

Development of a commercial cross-platform DICOM viewer based on Open-source software

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Purpose

eVida is a commercial DICOM exploration tool and viewer designed to work either integrated into a PACS system or as a stand-alone DICOM viewer. The viewer is intended for radiologists and general practitioners, so it has common digitized medical image transformations and it also includes a minimal set of image analysis tools like measuring angles, distances or image statistics over regions of various shapes. The target of this software are radiology diagnostic workstations but performance improvements have been introduced in order to make it work on desktop computers too. Moreover, the software is compatible with the three most wide-spread Operating Systems (OS), namely Windows, Mac OS and Linux. The software is built upon a proprietary Application Programming Interface (API), named MEDIT in this document, that uses third-party Open Source libraries for most of the DICOM I/O operations and image processing and visualization tasks. In this document we will discuss on the advantages and disadvantages of using such kind of libraries for commercial solutions intended for radiologists and researchers.

Methods

The chosen programming language is C++ because of its verified compatibility with different OS and the availability of many Open-Source libraries intended to medical imaging. The architecture design of this application (Fig.1) is modular and consists of assembling all together the different capabilities of several Open-Source libraries which are individually compatible with the three previously mentioned OS taking care of

maintaining cross-platform compatibility in the proprietary code.

The exploration part of our software uses the Grass roots DiCoM (GDCM) library to parse the metadata of the DICOM files in order to classify and organize all files contained in a repository. It is copyrighted as an Open-Source, Berkeley-style (BSD) license, allowing unrestricted use, including use in commercial products. GDCM is also used as an internal part of the Insight segmentation and registration ToolKit (ITK) library as an image loader.

Our application uses ITK as a model for the internal image structure representation. ITK is distributed as open source under the OSI-approved BSD license which allows use for any purpose, with the possible exception of code found in the patented directory, and with proper recognition.

ITK also offers a good compatibility with the Visualization ToolKit (VTK), which is used in eVida for the 3D visualization (surface and volume rendering) of medical images. It is also distributed under a BSD-like license and allows its use for commercial developments. Different volume rendering techniques were implemented, such as Iso-surface, Maximum Intensity Projection, Composite Ray-Casting and 2D and 3D Texture Mapping. These representations bring different advantages for medical diagnosis depending on the kind of the biological tissues characteristics to be analyzed. The use of both ITK and VTK offers the possibility of a future seamlessly integration of image processing and segmentation tools in the core application.

The VTK and ITK libraries are mainly developed by Kitware (Clifton Park, NY, USA). VTK also relies internally on the Open Graphics Library (OpenGL) API for low-level 3D graphics. OpenGL can be used in any software solution without licensing the source code or use of the OpenGL trademark. OpenGL is also directly used by our proprietary MEDical Imaging Toolkit API (MEDIT) to represent 2D medical images. This API consists in assembling all the previously mentioned libraries features,

bringing compatibility with different General User Interface frameworks (GUI) and defining memory management and image analysis tools implementations.

For the development of the application GUI, eVida uses the Qt cross platform application framework (Qt Software, Oslo, Norway), which has different licenses depending on the final use of the software (Commercial, Open-Source, Educational or Academic) but it remains Open-Source in all cases. Finally, the cross-platform development process is facilitated by the usage of the CMake open-source, cross-platform build system, which allows the development of build scripts that can be used seamlessly in different platforms.

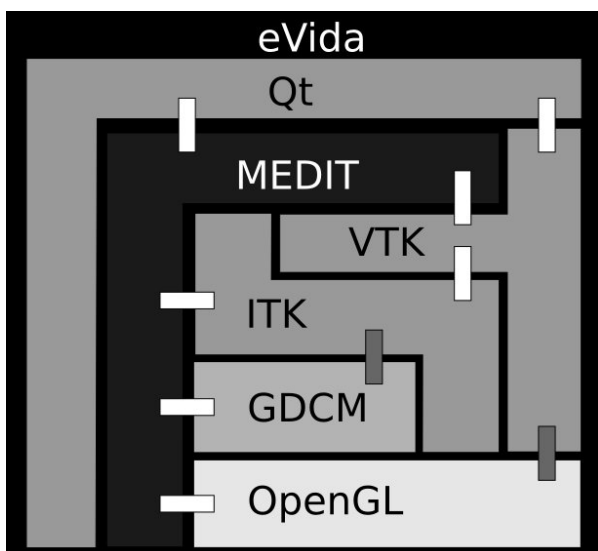


Fig.1 Modular design of viewer's architecture based on Open-Source libraries.

Results

The framework previously described has allowed us to develop a software that can be distributed under commercial license with the following features. eVida is a generic DICOM loader able to visualize medical images of almost any dimension, pixel type and modality. The exploration of the local or remote DICOM folders can be performed statically if all the data is already available or dynamically, by loading images as they become available across the PACS network. eVida contains different layouts for DICOM series (Fig. 2 and 3), it proposes 2D single image visualization, multi-planar reformatting

(MPR), on-screen comparison of several series and 3D volume visualization. Various interaction tools are also available: automatic scrolling over images, synchronization of different viewers, annotations, angles and distance measurements, and selection of diversely shaped regions of interest. eVida runs smoothly on any regular desktop computer thanks to the adoption of various strategies, such as caching images on disk, dynamic loading and multi-resolution. Real-time interaction on very large images (such as digitized mammography or angiography that can take up to 200 MB for a single image) is possible on a desktop computer (for example DualCore CPU with no graphic card and 2 GB of RAM memory). Loading a Computed Tomography series containing around 1500 images with 512x512 pixels resolution (around 450 MB on disk) from DICOM explorer takes under 3 seconds to show a sample of 9 images at once on screen, scrolling to other images in the same series takes less than half a second.

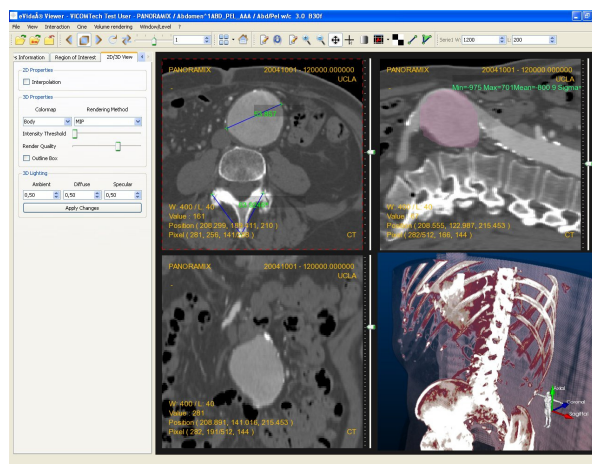


Fig. 2 Screenshot of viewer's main interface showing the Multi-Planar Reconstruction and 3D layout for a single series.

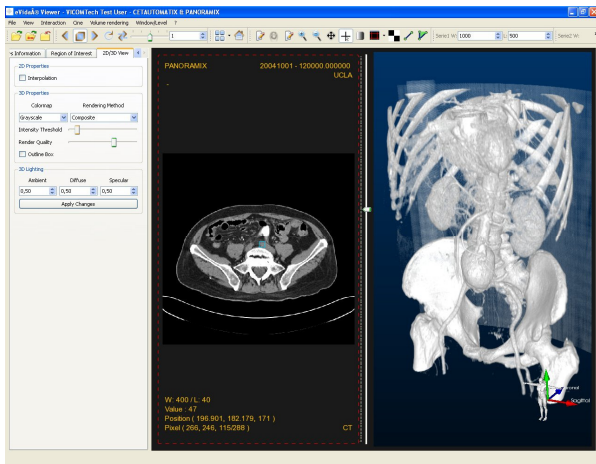


Fig. 3 Screenshot of viewer's main interface showing 3D viewer layout.

Conclusion

We have developed a generic DICOM viewer solution based on third-party Open-source software, intended for commercial purposes. Special efforts were spent to provide a cross platform, multimodal and flexible application. Specific strategies were adopted to optimize performance, so that the application can run on regular desktops, independently of the size of the image. Open-Source software solutions are often considered to be unreliable because of their lack of commercial support. But the development of eVida proves that this solution offers the same capabilities as fully commercial solutions and brings a flexibility adapted to constant technological evolutions in medical imaging research area. Such application is intended for customization to produce computer-aided diagnosis and intervention planning solutions at low cost. Various specific applications are currently being developed in vascular surgery, oncology and neurology.

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