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Open Source Software for Image Processing: (A Comparative Study)

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Abstract

The newest trend in software development is open source, which has become almost a revolution over the last decade. Led by the finest software minds on the planet, open source is not only a social and collaborative way to develop software, but in most cases is immune to the profit motive common in the closed source software company culture. Open source software gave rise to open standards of data exchange, control procedures, and interaction among open source software components. During the last years the medical image processing systems development environment have been proposed and scientific research in this field is rapidly increasing. Open source provides a well established framework for processing of these images and do scientific researches. In this paper, number of open sources for image processing are presented and evaluated. Comparison of open source software that is best suited for image processing is also discussed. This paper will also look into the issues and challenges of its implementation. Based on the objectives of the user, this paper furnishes guidelines that help in selecting the most appropriate open source for image processing research.

Keywords: Medical Image Processing, Open Source Software, Comparison, Research

Introduction

In the early days of computing, software was generally free, and it was something that was shared among researchers and developers, who were usually eager to improve it. However, that situation changed as computers became more common, and the production of proprietary software became an excellent business model for many companies. In recent years Open Source Software (OSS) has become a major interest both for the software industry and for economic theory.[1] Some companies have begun to realize that Open Source Software (OSS) can also be highly profitable. The most outstanding example of this is IBM, which continues to reap high returns from its approximately one billion-dollar investment in Linux.[2] Today substantial portions of primary data in biology are in the form of images. The volume of raw image data increased dramatically in recent years with wider adoption of high-throughput and high-content imaging technologies. There is an urgent need for extracting quantitative information from these massive datasets in order to address important biological

1 Mingzhi Li, Zhangxi Lin, Mu Xia, "Leveraging the Open Source Software Movement for Development of China's Software Industry" in *The Massachusetts Institute of Technology Information Technologies and International Development*, 2(Winter 2004)2, 45-63.

2 "IBM Managed Hosting - Linux virtual services taking a closer look", IBM Global Services, October 2003. See also C. Ciurea, "Collaborative Free Software Development" in *Open Source Science Journal*, 1(2009)2, 102-110.

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questions in particular from the systems biology point of view.[3] But re-implementing published work in medical image processing is often not feasible. So shared source code and shared development platforms are therefore becoming a necessity. The concept of open source serves this need.

Open Source Software (OSS)

Software can be classified as either proprietary software or free and open source software. The first computers were research tools and software was freely passed on to anyone who needed it. Only later, when computers reached the business world, did developers begin to restrict the rights to their software and to charge fees for each copy. In 1984, Richard Stallman - a former MIT employee - founded the Free Software Foundation. His aim was to promote and to defend the idea of free software. In order to protect the rights of the authors and the free software itself from becoming proprietary, he designed a set of rights, codified in the GNU General Public License (GPL). Open source software products represent the leading edge of innovation development and diffusion systems conducted for and by users themselves - no manufacturer required.[4] Its user has the right to look into the source code and learn how the internals of the software work. In response to emerging circumstances and needs, it can be adjusted. It can be passed on to others in the hope that it may serve their needs.

Medical Image Processing

Medical imaging is the technique and process used to create images of the human body for clinical purposes or medical science. Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are not usually referred to as medical imaging, but rather are a part of pathology. As a discipline and in its widest sense, it is part of biological imaging and incorporates radiology, nuclear medicine, investigative radiological sciences, endoscopy, thermography, medical photography and microscopy. It generally exploits tasks with very high computational demands. Such tasks can be handled by the "standard" processors and computers or by networks of such computers;[5] however, such solution is not always feasible for various reasons, such as difficulties with programming in multiprocessor system, large dimensions of the computer system, high consumption of energy, etc.

Open Source Software for Image Processing

Biologists, Clinical Researchers, Druggists, Chemical engineers and other researchers often analyze images obtained from various resources such as microscopes, MRI Scanners and so on. They need specialized image processing software for their

3 Pavel Tomancak, Stephan Preibisch, Johannes Schindelin, Albert Cardona, "Fiji Is Just ImageJ - an Open Source platform for biological image analysis". Cfr URL: http://pacific.mpi-cbg.de/

4 Karim Lakhani, Eric von Hippel, "How Open Source software works: 'Free' userto- user assistance".

5 P. Zemík, A. Herout, V. Beran, O. Fucik, J. Schier, "Reconfigurable Image Processing Architecture", *GVIP 05 Conference*, 19-21 December 2005, pp 230 -235.

research.[6] Open source software developed for medical imaging allows the conversion of various image file types, such as BMP, GIF, TIFF, PNG, PSD and PSP to JPEG format and enables collaboration of individuals and groups to produce high-quality tools that meet user needs.[7] We have listed a set of open source software that is used for image processing.

CELLPROFILER : CellProfiler is open source software that helps biologists to analyze cell / non cell images without much knowledge on computer or programming.

IMAGEJ : ImageJ is a Java-based image processing program designed with an open architecture. User-written plugins make it possible to solve many image processing and analysis problems, from three-dimensional live-cell imaging, to radiological image processing, multiple imaging system data comparisons to automated hematology systems.

FUJI : Fuji is a plug-in oriented image processing package. It is based on ImageJ but with Java, Java 3D and a lot of plug-ins organized into a coherent menu structure. The main focus of Fuji is to assist research in life sciences, helps review images.

SCILAB : Scilab is an open source scientific software package for numerical computations providing a powerful open computing environment for engineering and scientific applications.[8]Some toolboxes available within the system include 2D and 3D graphics / animation, linear algebra, sparse matrices, polynomials, rational functions and many others.

ENDROV : Endrov is an open-source plug-in architecture aimed for image analysis and data processing. It is a multi-purpose image processing tool. It can analyze images from Microscope too. It is portable and can both be run locally and as an applet.

3D Slicer : 3D Slicer is a free, open source software package for image analysis and scientific visualization. Slicer is used for autism, multiple sclerosis, systemic lupus erythematosus, prostate cancer, schizophrenia, orthopedic biomechanics, cardiovascular disease and neurosurgery.

ITK : ITK is a cross-platform, open-source application development framework widely used for the development of image segmentation and image registration programs.

Osiri X : OsiriX is an image processing application dedicated to DICOM images. It can also read many other file formats: TIFF (8,16, 32 bits), JPEG, PDF, AVI, MPEG and QuickTime. OsiriX is able to receive images transferred by DICOM communication protocol from any PACS or medical imaging modality.

6 A. Herout, P. Zemcík, V. Beran, J. Kadlec, "Image and Video Processing Software Framework for Fast Application Development", *AMI/PASCAL/IM2/M4 Workshop*, Martigny, CH, 2004, p. 1.

7 Sorin Vinturis, "Open-source procedures for image processing", *Open Source Science Journal*, 2(2010)2.

8 Didier Halgand, "Scilab at a glance - Example of implementation at CNES", *Scilab Consortium,* INRIA, ESTEC, October 4, 2006.

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Free Surfer : FreeSurfer is an MRI brain imaging software package. It is an important tool in functional brain mapping and facilitates the visualization of the functional regions of the highly-folded cerebral cortex. It includes tools for the reconstruction of topologically correct and geometrically accurate models of both the gray/white and pial surfaces, for measuring cortical thickness, surface area and folding, and for computing inter-subject registration based on the pattern of cortical folds.

Micro Dicom : Micro Dicom is an application for primary processing and preservation of medical images in DICOM format. Images produced by medical equipment (MRI, PET, CT) and other image formats - BMP, GIF, JPEG, PNG, TIFF, can be processed by this application.

Image Magick : Image Magick is a software suite to create, edit, and compose bitmap images. It can read, convert and write images in a variety of formats (over 100) including DPX, EXR, GIF, JPEG, JPEG-2000, PDF, PhotoCD, PNG, Postscript, SVG, and TIFF. Use ImageMagick to translate, flip, mirror, rotate, scale, shear and transform images, adjust image colors, apply various special effects, or draw text, lines, polygons, ellipses and Bézier curves.

The presented open-source software, besides the conversion functions, also provide functions for filtering and transformation operations necessary for processing any kind of images.

Comparative study

There is a great deal of freely-downloadable open source software. In some cases, the entire system can be built cost free using an open source operating system, web server, and database. Some of the major features of open source image processing software which can be used to make image processing and analysis are compared in the table below:

OSS	Type	OS	Web Server	Database	Supported File Formats
CELL PROFILER	Microscope image processing	Windows, Mac, and Unix	Mysql or oracle server	Mysql. MS Access, Excel	TIFF
IMAGEJ	IP	Any Java based OS	Imagej dicom server	Mysql	TIFF, JPEG, BMP, Animated GIF, PNG
FUJI	DIP	Mac OS	Apache	-	
SCILAB	Image processing	Linux Wndows Mac OS X	Apache	-	BMP, GIF, JPG AND PNG

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OSS	Type	OS	Web Server	Database	Supported File Formats
ENDROV	Image processing & image analysis	Any Java based OS	Apache	SQL database	OST (tree based object file format)
3D Slicer	Visualization, registration, segmentation & quantification of medical data	Cross-Platform	Apache	MySql	DICOM images
ITK	Image registration & segmentation	**Windows**	Apache	MySql	2D(JPG, BMP, PNG) 3D(GIPL, RAW)
OsiriX	Navigation and visualization of multidimensional images	MAC OS X	Apache	MySql	TIFF (8, 16, 32 bits), JPEG, PDF, AVI, MPEG
Free surfer	Image segmentation	Linux, Mac OS X	Apache	Excel, MySql	Own File Formats
MicroDicom	Processing & Preservation of medical images	**Windows Vista and Windows 7 compatible**	Apache	MySql	BMP, GIF, JPEG, PNG, TIFF
ImageMagick	Bitmap Images Segmentation	Unix, Windows	Apache	MySql, Oracle	TIFF, JPEG, PNG, PDF, PhotoCD, and GIF.

Conclusion

"We were discussing the future challenges in information technology, including the issues related to software security. I made a point that we look for open-source codes so that we can easily introduce the users built security algorithms", said Dr. Abdul Kalam, Former President of India.[9] OSS development can provide useful cost effective tools tailored to specific needs and clinical tasks. This paper illustrates how open software development for medical imaging tools can be successfully designed, implemented and disseminated. The integrity and quality assurance of open software developed by a community of users does not follow the traditional conformance and certification required for commercial medical software programs. However, open software can lead to innovative solutions designed by users better suited for specific tasks.

9 David Becker, Staff Writer, CNET News, "Indian leader advocates open source", May 29, 2003, URL: http://news.cnet.com/India-leader-advocates-open-source/ 2100-1016_3-1011255.html