Chapter XXIII

PACS Based on Open-Source Software Components

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ABSTRACT

This chapter discusses the concept of open-source picture archiving and communication systems (i.e. PACS), which are low cost, and easy to re-configure and to customize for the specific user needs. Open-source PACS are based on relatively low cost computational resources, and are built by integrating open-source software components that implement basic services of a PACS. These services are described in this chapter, as well as how to integrate them. As an illustration, a PACS based on open-source software components for angiographic studies is discussed. Using the open-source approach, we expect to help diffusing the PACS technology by reducing its development and maintenance costs by using components easily available (e.g. desktop PCs).

INTRODUCTION

Nowadays, there is a growing tendency of integrating the technologies used in medical digital imaging for acquisition, storage, management, transmission, reception and visualization, and moving towards systems known as picture archiving and communication systems (i.e. PACS). These systems comprise software and hardware components, and often adopt the open DICOM
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standard for image representation, archiving and communication (Hludov, Meinel, Noelle & Warda, 1999). The DICOM standard was originally proposed to facilitate the interoperability between imaging equipments and health informatics systems. This standard also specifies services, such as archiving and retrieval of medical images, messaging syntax, and file formatting based on specific tags that represent objects (e.g. the 2D matrix pixels) (Bankman, 2000).

The digital images managed by PACS can be recovered locally or remotely, and such systems also can be considered as teleradiology tools (Engelmann, Schröter, Baur, Werner, Schwab, Müller & Meinzer, 1998). In the context of teleradiology, specifically, PACS provide mechanisms to facilitate the access to images and associated information, fastening the interpretation of medical studies. Known examples of such systems are the eFilm Workstation (Sachpazidis, Ohl, Polanczyk, Torres, Messina, Sales & Sakas, 2005; MERGE, 2007), the Impax family of products (Agfa, 2007), Centricity Imaging PACS (General Electric, 2007) and Osirix (Rosset, Spadola & Ratib, 2004). Nevertheless, the widespread utilization of these systems still is limited, mostly because of cost and technological issues. The patent protection of PACS software components imposes license costs and restricts the access to this technology to more affluent societies (Fogel, 2005), and is one of the most important issues preventing the widespread utilization of PACS. Coincidently, the most pressing needs to increase health care efficiency often are found in less affluent societies, especially in developing countries.

Recently, open-source software components to support the development of several PACS services became available. For example, nowadays there are available several open-source software components to implement DICOM services, such as image compression and transmission, storage, query, retrieval, and media management, among other services. Besides, the open-source software approach for constructing PACS allows to further develop and customize the system software components, while substantially reducing the development and maintenance costs, as compared to patent protected software.

The first Section of this chapter presents a survey of the PACS open-source software components currently available; next, a PACS model based on the integration of open-source software components is presented, and a test case illustrating the application of this PACS model to hemodynamics series management is discussed. Finally, we present some concluding remarks.

INTEGRATING OPEN-SOURCE SOFTWARE COMPONENTS TO BUILD A PACS

A PACS can be understood as integrated systems that provide the functionalities to facilitate medical image storage, management and communication, and these functionalities (i.e. services) are the system building blocks (i.e. the system components). These building blocks often are inter-dependent, and organized hierarchically, with some components providing the infra-structure to other components perform their functions. In this chapter, the term component is used as a binary, functionally self-contained software which interacts with its environment (i.e. the other components in a PACS) via a well-defined interface (Stal, 1999). This Section discusses the characteristics of the open-source components currently available, and the services they provide in the PACS environment.

Open-Source Components for PACS

Nowadays, most PACS rely on the DICOM standard for image representation and communication (Bankman, 2000). For this reason, we initially present a lower level component that performs DICOM decoding (i.e. the DICOM decoder), which provides the basic infra-structure for several other
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