European Journal of Radiology 78 (2011) 210–224

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Integrating image processing in PACS

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ARTICLE INFO

Article history:
Received 21 June 2009
Accepted 22 June 2009

Keywords:
Radiology information system
Picture archiving and communication system
Image processing

ABSTRACT

Integration of RIS and PACS services into a single solution has become a widespread reality in daily radiological practice, allowing substantial acceleration of workflow with greater ease of work compared with older generation film-based radiological activity. In particular, the fast and spectacular recent evolution of digital radiology (with special reference to cross-sectional imaging modalities, such as CT and MRI) has been paralleled by the development of integrated RIS–PACS systems with advanced image processing tools (either two- and/or three-dimensional) that were an exclusive task of costly dedicated workstations until a few years ago. This new scenario is likely to further improve productivity in the radiology department with reduction of the time needed for image interpretation and reporting, as well as to cut costs for the purchase of dedicated standalone image processing workstations. In this paper, a general description of typical integrated RIS–PACS architecture with image processing capabilities will be provided, and the main available image processing tools will be illustrated.

1. Introduction

The increasing availability of integrated RIS–PACS solutions for image reading and reporting of medical imaging examinations has fuelled the development of integrated tools for digital image processing on RIS–PACS systems. This evolution represents a further step towards total integration of all instruments needed for interpretation and reporting of diagnostic imaging examinations in a health service environment, and technical problems have been faced, especially in early times, due to the relatively stringent hardware and software requirements for accomplishing such task. In the following sections, a general description of integrated RIS–PACS systems with image processing capabilities will be provided, and the main available image processing tools will be illustrated. Examples of the various image processing options were obtained by means of the open-source software OsiriX (version 3.5.1, http://www.osirix-viewer.com) integrated with our Institution PACS network (Fig. 1), and are illustrated in the following dedicated sections.

1.1. From dedicated workstations to server-based RIS–PACS solutions

As known, a strong impulse toward evolution and diffusion of image processing tools has been represented, on one side, by the transition from analogue to digital image acquisition. In particular, the evolution of digital imaging (for instance, conventional radiography) into a filmless direction has introduced the need for image visualisation software in order for images to be evaluated [1,2]. In addition, the possibility for the technician and the reporting radiologist to modify image settings in the post-processing phase as to emphasise peculiar image features (that might be underestimated or missed under standard display settings, thereby potentially compromising diagnosis), has made image conditioning functions on visualisation stations a must-have. This is the case for elementary tools for adjusting window levels (as previously available on consoles of computed tomography [CT] or magnetic resonance imaging [MRI] scanners) or applying filters, such as high frequency filters for magnification of bone details or low frequency filters for noise reduction. Such scenario has been decisive for the evolution of PACS systems and their integration with RIS stations. Another important point is that data transmitted to the integrated RIS–PACS station must contain the whole image information in order to allow accurate image processing, and are to be shared over a universal digital platform. This has lead to adoption of the DICOM format as a universal standard for medical image data exchange; however, the necessity to preserve data integrity of medical images with a high degree of accuracy makes DICOM files relatively large, thus prompting development of faster internet and intranet connections for reasonably quick data flow [3,4].

The problems related to the high amount of generated data have been boosted by the concurrent evolution of cross-sectional imaging techniques, such as CT and MRI. In particular, the advent of multidetector CT (MDCT) scanners with an increasing number of detector rows has urged the search for new technical solutions

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doi:10.1016/j.ejrad.2009.06.022

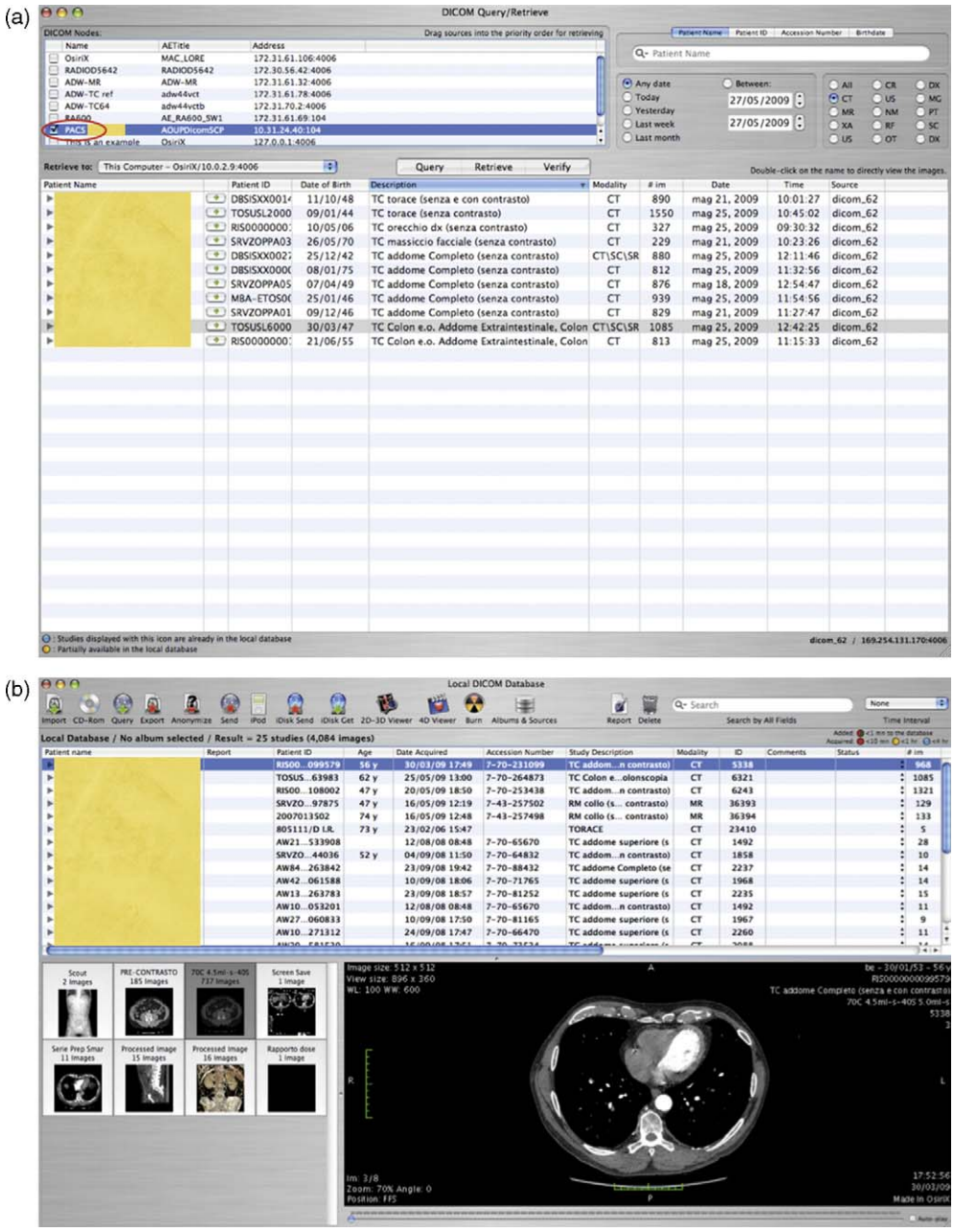

Fig. 1. OsiriX integrated RIS–PACS interface: query list for retrieval from PACS (a) and image list for a given PACS-retrieved examination (b).

enabling efficient RIS–PACS integration, both in terms of image reading and reporting times [5,6]. In fact, modern MDCT scanners with 64 detector rows and beyond can produce thousands of images, each of them having submillimetric thickness in the longitudinal axis and a relatively high noise index in order to keep radiation dose down to acceptable levels. This would make analytic evaluation of every single image (as traditionally done with single slice CT examinations) extremely time consuming – incompatibly with the routine workflow of a diagnostic imaging centre – and error-prone due to the high image noise and increasing reader's fatigue. In addition, the advancements of MDCT technology have gained to this latter application fields once pertaining to other imaging modalities: this is the case, for example, of CT colonography, CT angiography (with particular reference to CT angiography of peripheral vessels and CT coronography), and trauma evaluation. In this respect, if such transition to MDCT has, on one hand, brought several diagnostic advantages, on the other hand it has implied a further multiplication of the amount of generated MDCT images. The key point is twofold:

(1) many images need a large amount of space to be loaded, both in terms of hard disk and random access memory (RAM) space;

(2) post-processing of such large datasets – both in 2D, and especially, in 3D mode – requires vast calculating power, both from CPU and graphics card.

Putting things into perspective, for large MDCT datasets to be processed, a relatively enormous amount of power would be needed, far superior to that of common RIS–PACS systems, and comparable to that afforded by dedicated image processing workstations. Indeed, the former are usually cheap, medium-to-low power computers designed for word processing (the RIS part) and visualisation of digital images retrieved online from the local area network (the PACS part), while high-end image processing consoles are much more expensive and usually not designed for RIS integration.