Developing the Information Architecture for the Outsourcing Physical Examination

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ABSTRACT: *In the developed country, it is necessary that the enterprise should arrange the occupational physical examination yearly, there are millions cases, results in heavy loading to the hospital. Because of the limited scale, the hospital usually needs outsourcing physical examination institutes. But the introduction of the outsourcing institute results in problems of examination information sharing. Although the information systems for hospital have been developed for decades, and now there are various successful systems. But the information system for outsourcing institute integration is not yet developed. This study is to develop the information architecture for outsourcing institute integration, which is basing on the relational medical information standards, includes DICOM, HL7 CDA, and IHE XDS. The proposed architecture would provide the information sharing in heterogeneous systems for different hospitals.*

Keywords: Component, IHE XDS, HL7 CDA, DICOM

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1. Introduction

In the developed countries, it is usually necessary that the enterprise should arrange the physical examination for the employees yearly. As a result, there are million employees should undergo examination every year, which makes the heavy loading to the hospitals and lots of traffic time to the employees. Additionally, basing on the cost considerations, the enterprise always requests the hospital to provide on-site examination service. The general hospital is originally designed for treatment, not for physical examination. But physical examination should be done by the hospital is necessary by law. Then the hospital needs the outsourcing institute for on-site physical examination.

Along with the development of the healthcare process that has involved complicated information flow [1]. Nowadays there are various information systems for the operation of the hospital, and due to the heterogeneity, the hospital information systems can not share data between different hospitals. As a result, when a hospital requests the outsourcing institute, which would be problems in examination information sharing. The outsourcing institute is impossible to design different system for different contract hospital. Although the information systems for hospital have developed for decades, and now there are

various successful systems, e.g. HIS, RIS, LIS. But the information system for outsourcing physical examination is not yet developed. As a result, the outsourcing institute usually adopts the modified commercial MIS (Management information system) for institute management, and the associated paper-forms for data sharing with contract hospital. The general paper-form [2] workflow is shown in Figure 1. In the workflow of the on-site physical examination, before the examination the employee should get a blank form firstly, and then fill his/her personal information, and then the healthcare provider note the results of physical examination on the form. Then the paper form would deliver to clerks for data key-in for the information system of contract hospital, additional double checking process is necessary. Finally the examination report is generated, and then sends to the employee.

Paper-form based workflow is a error-prone process, and consuming lots of time and manpower. With more and more outsourcing institutes being introduced into hospital, a key issue is how to design the necessary information architecture, which can reduce data errors, time consuming and even the data loss risk. This study is to develop the information architecture for outsourcing institute, which transfers the current process from paper-form to electronic-form, would well reduce lots of processing time and manual resources. Additionally, the developed architecture is basing on the relational medical information standards, which provides the information sharing in heterogeneous systems for different contract hospitals.

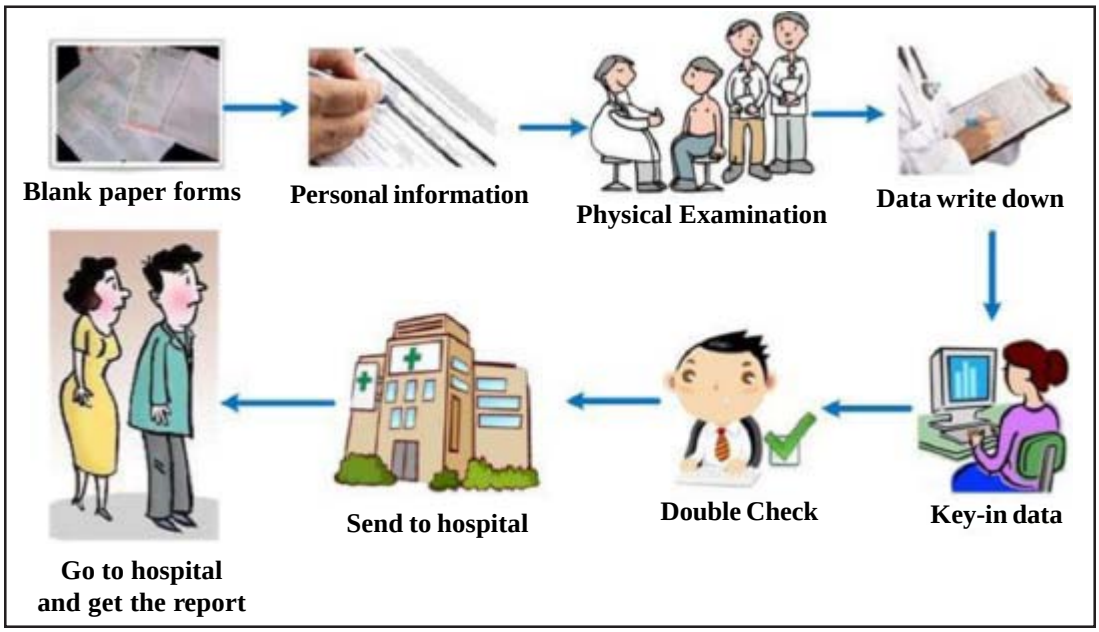

Figure 1. Traditional paper-form based on-site physical examination flow

2. Methods

For the outsourcing physical examination, the development of the information architecture is to re-design the workflow firstly. Then the key information modules are developed for replacing the current manual operations, which includes electronic form, ultrasonography encapsulation. Additionally, the architecture development is basing on the medical information standards for data exchange with the current healthcare information systems.

2.1 Redesign workflow

The workflow is redesigned, which referred the current examination procedure of Taipei Veterans General Hospital, and the current workflow of outsourcing institute.

2.2 Electronic form

We use Android SDK to develop the electron-form system. Android is a Linux-based operating system developed by Google. In addition to the operating system, it also provides Android SDK/NDK application software development kit that allows embedded systems developers to develop Android platform applications. There are lots of facilities involved in the study, include Eclipse, Java Development Kit (JDK), Android Development Tools (ADT), Android SDK, and ASUS TF101.

2.3 Ultrasonography acquisition

The most common medical image modalities are ultrasonography for its non-radical. But the most general ultrasonography is non-dicom compatible for its cost. The proposed ultrasonography acquisition module includes three parts: the driver for image acquisition device, DICOMDIR generator, and the shared dynamic link libraries (DLLs), which as shown in Figure 2. For inherent low resolution of ultrasonography and the ease of future maintenance, the off-the-shelf image acquisition device was adopted. As a result, the driver should be developed for controlling the acquisition device. The acquired image is JPEG format, and then a DICOMDIR generator is required for image converting. Additionally, the acquired image could be also import to other DICOM applications in local clinics for further study, which is necessary to develop shared dynamic link libraries for cooperating with other software applications.

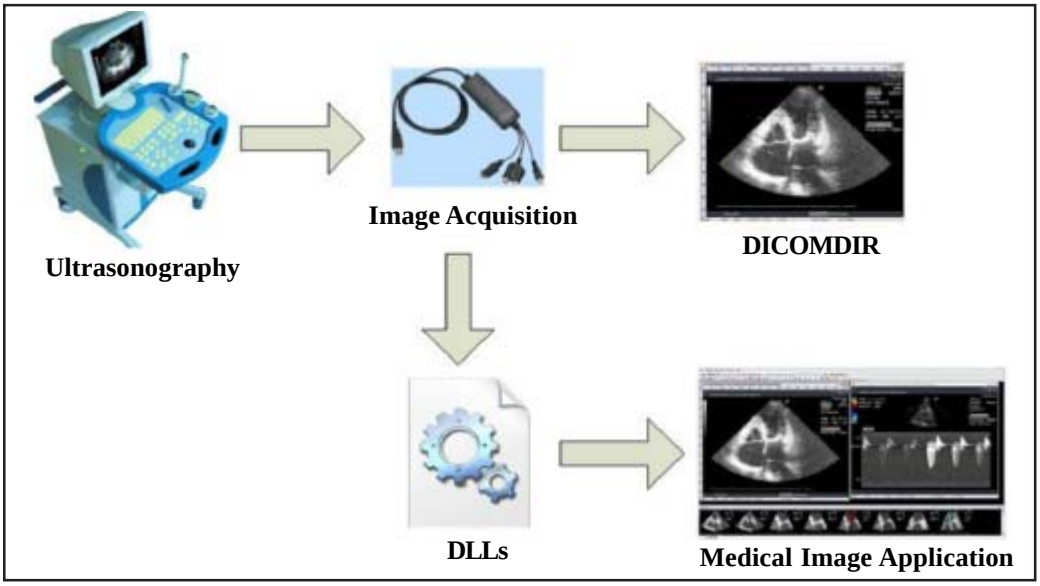

Figure 2. Ultrasonography acquisition module

National Instruments (NI) LabVIEW is a graphical based programming language, which support rich libraries to facilitate the development of device driver or instrument control console [3]. NI LabVIEW Plug and Play Instrument Drivers is deployed to develop the driver for the off-the-shelf image acquisition device. The LabVIEW Instrument Driver Finder (IDFinder) is firstly applied to find, download, and start using the similar instrument driver. The DICOMDIR is a directory object, which is to serve as an index for organizing and finding DICOM files inside a physical storage media [4]. The DICOMDIR object formal definition and its structure are in part 3-annex F and part 10-section 7 of the DICOM standard document. The DICOMDIR file contains hierarchically sorted registers with the information related to objects stored into a DICOM files set. [5] In most DICOM storage media, a set of DICOM information is described by an index file, DICOMDIR, which accompanies the files that it references. The main function of the DICOM encoder is to convert the NTSC video signal into a DICOM-compatible digital file. Besides NI LabVIEW, the Intel JPEG Library and DicomObjects are also included for developing the DICOM encoder. The NI LabVIEW Application Builder to pack the developed application and the shared dynamic link libraries.

2.4 Report generation

Currently, the text and image reports of physical examination are separately. We use NI LabVIEW Report Generation Toolkit for Microsoft Office in report generation, which integrates the results of text and image.

2.5 Medical information standards

We referred the IHE XDS standards [6] and the requirements for healthcare institute. The system framework is based on HL7 [7] and DICOM [8] standards. The report system is basing on the HL7 [9] CDA [10], which shares the medical text files in different platforms.

The XML (eXtensible Markup Language) is the most popular format, which supports global data exchange. Additionally, XML could be embedded in Web service. As a result, the XML document is easy shared via internet. Health level 7 (HL7)

clinical document architecture (CDA) provides a standard form for digitizing a series of medical documents, and cross-discipline data exchange [11, 12]. The CDA is a XML based format, which is constituted by medical objects, including text, image, and voice. As a result, the CDA document could be accessed via Web browser. In this study, we demonstrate the electronic forms of the physical examination basing on HL7 CDA standard. The examined data and image are described by CDA level 3.

3. Results

The developed electron-form based architecture is shown in Figure 3. The developed ultrasonography acquisition application is shown in Figure 4, which had been confirmed in hospital. The GUI of ultrasonography DICOM transformer is shown in Figure 5. The GUI of report generation is shown in Figure 6. The remolded information architecture is shown in Figure 7. During the on-site physical examination, healthcare staff confirms the examination items with employee firstly. Then collect specimens and medical images (X-ray or ultrasonography). After investigation, transmit all data to the database. Then output report from database and deliver via Internet.

Figure 3. The GUI of electronic form

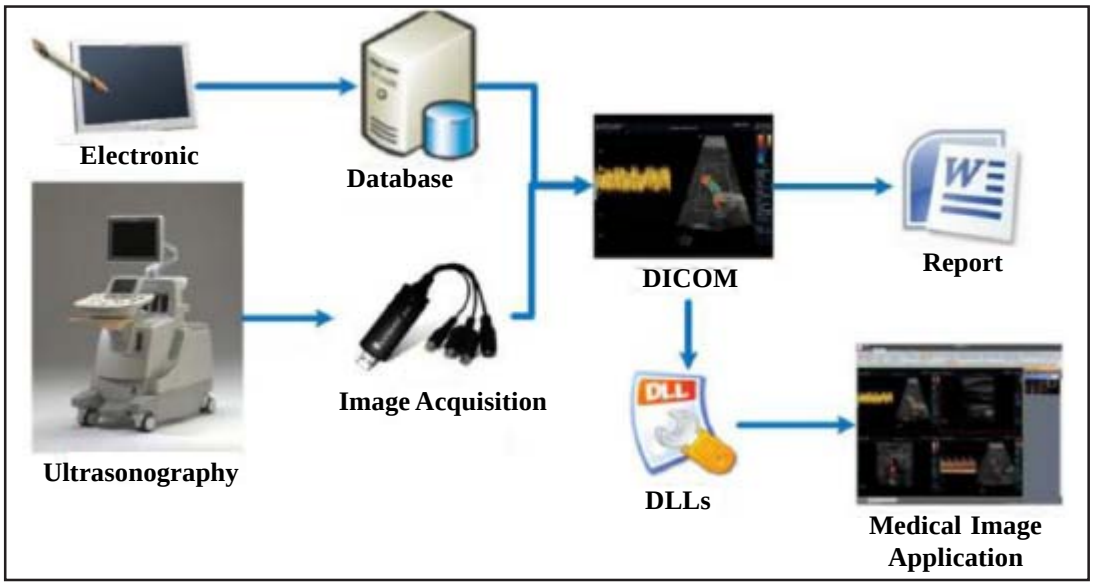

Figure 4. The developed ultrasonography acquisition application

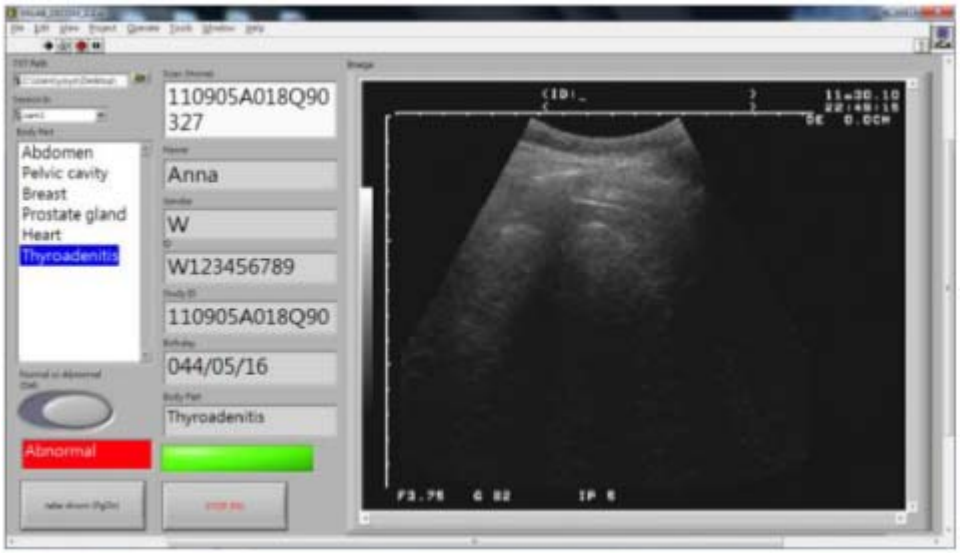

Figure 5. The GUI of ultrasonography DICOM transformer

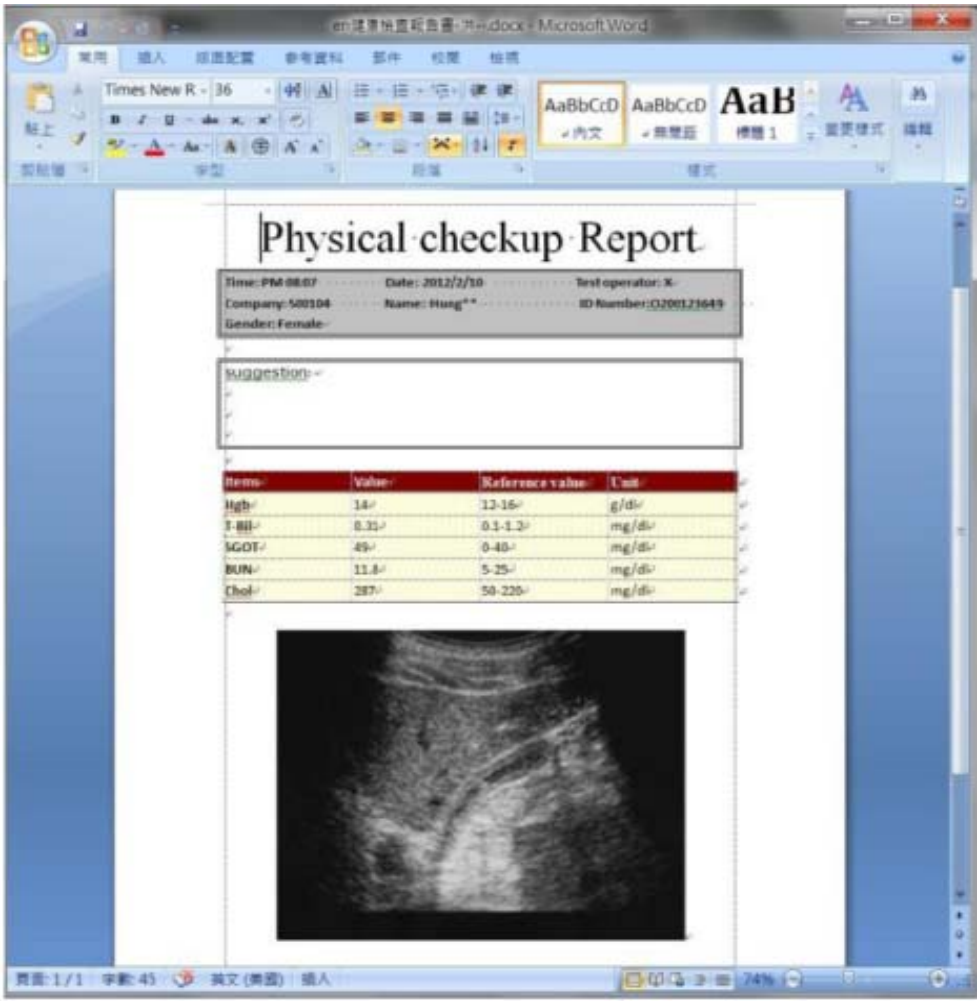

Figure 6. The GUI of report generation

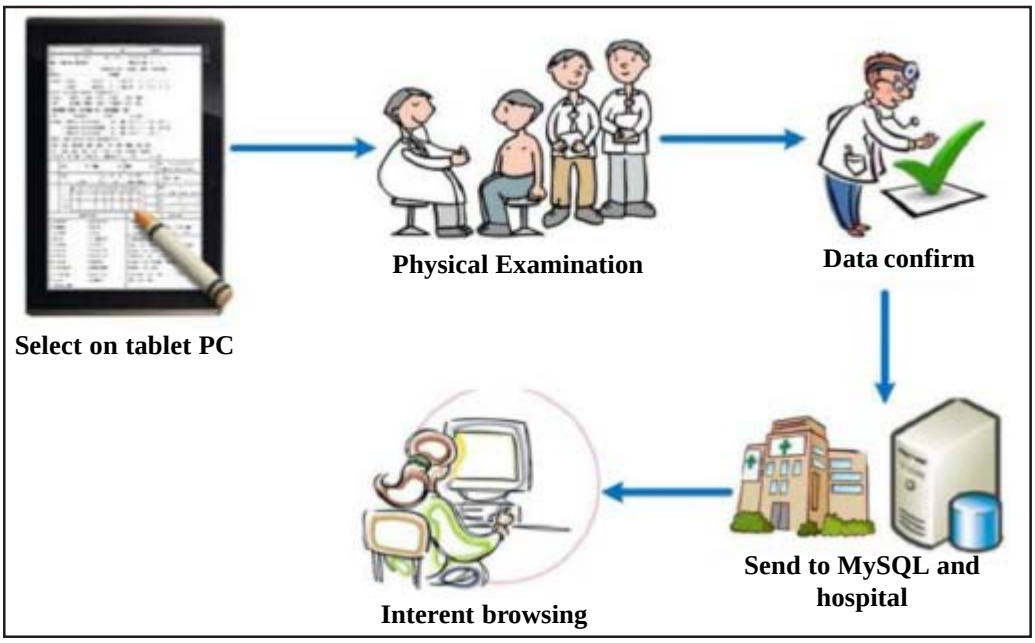

Figure 7. Developed information architecture

4. Conclusions

In order to exchange data between outsourcing laboratory and hospital. We provide the information architecture for outsourcing medical laboratory, which referred the standards of IHE and HL7. The research aims is not only to improve the information exchange, but also effectively reduce incident errors. We will develop personal health record system in the future, so the subjects can search personal healthy situation in real-time at home and provide long-term caring services.

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