Automatic documentation of users interactions with DICOM images: A case study in medical grand rounds

Renato F. Bulcão-Neto[1], José A. Camacho-Guerrero[1], Alessandra Alaniz Macedo[2]

[1]Innolution Sistemas de Informática Ltda. – Ribeirão Preto-SP – Brazil

[2]Departamento de Física e Matemática – Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP-USP) – Ribeirão Preto-SP – Brazil

{rbulcao,jose.camacho}@innolution.com.br, ale.alaniz@usp.br

Abstract. *This paper presents a work in progress on automatic documentation of users interactions with digital medical images in DICOM format. As a proof of concept, we have developed a prototype application which automatically captures, registers and documents users interactions in a medical grand round scenario. The documentation resulting can aid medical professionals in several contexts of use, including decision taking processes, review of clinical cases, teaching and learning purposes, among others.*

1. Introduction

In order to tackle the issue of single identification of digital radiology images, the healthcare industry developed the Digital Imaging and Communications in Medicine (DICOM) standard [1]. It has been widely adopted as a standard for handling, storing, printing and transmitting medical diagnostic and therapeutic information in disciplines that use digital images and associated data. The core of DICOM includes an application-level communication protocol and a file format definition, which combined allow DICOM files to be exchanged between two entities (e.g. system software).

Several medical professions have benefited greatly from DICOM-enabled software [2, 3] for diagnostic and therapeutic purposes, including cardiology, surgery, neurology, etc. From an ethnographic study we did at a university hospital [4], we could observe the use of a DICOM imaging viewer to aid doctors towards the pre-surgical decision taking in medical grand rounds of Neurology and Gastroenterology.

However, we also identified from that study that most users interactions with DICOM images could be automatically documented for later access, e.g. for the future review of clinical cases. The documentation of interactions with DICOM images has been strongly supported by doctors due to the quality and the relevance of those interactions in decision taking processes as well as the large number of digital images presented in medical grand rounds.

In this paper we present our ongoing work on a prototype application that automatically captures, stores and documents recurrent types of users interactions with DICOM images, as observed in our study of medical grand rounds [4], including textual and digital inks-based notes, changes in contrast, brightness and negative color effect, zoom in/out operations, among others. The documentation generated represents users interactions upon DICOM images according to their original temporal sequence, and it is made available in different file formats for later access [5].

2. Background

During a grand round (or clinical meeting), a multidisciplinary team of doctors, nurses, residents and postgraduate students discusses clinical cases of patients in a collaborative way leading team members to share clinical and scientific evidence-based knowledge, individual experiences, and responsibilities from the surgical decision taking.

Team members collect and discuss pre and post surgical data for every clinical case, including radiological plain films, medical and paramedical reports, digital videos, and DICOM key images. In general, all data is presented using the Microsoft Office© suite, a negatoscopy for plain films, and a shareware DICOM imaging viewer [2].

When presenting DICOM images, some team members make use of a laser pointer as an attempt to delimit areas in the image that are valuable for their own assessment. Other members make changes in contrast, brightness and negative color effect as well as zoom in/out DICOM images in order to obtain a better visualization of such examinations. They also use tools to measure particular image sections (e.g. areas).

Paper sheets describing the summary of every clinical case are handed out so that team members have to fill in blank fields with their corresponding assessments and the collaborative diagnostic conclusion, including such assessments related to image-based examinations. Hence, it has been a general consensus between team members that they do not have an appropriate means of recording and retrieving grand rounds documentation, including users interactions with DICOM-based examinations.

Based on our study, we have developed the ArcaMed software framework [5] for automatically capturing, recording, retrieving, extending and documenting patient information. Using ArcaMed, we aim at facilitating the build of applications which demand the automatic documentation of information discussed for diagnostic purposes.

3. A prototype application

From our observations of medical grand rounds, we have also developed a prototype application based on ArcaMed in order to automate the capture, storage, extension and documentation of clinical cases information, especially of common users interactions with DICOM images. Details about the prototype architecture are found elsewhere [5].

Before a grand round, clinical case information (including DICOM images) is stored both on a particular XML document and a database. DICOM images can be imported both from local and remote repositories.

During a grand round, a team member presents his material through the interface of our prototype (Figure 1). He traces digital inks and types textual notes upon DICOM images to delimit and describe regions of interest, respectively (Figure 2). Images, text and inks are recorded in separate layers to preserve their contents for later processing.

As a user browses on a series of DICOM images, it is created a *Visit* object, which is described by **a)** the identification of the current image visited; **b)** the time duration of the visit; **c)** and the XML encoding of digital inks (XY coordinates, and trace color and thickness), textual notes (font name, color, size and style), measurement tools (color, XY coordinates, angle value, etc.) and manipulation tools (brightness and contrast levels, inverse color effect, and zoom in/out levels).

Every visit to a particular DICOM image is then registered on the XML document of the corresponding clinical case. Thus, the *Visit* object is the mechanism that we have implemented to capture and record users interactions with DICOM images.

When a grand round *finishes*, its XML document is then stored on prototype's database and automatically transformed and formatted into Web-accessible documents both for desktop and mobile access as shown in Figure 3.

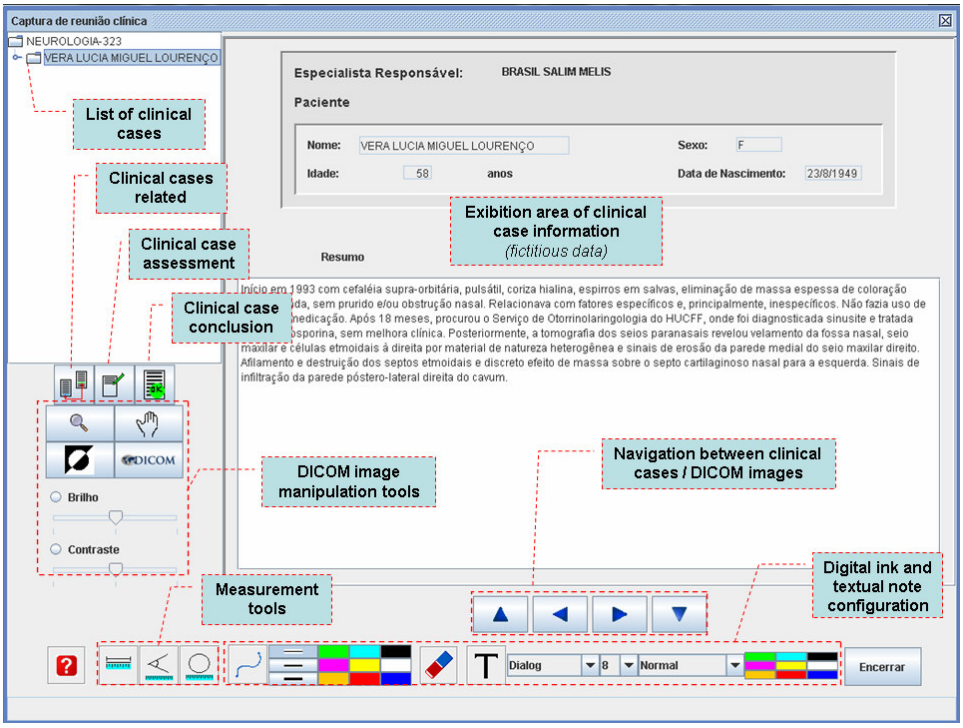

Figure 1. The prototype main interface

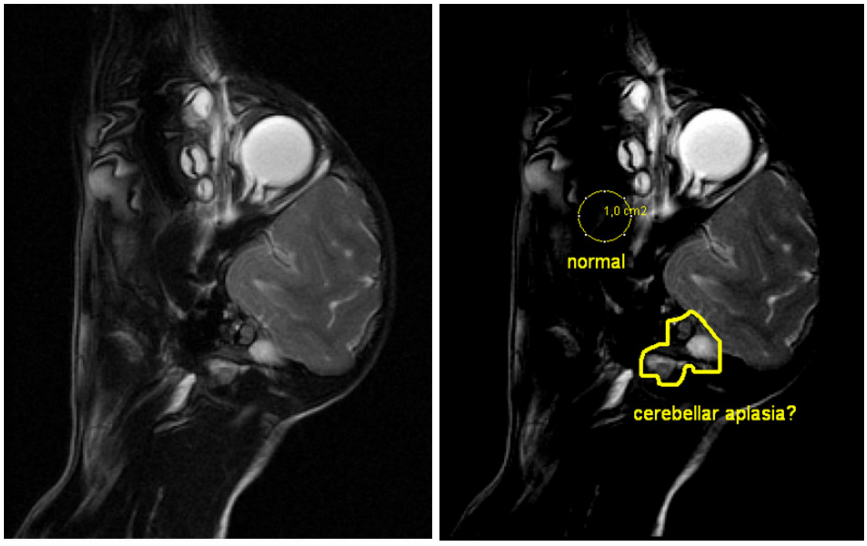

Figure 2. (a) Magnetic resonance imaging; (b) the same image with inks, textual notes, an elliptical region of interest and changes in contrast

Figure 3. A slide of a grand round documentation in PDF format for mobile access

4. Concluding remarks

We are aware of that our prototype requires enhancements in comparison with traditional systems, e.g. a configurable handling of multi-frame DICOM images [2] and a DICOM tag viewer [3]. Our work also does not address advanced features for images manipulation, e.g. the generation of 3D models from DICOM imaging [6] as well as the planning, simulation and execution of procedures of real-world surgical interactions [7].

On the other hand, using the aforementioned efforts, both the sequence and the information of users interactions get lost after users manipulate and/or process medical imaging. In our opinion, this type of feature has been given little attention both from the academia and the medical software marketplace. Moreover, such documentation can be useful for the review of clinical cases, teaching and learning, research database, pre-surgical decision taking processes, surgical procedures, and legal instrument.

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