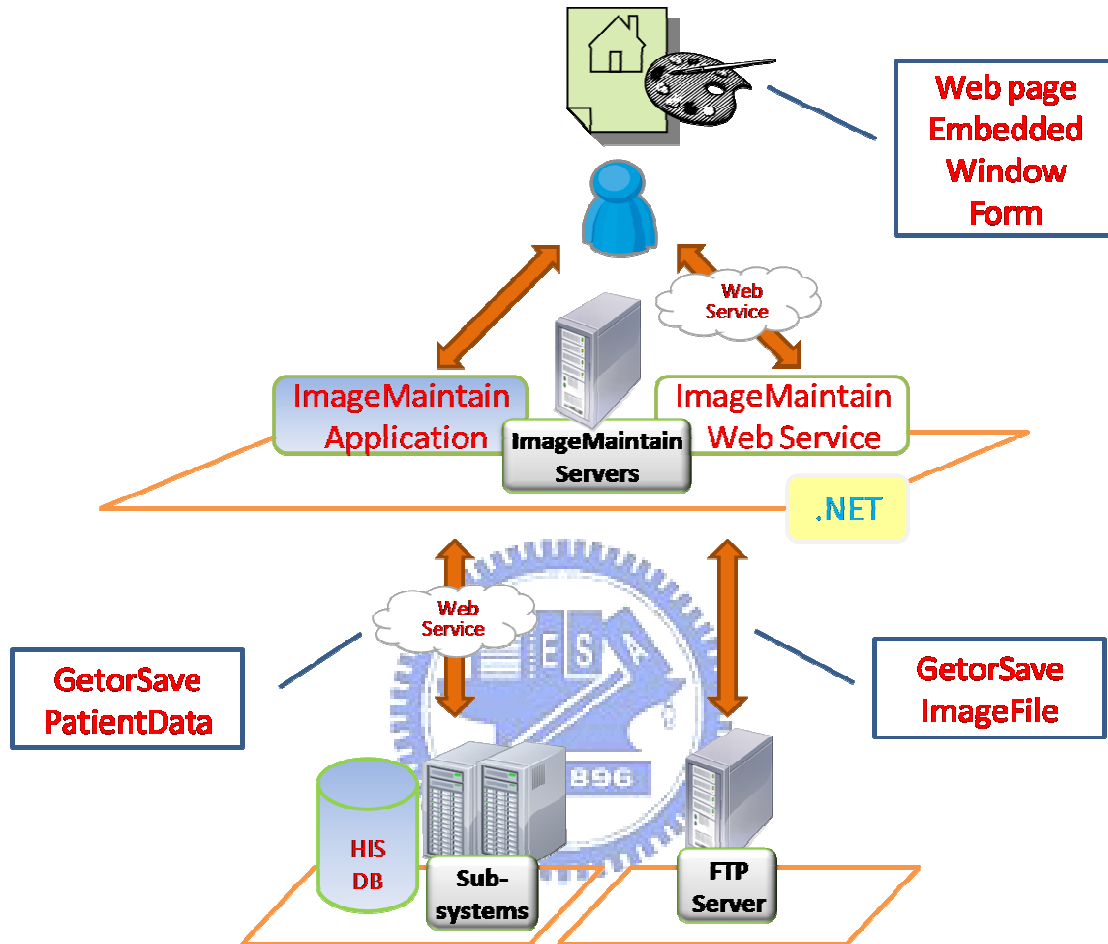


Figure 5.1 System Architecture

From Figure 5.1 we can clearly see the overall Medical Image Maintenance System architecture; here I would briefly introduce the overall architecture of Medical Image Maintenance System. The system is set up to provide users on-line editing medical image record and query related medical image records, so system uses the window form embedded in the web page to allow users to edit image on-line and using the database with FTP server to store medical image data.

Because HIS of NTUH is built under ASP.NET environment, Medical Image Maintenance System is also built under ASP.NET environment. And Medical Image Maintenance System also uses a lot of Web Services in order to query database, communicate with window form, etc.

The above is the outline of overall architecture of Medical Image Maintenance System; in the following I will describe the functions of the system.

➤ 5.1 Medical Image Maintenance System main Interface

The screenshot shows the '新增圖檔' (Add Image) interface. It is divided into three main functional areas:

- 查詢病人就診紀錄區塊 (Query Patient Visit Record Block):** This area includes a search bar for '以帳號、身分證號或病歷號' (by account, ID number, or medical history number) with the value '3268702'. It also features a dropdown for '就診記錄' (Visit Record) showing '2008-10-02 總院區 內科部 周○○ ○-08T02186025' and a '目前帳號' (Current Account) of '08T02186025'.
- 建立病人圖檔紀錄區塊 (Create Patient Image Record Block):** This area contains a '瀏覽本機既有圖檔' (Browse Local Images) section with filters for '院區' (Hospital Area), '科別' (Department), and '樣版圖' (Template). Below this is a '圖檔說明' (Image Description) text area and a '指定瀏覽權限' (Specify Access Rights) section with radio buttons for '僅上傳者' (Only Uploader), '僅同科部' (Only Same Department), and '所有人都可' (All Users). At the bottom, there are '編輯上傳' (Edit Upload) and '直接上傳' (Direct Upload) buttons.
- 圖檔紀錄查詢區塊 (Image Record Query Block):** This area is titled '圖檔檢視' (Image View) and includes a '本人新建圖檔' (My New Images) button and a search input for '依病人身份證字號、病歷號或帳號查詢' (Search by patient ID, medical history, or account) with the value '08T02186025'.

Additional text in the interface includes instructions: '說明一：上傳前，請務必填寫病人帳號或病歷號' (Before upload, please fill in patient account or medical history number), '說明二：上傳圖檔僅限jpg.png.gif及bmp檔，圖檔名稱請盡量使用半形英文字與_，以免程式無法判讀' (Upload images only in jpg, png, gif, and bmp formats; use lowercase letters and underscores for filenames), '說明三：預覽後，若確定上傳，請儘速按下「上傳」鈕，否則可能會被系統定時清除' (After preview, press 'Upload' if confirmed), and '說明四：上傳功能僅提供便利瀏覽之用，請使用者仍需自行備份，以免資料遺失' (Upload is for viewing only; users should back up their data).

Figure 5.2 System interface

Figure 5.2 is the interface of Medical Image Maintenance System, system is mainly divided into three areas of query the medical treatment records of the patient area, establishing patient medical image record area and query patient 's medical image record area. Each area has its unique function and Medical Image Maintenance System has four major functions:

1. Query patient medical treatment records
2. Establish patient medical image records
3. Query patient medical image records
4. Medical Image Maintenance System integration

5.1.1 Query patient medical treatment records

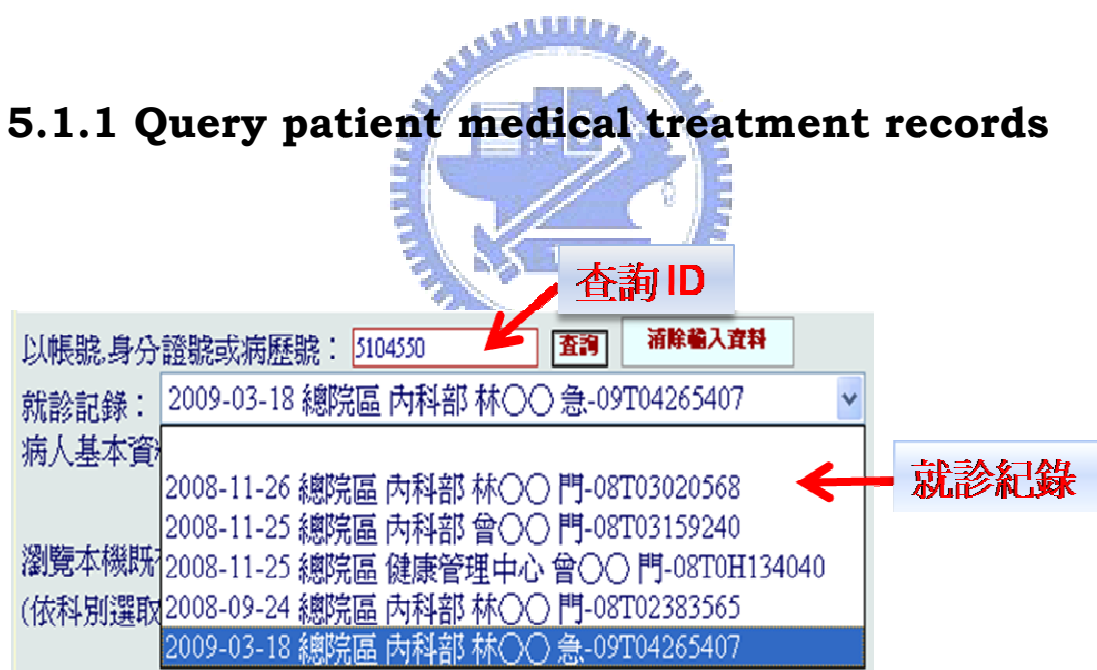


Figure 5.3 Search patient record interface

Figure 5.3 is the interface of querying patient medical treatment record. When doctor enter identity card number or medical record number to query, the drop down list will show all of patient medical treatment records. If doctor enter account to query, the list only shows that record.

The medical treatment record provides the date of treatment, the hospital district, department of treatment, the attending physician and medical treatment account then doctor can get the treatment information about the patient.

5.1.2 Establish patient medical image records

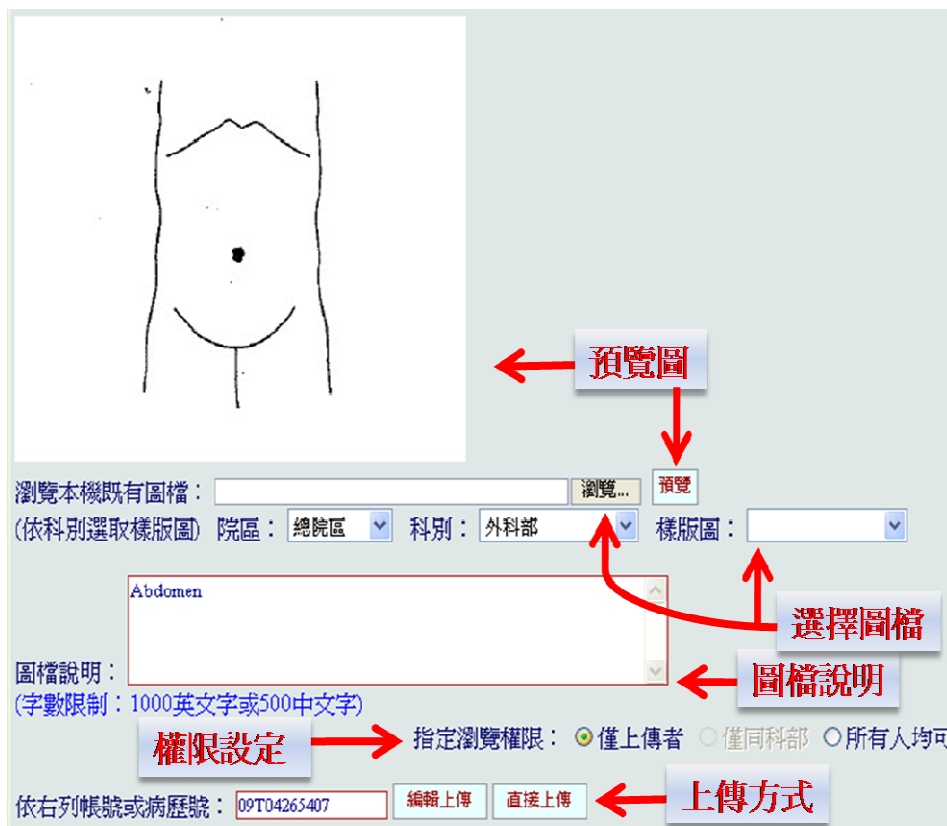


Figure 5.4 editing interface

Figure 5.4 is the interface of editing medical image record.

Doctors often need to do some records for patient treatment. Therefore, this interface provides for their requirements.

This interface allows users to upload their local side image file or the

medical template image file as the source image file. User can write the comment and set the browsing permission on the record. Through setting the permission, we can protect some records will not be browsed and modified. Patient treatment account, medical record number and identity card number can be used as the ID to upload the record and users can direct upload or editing upload. Editing upload will provide an editing page as shown in Figure 5.5 to allow users to do on-line image modification.



Figure 5.5 editing page

5.1.3 Query patient medical image records

When the doctor treats the patient, the doctor often need to refer to patient related records for doing more accurate diagnosis. This query function allows the doctor to immediately query the patient medical image records to reduce the time person takes to find the records

The query has two ways to query the medical image records. One can query the records created by themselves and the other is based on the patient treatment account, medical record number or identity card number to query patient medical image records. Figure 5.6 is the query interface, in the record where I provide to delete, modify, view and view record's editing history functions.

圖檔序號	病人資料	帳號	建檔日期	原圖檔人	說明	修圖建檔人	瀏覽權限	刪除	修改	選圖	歷次修改
451	翁○卿 (3268702)		2009/03/27 18:08	翁永卿 (030808)	Thyroid	翁永卿 (030808)	上傳者	刪	改		VIEW
449	翁○卿 (3268702)		2009/03/22 23:51	翁永卿 (030808)	Brain Base	翁永卿 (030808)	上傳者	刪	改		VIEW
448	翁○卿 (3268702)		2009/03/22 23:35	翁永卿 (030808)	Thyroid	翁永卿 (030808)	上傳者	刪	改		VIEW

圖檔序號	病人資料	帳號	建檔日期	原圖檔人	說明	修圖建檔人	瀏覽權限	修改	選圖	歷次修改
451	翁○卿(3268702)		2009/03/27 18:08	翁永卿(030808)	Thyroid	翁永卿(030808)	上傳者	改		歷次修改
450	翁○卿(3268702)		2009/03/23 00:01	翁永卿(030808)	Thyroid	翁永卿(030808)	上傳者	改		

Figure 5.6 Search Image record interface

5.1.4 Medical Image Maintenance System

integration

There are a lot record systems in HIS system. However, these systems are only simple text record and these records often need the images to assist. So I divide Medical Image Maintenance System into four main modules:

1. Query medical treatment record module
2. Establish medical image record module
3. Query medical image record module
4. Edit medical image record module

These four modules are implemented by “User Controls Component” of ASP.NET. So System designers only need to add “User Control Component” to the system and set some parameters and then these functions can be used on the system.

Figure 5.7 is the result of Operation Record System combined with Medical Image Maintenance System. Thus, Medical Image Maintenance System can easily be joined in other record systems.

台大醫院 NTUHH 手術室作業 登入翁永卿 者: (03XX08)

院區: 台大總院(公館)

急 林○和(M,73_2) 手術日: 2008/10/09 房號: 001 序號: 01 未執行 詳細 修改 更新 帳務 記錄

開始: 費時: 麻醉: 神經阻斷 傷口:

科部	術式	狀態	印	新增者	新增時間	修改者	最後修改	印	刪
選 外科部	test	完成	0	翁永卿	2008/12/25 13:53	翁永卿	2008/12/25 13:53	印	刪
選 外科部	ttt	完成	0	翁永卿	2009/01/08 13:29	翁永卿	2009/01/08 13:29	印	刪
選 外科部	test3	完成	0	翁永卿	2009/01/08 14:11	翁永卿	2009/01/08 14:11	印	刪

手術紀錄

科部: 外科部 術式名稱: 紀錄總本 主治醫師 助手

圖檔操作

圖檔序號	病人資料	帳號	建檔日期	原圖檔人	說明	修圖建檔人	瀏覽權限	刪圖	修改	選圖	歷史修改
402	林○和(5128631)	07T04835176	2009/01/08 15:08	翁永卿(030808)		翁永卿(030808)	上傳者	刪	改	VIEW	
401	林○和(5128631)	07T04835176	2009/01/08 15:08	翁永卿(030808)		翁永卿(030808)	上傳者	刪	改	VIEW	

圖檔檢視

圖檔上傳及編修

瀏覽本機既有圖檔: 瀏覽... 預覽

(依科別選取樣版圖) 院區: 科別: 樣版圖:

圖檔說明:

指定瀏覽權限: 僅上傳者 僅同科部 所有人均可

編輯上傳 直接上傳

Figure 5.7 Medical Image Maintenance System in Surgical System



Chapter 6 Conclusion and Discussion

The thesis presents Medical Image Maintenance System, which is a secure, multi-tier, Web-based, multi user, and user friendly system.

The Medical Image Maintenance System is efficiently integrated with the NTUH HIS under SOA. The HL7/Web Service middleware framework is used to deal with all data access as well as exchange. The Web Service server receives the XML format HL7 message from Web application server and then accesses the database according to HL7 message.



Moreover, through the design of authentication as well as authorization is provided by session service, the system can achieve reliable security mechanism. The session service integrates all authentication requirements to realize the Single Sign On (SSO) mechanism, which means the user login the system once and then he or she can use all subsystems without logging again. And the authorization mechanism determines if some application page can be accessed by the authenticated user.

Medical Image Maintenance System under the HIS System, let NTUH doctors could be more convenient, fast in the establishment of medical image records and avoid the medical records stored in paper trouble, doctors access to the medical image records can have the fastest speed

to get the doctor wanted medical image. To increase the efficiency of medical treatment reduces unnecessary waste of manpower.

And Medical Image Maintenance System can be added to many record systems that need the medical image records, to make Medical Image Maintenance System could give full play to its function in any needed place.



References

- [1] "Health Level Seven Taiwan" [Online] Available:
<http://www.hl7.org.tw/>
- [2] S.H. Hsieh, S.L. Hsieh, Y.C. Weng, T.H. Yang, Feipei Lai, and P.H. Cheng etc. "Middleware based Inpatient Healthcare Information System", Proceedings of the 7th IEEE International Conference.
- [3] T. H. Yang, P. H. Cheng, C. H. Yang, F. Lai, C. L. Chen and H. H. Lee et al. "A Scalable Multi-tier Architecture for the National Taiwan University Hospital Information System based on HL7 Standard", Proceedings of the 19th IEEE Symposium on Computer-Based Medical Systems.
- [4] Yung-Ching Weng, Sheau-Ling Hsieh, Sung-Huai Hsieh, Feipei Lai. "Design and Enhance a Dynamic Healthcare Portal Site", Proceedings of the 2007 IEEE International Conference.
- [5] Tsung-Yu Chuang. "Intelligent Patient-and-Family-Centered Medical Social Work Information System", Department of Computer Science and Information Engineering College of Electrical Engineering and Computer Science National Taiwan University Master Thesis.
- [6] Ching-Liang Su. "Medical Record and Medical Image Processing by Use the Internet SQL Searching Engine", Proceedings of the 2000 IEEE International Conference.
- [7] S. L. Hsieh, Feipei Lai, P. H. Cheng, J. L. Chen, H. H. Lee and W. N. Tsai et al." An Integrated Healthcare Enterprise Information Portal and Healthcare Information System Framework", Proceedings of the 28th IEEE EMBS Annual International Conference.

- [8] D r H K Huang. “Medical Image Management in Healthcare Enterprise”, Business Briefing : Global Health Care 2002 issue pp. 84 – 88
- [9] World Wide Web Consortium (W3C), “Web Services Architecture”, <http://www.w3.org/TR/ws-arch/> , Feb, 2004.
- [10] 張寶源、李世傑、鐘國晃、楊芷絜、王魯發等人。” 慈濟醫學中心醫療影像儲存與傳輸系統(PACS)之建置與效益評估”, Tzu Chi Med J 2004 · 16 · No.6
- [11] <http://msdn.microsoft.com/zh-tw/default.aspx>

