DIGITAL IMAGE AND DATA NETWORKING FOR ELECTRONIC MEDICAL RECORD IN OPHTHALMOLOGY CLINICS

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Abstract: Electronic Medical Record (EMR) in the field of medicine can provide wide range of useful information for the clinical research. Experiences using digital image network and associated research will be introduced to help other researchers who are interested in this kind of work. Various techniques and devices are adopted for data acquisition, such as digital single lens reflex (SLR) camera, digital video camera, parallel port capture, digitizers and so on. All the data were transferred to medical record server for the data sharing and retrieval. By gathering a multitude of data from various ophthalmologic devices, electronic medical record system (EMR) was successfully developed.

Introduction

Electronic Medical Record (EMR) in the field of medicine can provide wide range of useful information for the clinical research. It encompasses not only the physician’s chart, but also order communication, laboratory data search, archiving and retrieval of medical images and various data from the devices for diagnostic use. However, launching EMR in real clinical setting has numerous hurdles to be overcome. Retrieving useful medical information from the diagnostic medical devices is one of the most challenging one, because the old analogue devices coexists with newly developed digital devices and the data formats and data ports are not fully compatible even between the new devices. It is especially difficult in ophthalmology clinic, because more than 5 or more different devices are simultaneously in operation even in the smallest clinic.

Recent advancement of the digital imaging devices such as the high-resolution CCD camera or digital SLR camera switch the analog, film-based ophthalmologic measuring systems to the digital ones. And the digital images and network in the field of ophthalmology enable computer-assisted image analysis and objective investigation of the ophthalmologic examination.

In this paper, experiences in establishing EMR in the ophthalmology clinic of Seoul National University Hospital will be introduced to help other clinicians and biomedical engineers who are interested in this kind of work.

Materials and Methods

More than 20 different ophthalmologic diagnostic devices are wired for EMR.

A. device integration

The film-based analogue imaging devices such as fundus camera and photo slit lamp were switched to digital photographic systems by attaching digital single lens reflex (SLR) camera and digital video camera. On fundus camera (CF-60UVi, Canon, Japan), Canon EOS D60 digital SLR camera was attached by using CF-DA synchronization mount, and the camera was controlled by the Canon Eye Q digital imaging software. On photo slit lamp (FS-3, Nikon, Japan), Nikon D100 digital SLR camera was attached. To synchronize the camera shutter to the control stick of the photoslit lamp, MB-D100 motor drive pack and MC-25 electrical release adapter was integrated into the D100 camera. Nikon Capture 4 and Nikon View 6 software was used for the image capture and transfer from the camera through USB port (figure 1).

Figure 1: Integration of the digital SLR camera into the conventional retinal camera (top) and photo slit lamp (bottom)

Digital video image was captured on the video-based, still image-generating devices such as ophthalmic ultrasound machine (BVI, France / Humphrey, U.S.A.) and noncontact specular microscope (Konan, Japan) by image grabbing computer video card. ATI Radeon 9200 VIVO AGP card was chosen and ATI Video ver 7.0 was used for image grabbing and transfer. Motion digital video image was recorded in digital video 25Mbps (DV25) format or motion picture experts group (MPEG) 2 or 4 format.

Reports from the computer-based systems without figure generation ability were captured by the SnagIt capture driver ver 6.13 without any modification of original operation programs. Optical coherent tomography (STRATUS OCT, Zeiss Meditec, U.S.A.), multifocal electro-physiology system (Roland, Germany), OrbScan IIz (Bausch & Lomb, U.S.A.), Heidelberg retina tomograph (HRT, Heidelberg engineering, Germany) were in this category.

Computer-based system with figure generation ability was set to export the images or reports in BMP or JPEG format and transferred the data to the server. Heidelberg retina angiograph (HRA2, Heidelberg engineering, Germany) using Heidelberg Eye Explorer software was in this category.

Closed computer-based system with external printer support was captured through the external printer port by parallel port intercept. Humphrey field analyzer II (Zeiss Humphrey, U.S.A.) was in this category, and the ATEN SXP-500 parallel to serial converter (figure 2) and PrintCapture ver 3.1.2 software were used to intercept the parallel data to the printer. Intercepted data was converted to JPEG file for the archiving and reviewing.

Figure 2: Parallel to serial converter

Analogue devices without computer interface such as Goldmann perimetry and Lancaster test were modified by attaching digitizer-integrated computers. Wacom Intuos3 9x12 inch digitizer and Wacom LCD tablet DTU-710 were adopted for this purpose.

B. Handling of figures and reports.

General figures and reports were integrated into the EMR system. The picture and data interface module (PDIM) was developed for each devices for the connection and data transfer to EMR server. All the pictures were saved or converted to JPEG format, 300dpi, YUV 4:2:2 compression, and 95% preservation. For the NTSC video signal, 720 x 480 pixels were adopted as a standard format, 3,000 x 2,000 pixels for digital SLR camera, and 6,300 x 8,610 pixels for conventional report form at A4 size by SnagIt.

Fluorescein angiography and fundus photography were integrated into the picture archiving and communication system (PACS) for the ease of access by other departments. Server connection was established through DICOM gateway and 1,536 x 1,024 pixels of DICOM image was transferred.

For the medical recording by the physician, pen-assisted, LCD display type digitizer (Wacom LCD tablet DTU-710) was adopted.

C. Network for EMR

Gigabit Ethernet was chosen for the inter-departmental network and 100Mbps Ethernet for the intra-departmental network. 802.11a/b/g wireless network was installed for the stand-alone medical devices.

D. Structure of EMR/PACS/OCS

All the clients were operated on the Microsoft Windows XP professional operation system and the Microsoft Internet Explorer (IE) was selected as the operational frame of the client software. Updated Active X control and script engines were distributed by pushing from sever on the initial HTTP connection request. On the server part, Microsoft Windows Sever 2003 Enterprise Edition was selected as the operation system. Microsoft Internet Information Service (IIS) took the front line of the HTTP response for the .NET framework operation. Web forms for the client part IE was developed on the basis of Active Server Page (ASP.NET), and ActiveX Data Object (ADO.NET) were integrated for the property and data handling (figure3).

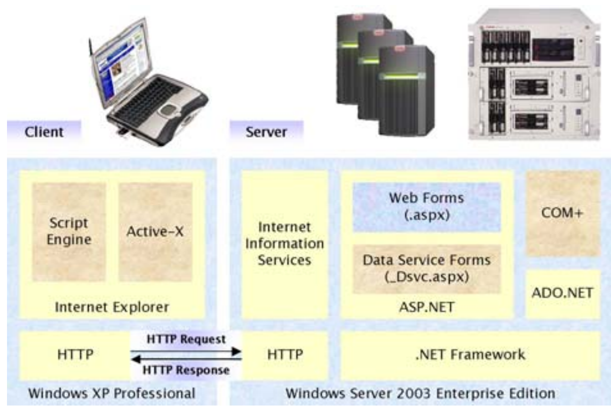

Figure 3: Structure of EMR, PACS, and order communication system (OCS).

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Results

By gathering a multitude of data from various ophthalmologic devices, EMR was successfully developed and installed. Pre-installed Order Communication System (OCS) was fully integrated into the new EMR system and Picture Archiving and Communication System (PACS) was used in parallel for radiologic medical image review.

Discussion

Connecting various devices with different systems and interfaces are always the biggest challenge during launching EMR at already well-established hospital, because they have old systems and devices which do not support the up-to-date communication protocols, such as USB, IEEE 1394 and even Ethernet. The most important thing in upgrading or renovating the old systems is the stability and the reliability of the system itself. Thus, preserving the original operation system and the software is mandatory. In this paper, various methods are proposed to achieve this goal, and if there were some novel devices not listed in this work, choosing appropriate category of the device can provide the best connectivity for the EMR network.

Conclusion

Even though there are many hurdles to be overcome during the development and installation step, EMR can be successfully introduced to the ophthalmologic clinic and the whole hospital. EMR will be a powerful and firm base not only for the patient care but also for the clinical study.

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