Development of a Kidney TeleUltrasound Consultation System

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This paper presents the development of kidney TeleUltrasound consultation system. The TeleUltrasound system provides an innovative design that aids the acquisition, archiving, and dissemination of medical data and information over the internet as its backbone. The system provides data sharing to allow remote collaboration, viewing, consultation, and diagnosis of medical data. The design is layered upon a standard known as Digital Imaging and Communication in Medicine (DICOM). The DICOM standard defines protocols for exchanging medical images and their associated data. The TeleUltrasound system is an integrated solution for retrieving, processing, and archiving images and providing data storage management using Structured Query Language (SQL) database. Creating a web-based interface is an additional advantage to achieve global accessibility of experts that will widely open the opportunity of greater examination and multiple consultations. This system is equipped with a high level of data security and its performance has been tested with white, black, and gray box techniques. And the result was satisfactory. The overall system has been evaluated by several radiologists in Malaysia, United Arab Emirates, and Sudan, the result is shown within this paper.

KEY WORDS: TeleUltrasound, DICOM, image processing, physician groups

INTRODUCTION

The TeleUltrasound system was developed in response to the absence of a digital system which enables the sharing of ultrasound images and data among radiologists, doctors, clinics, laboratories, and other medical officers who require this sort of data remotely, at any location in the country or the world.

In one form or another, telemedicine has undeniably been practiced since the past 30 years¹. In short, telemedicine may involve as simple as two health professionals discussing a case over the telephone, or as sophisticated as using the satellite technology to broadcast a consultation between

providers at facilities in two countries, using video conferencing equipment².

Telemedicine has the potential to make a difference in the lives of many people³. In particular, in remote rural areas where a patient and the closest health professional can be found hundreds of miles apart⁴, telemedicine importance lies in the improvement of the medical service and in the availability of quality medicine⁵.

In emergency cases, TeleUltrasound access can mean a big difference, i.e., between life and death. In the cases where fast medical response time and specialty care are needed, the availability of this telemedicine can be very critical⁶. For example, a specialist at the North Carolina University Hospital was able to diagnose a rural patient's hairline spinal fracture at a distance, using telemedicine video imaging. The patient's life could be saved because the treatment was done on-site without having to physically transport the patient to the specialist who was located a great distance away⁷.

In general, the TeleUltrasound system used in this project provides a Web interface with a remotely accessed .Net Solution Imaging and Diagnostic, distributed application over the Internet for accessing and viewing information, while a Structured Query Language (SQL) database is deployed for data storage management. The .Net Solution technology enables web-based distributed interface which is server- and platform-independent

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ent across a network, without requiring pre-installation and tedious networking configuration.

METHODOLOGY

The approach is generally designed using the “bottom-up” methodology. Each simplified function is first created and tested for its functionality. Integrated functions which carry out a single process are combined in a single .Net Solution file. The imaging application is designed in vb.Net language which is a Microsoft framework. The development of the complete system took approximately 6 months to reach the desired result. There are several advantages of using .Net solutions, such as the .NET Class Library provides availability to all .NET languages resulting in a consistent object model, regardless of the programming language the developer uses. Besides that, ASP.NET and the .NET Framework simplify development by separating the application logic and presentation logic which makes it easier to maintain the code. Later, the .NET Framework makes it easy to deploy applications. The application can run at any platform using a web browser.

In this study, a large number of remote clients, offices, and home users may not have high-speed broadband connections. Especially for those located in rural areas, they may only have dial-up connections. However, joint photographic experts group (JPEG) images are used within this system. In addition to providing a smaller file size for the image, JPEG images are Internet friendly. This allows the images to be viewed from any browser

or application without additional codes. DICOM format is also supported within the system; although it has JPEG lossless in it.

An open source image processing tools has been incorporated into the imaging and diagnostic application to perform basic functions respectively as follows:

1. The system provides image processing functions directly online to add the final diagnosis and submit it in a report.
2. The system is able to sort patient/physicians into groups depending on their field and status. And also search for a specific patient or group of patients. This sorting function has a great benefit in saving time and effort as well to keep track of the patient information and diagnosis.

A. System design

The system is designed using .Net solution programming technique through the following major classes

- Image Resources.Net Solution

This class builds up a resource panel for images in the database, which is connected using SQL server, the class will act as a simplified user interface to allow the user to easily query an image available in the database, and as well allow the user to retrieve certain images and patient information.

- Patient Information.Net Solution

This class creates interactions with Patient Information, where the user can enter the patient

Physicians List

Add New	Delete	Search:	<div><div></div></div>	Search	Show All	Page Size:	<div>20</div>	OK
Edit	☐	Name	Qualification	Hire date	Hospital	Groups	Related Patients	
Edit	☐	Dr.Hamza	DR	12/5/1999	hospital kl	Show	Show	
Edit	☐	Dr.Intisar	pathology	12/6/2005	Um hospital	Show	Show	
Edit	☐	Prof.Fatimah	Professor	1/1/1999	Um Hospital	Show	Show	
Edit	☐	Dr.Ibrahim	Doctor	1/1/2002	El shorok	Show	Show	
Edit	☐	Dr.shehab	ENT Sergent	8/8/2004	University malaya	Show	Show	
Edit	☐	Dr.Mohammad	Doctor	1/6/2006	Ramadan ho.	Show	Show	
Edit	☐	Dr.Ahmed	Doctor	1/12/2004	University malaya	Show	Show	

7 record(s) found in 1 page.

Page : [1]

Fig. 1 Admin control page.

Patient diagnosis List

Add New	Delete	Search: <input type="text"/>	<input type="button" value="Search"/>	<input type="button" value="Show All"/>	Page Size: <input type="text" value="20"/>	<input type="button" value="OK"/>
Edit ☐	Patient Name	Diagnosis	Image	Date		
Edit ☐	Haytham	Show	Show	9/3/2008 7:53:00 AM		
Edit ☐	Haytham	Show	Show	9/3/2008 7:50:00 AM		
Edit ☐	Haytham	Show	Show	7/29/2008 12:12:00 AM		
3 record(s) found in 1 page.						
Page : [1]						

Fig. 2 Physician homepage.

information into the database; this class has a simple interface where the user will key in different information such as contact name, patient, address, and ID/password. By determining these values the admin will give the patient the ability to log in into his personal information, images, and diagnosis throw a pre-determined password.

- Update Diangnosis.Net Solution

This class basically works by searching for a specific patient or a specific diagnosis from the system, the application will call all the related data from the database, then the user/physician can update the patient diagnoses or the patient and just

click the [submit] button, the class will automatically connect to the system and update the database entries and will post the new diagnosis in the patient page.

- ImageDispaly.Net Solution

The method is called by the image manipulation class. When the class is loaded, it will first load and display the selected image to perform needed processing. The original copy of the image is stored in the memory, and not over written to allow quick resetting of image. Another buffer image is made to be a copy of the original image, and all processing is performed on the buffer image.

Physician Groups Welcome Administrator

Images : Add/Edit

Patient Name :

patient image: [Show Image](#)

Diagnosis :

Style Format Font Size

well i think we should use (testing treatment)

Fig. 3 Diagnosis function panel.

Fig. 4 Image processing tool.

B. Web-based application design

The URL chosen for the system is www.umtelemed.net. The user will be directly dealing with the ASP pages to perform different kinds of functions depending on his access level.

- Log-in

There are different types of users, Admin, physicians, and patients. After successful log-in

each user will be directed to their specified homepage.

- Admin homepage

As the admin log-in into the system, he/she will be directed to the admin control page, where the admin can control the system through various functions, as adding new physicians/patients, assign physician/patient to group, and assigning

Fig. 5 Evaluation chart by specialists feedback.

patient to a specific physician through hyperlinks indicated in blue as shown in Figure 1.

- Physician homepage

After physician log-in, the system will determine the role specified by admin to the logged physician, and then direct the physician to his homepage, where he can view and examine patient assigned to him and add his diagnosis by clicking the show hyperlink either under diagnosis column or image column, as shown in Figure 2.

- Patient homepage

The patient also has access to the system; however, it is limited to certain functions such as viewing his diagnosis and updating his personal information.

- Show/edit diagnosis

This function can only be accessed by admin and physicians, to show the patient diagnosis, and edit the diagnosis history if any as shown in Figure 3.

- Show image/edit

The patient image will load with the image processing tool when called for viewing. The physician will apply his desired image processing functions on the image, until he reaches a satisfactory image for diagnosis, image processing functions was chosen depending on the best tools for kidney diagnosis. As shown in Figure 4.

CONCLUSION AND FUTURE WORK

The performance of the system was evaluated by several medical specialists who deal extensively with radiology imaging and ultrasound imaging. Several specialists from different countries such as, Malaysia (five physicians), United Arab Emirates (two physicians), and Sudan (two physicians) were involved in the assessment of the system in order to reach a high level of accuracy.

The evaluation tool is a questionnaire consists of seven questions; the first question was about the opinion of the specialists on the patient digital image storing option and 100% totally answered "very good".

Questions two to four, are on the overall performance of the system. Furthermore, questions

five to seven, are on the ability to access remote patient images and diagnosis and the opinion of the specialists on implementing the system within their hospitals. The overall feedback has been summarized in Figure 5.

The specialists believe that storing images in digital format is a good idea and these digital images are very useful for diagnostic purposes.

The users have the ability to view images/diagnosis by series or dates. Currently, there are number of medical images such as computed axial tomography and magnetic resonance imaging. Digital imaging is superior than traditional analogue images. The radiologists also believe that this will overcome the problem of losing medical films constantly. This archiving system is also thought to be a good advantage as historical images can be searched quickly.

There are improvements that can be made to the system for future developments. The security of the Web-system can be improved by using secure Secure Sockets Layer and encryption methods for logging the site. As this project focuses on the Internet medium for transmitting images, JPEG images are being used. However, as broadband access becomes more widespread especially to remote areas, options can be included to transmit three dimensional images to the client. This will be useful to extract more information and perform image-processing functions such as measurements on images. The diagnosis text and posting box can be improved by displaying it in a better format and allow better postings in formatted text. For further future system development there are a promising open source tools that would rapidly develop medical imaging applications from an extensible set of modular elements, the extensible Imaging Platform project. other approach is the Cross-enterprise Document Sharing for Imaging given by Integrating the Healthcare Enterprise to share images, diagnostic reports, and related information across a group of care sites.

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