Chapter 64
Open Source Applications for Image Visualization and Processing in Neuroimaging Training

Juan A. Juanes
University of Salamanca, Spain

Alberto Prats-Galino
University of Barcelona, Spain

Pablo Ruisoto
University of Salamanca, Spain

Andrés Framiñán
University of Barcelona, Spain

ABSTRACT

The aim of this paper is to demonstrate the major role and potential of three of the most powerful open source computerized tools for the advanced processing of medical images, in the study of neuroanatomy. DICOM images were acquired with radiodiagnostic equipment using 1.5 Tesla Magnetic Resonance (MR) images. Images were further processed using the following applications: first, OsiriX™ version 4.0 32 bits for OS; Second, 3D Slicer version 4.3; and finally, MRIcron, version 6. Advanced neuroimaging processing requires two key features: segmentation and three-dimensional or volumetric reconstruction. Examples of identification and reconstruction of some of the most complex neuroimaging elements such vascular ones and tractographies are included in this paper. The three selected applications represent some of the most versatile technologies within the field of medical imaging.

INTRODUCTION

In the last decade we are living exciting times due to the continuous development of new technologies and applications aim to enhance both visualization and processing of biomedical images. In the context of medical training these applications have overcome the limitations of traditional methods and have increased the involvement and interaction of students with medical contents in a wide range of medical disciplines (Seow Hiong, 2005; Parker, 2007; Renhin, Janchiv & Sanjaa, 2008).

Neuroimaging software is used to study the structure and function of the brain. The traditional approach to the study of these brain images has based on the exploration of individual two-

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dimensional (2D) images acquired by devices such as Magnetic Resonance (MR). However, recent developments in the field of medical informatics for advanced image processing have grown significantly and allow us to enhance the basic and clinical information that we can obtain from those images (Gunderman & Wilson, 2005; Arenson, Andriole, Avrin, & Gould, 2000).

Processing of complex brain images is no longer the domain of expensive and inaccessible workstations. New powerful applications provide tools for their effective visualization and manipulation in neuroanatomy (Ruisoto, Juanes, Contador, Mayoral, & Prats, 2012; Seymour et al., 2002). Mentioned applications deal with specific tasks of visualization or image processing; packages able to address many different areas; client-side applications, which are generally easier for the end user; or server-side applications, which are generally more stable but less user friendly (Seow Hiong, 2005; Renhin et al., 2008; Mahmoui, Akhondi-Asl, Rahmani, Faghih-Roohi, Taimouri, Sbouir, & Sotanian-Zadeh, 2010). For a detailed technical review of advanced image processing applications, readers are recommended to consult Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC).

In recent years, there has also been a growing interest in three-dimensional visualization of anatomical structures. The development of tools for the study of bone and joint anatomy using Computarized Tomography images has been relatively easy since density is significantly different from soft tissue (Sierra-Martínez, Cienfuegos-Monroy& Fernández-Sobrino, 2009). In particular, three applications have been widely used: On the one hand, OsiriX™, an affordabe opensource application, which has shown high accuracy and reliability in length measurements on this kind of reconstructions (Kim, Jung, Lee, Lee, Koo, & Chang, 2012). Similarly, a study published in 2009 by Miller et al. applied OsiriX to the study of the anatomy of specific cranial nerve (Miller, Dun, Milton, Burchiel, & Kim, 2009). Second, two free open source applications, 3D Slicer and MRICron, which have been extensively used in the study of complex brain structures.

The aim of this paper is to demonstrate the major role and potential of OsiriX™, 3D Slicer and MRIcron, as powerful open source computerized tools for the advanced processing of medical images from the perspective of its usability in medical settings. In this study we will skip the technical analysis of these applications. Instead, we will provide an overview of overview of the core functionalities of these applications and illustrate their possibilities in the study of two complex medical contents such as neurovascular structures and tractography.

Methods

For this purpose we have selected three well-known applications, associated with an increasing number of publications in scientific peer review journals. These three tools are: OsiriX 3D Slicer and MRIcron. The description of each of these applications is organized based on the following three criteria: first, analysis of the flexibility of each application in terms of the different types of image formats that can be used; second, main 3D visualization features such as volume rendering, minimum intensity projection, among others; and third, main 2D image processing tools, such as segmentation, measurement or registration.

Image Acquisition

All the images included in this study were obtained from regular explorations from the Department of Radiology at the University Hospital of Salamanca, corresponding to healthy and clinical cases of both sexes. Ages ranged from 31 to 45 years old. All participants gave their informed consent to participate in the study, which was approved by the local ethics committee following the principles established in the Declaration of Helsinki.