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A Survey: Medical Image Processing Applications with ImageJ

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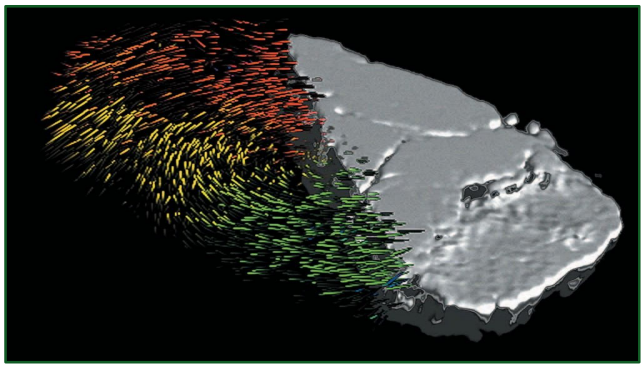
Abstract

Medical image processing is a discipline that involves the use of technology to take images of the inside of the human being in a way which is as non invasive as possible .Hence with the advancements in medical and biological sciences, imaging has become an increasingly important discipline.

1. Introduction

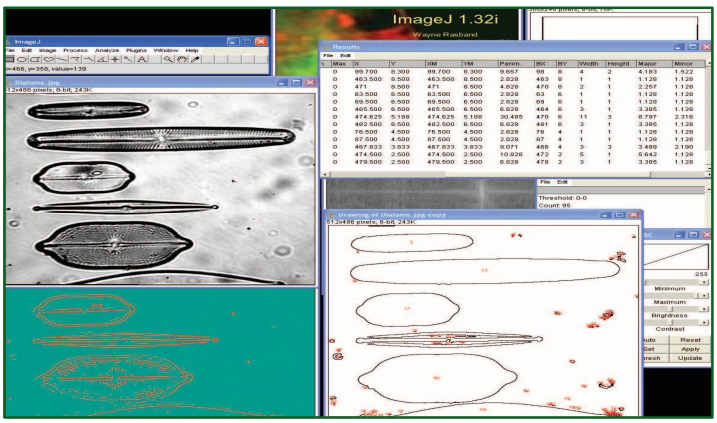
There are various image processing softwares available but are usually not flexible and do not allow complex manipulations in images. ImageJ is one such software which is a public domain, Java based image processing program developed at National Institutes of Health. By public domain we mean that the source code is available to all and its license free . Another feature which makes it distinctive that it can run on any operating system (Microsoft windows, Mac OS, Mac OS X, Linux). The software was developed by Wayne Rasband of Research Services Brand ,National Institute of Mental Health. ImageJ can run as an online applet, a downloadable application or any computer with Java5 or later virtual machine. Its first version 0.50 was released on 23rd September 1997, a stable version of it (1.41i) was released on 25h January 2013 and now currently it is in version 1.31, released in February. Prior to the release of ImageJ in 1997 Wayne Rasband worked for 10 years on NIH image (Precursor to ImageJ) which was developed for Macintosh computers running pre-Mac OS X operating system -ported by Scion Corp. but it didnt have a future scope though various modifications in it are still made further developments of this code continues in the form of Image SXM.A scintillation rendering of 3D motion field of a flat muscle phantom was combined with a surface rendering to show motion and anatomy of

phantom. The motion data was obtained as 1.5-T MRI gradient echo T1 weighted image sequences while the phantom was rotate inplace at 5 degree per frame.



2. Imaging Capabilities

ImageJ has the potential to display, edit, analyze, save and print 8 bit color and grayscale, 16 bit integer and 32 bit floating point images. It can read almost all types of image formats including TIFF, PNG, GIF, JPEG, BMP, DICOM, FITS as well as raw images. If a file format is not supported by ImageJ, it can be done by some international developer community within a short period of time. ImageJ can acquire images directly from scanners, cameras and any video. ImageJ supports image stacks (usually called as volumes) which is series of images that can be operated together as a whole. ImageJ can calculate area and pixel values and intensity thresholded objects, edge detection. It can also create density histograms and line profile slots. It also supports basic arithmetic and logical operations on images like convolution, contrast manipulation, sharpening, smoothening, fourier analysis. It even supports geometric functions like scaling, rotating and flips. It can support any number of images simultaneously but limited by available memory.



This is a screenshot showing edge detection, thresholding, particle analysis with particles indicated and histogram analysis on grayscale diatoms image (upper left).

3. Cross Platform

One of the characteristic property of ImageJ is it's ability to run on different platforms. Statistics show that ImageJ has been downloaded mostly to be used with Microsoft Operating system (80%) followed by Macintosh and linux.

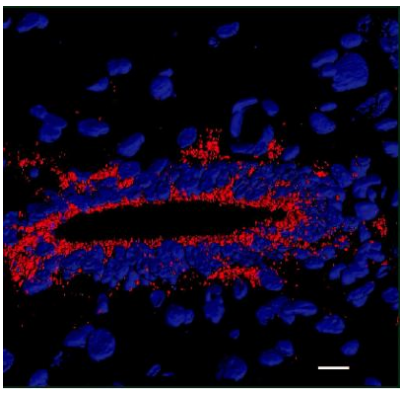
3.1 Extensions: Macros And Plugins

Plugins and macros are loadable code modules that extend the capabilities of ImageJ. Plugins are written in Java programming language and compiled in .class files. Macros written in ImageJ's Java like programming language are stored in .txt files. Plugins run faster and are more flexible but macros are easier to write and debug. Plugins are external programs that offer image processing capabilities that do not exist in core capabilities of ImageJ. Plugins have become a framework that can be used by scientists so that they can develop their own imaging solutions.

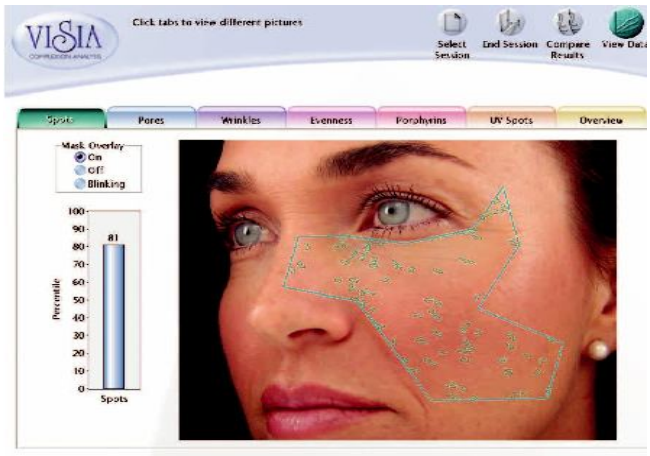
Plugins range from very small Grid Plugin that draws a grid on an image to complex plugins like surface or volume rendering plugin called as VolumeJ.

4. Imaging Library

Another way of extending ImageJ (usually adopted by small number of developers) is to use its imaging capabilities and plugins from their own programs so technically they are using it as a library of imaging methods. This is called as ImageJ's application programmer's interface (API). Hence using these several image database servers have been developed specially for ophthalmologists.Following figure shows 3-D reconstruction of DAPI-stained (blue) nuclei in a rat spinal cord section after intraventricular DiI injection results in red-staining of cells in the ependymal cell layer of the central cord. Scale bar = 10 µm. Image processed with ImageJ running VolumeJ and provided by Andrea Mothe and Tony Collins, Toronto Western Research Institute.



ImageJ can be applied to applications of various fields. Engineering students are taught image processing using the ImageJ program at the Biomedical Imaging Group of the Swiss Federal Institute of Technology. The Centre for Image Processing in Education of Tucson, Ariz is using imaging software ImageJ program for teaching basic imaging to high school students.



Above Fig shows Visia complexion analysis system uses ImageJ to analyze how the client compares with a database of women in her age and skin-type groups for the given categories — in this example, spots. It includes scores that indicate the percentage of women who scored below the client's evaluation for the category. Provided by Procter & Gamble.

Above Figure shows how ImageJ is being used to examine the second to fourth digit ratio (index to ring finger) in the anole lizard, which is thought to reflect the relative concentration of or sensitivity to androgens during development. Provided by Peter Hurd, University of Alberta.For measuring the differentiation of orbital tumour and the motion in the soft tissues, Dr Michael D. Abramoff and co-workers at the department of ophthalmology and radiology at University hospital Utrecht in the Netherland have used ImageJ and FlowJ. Imaging on the boundary between field of science and field of engineering was illustrated by program. The solutions that are proposed or implemented with the help of developers and users are sometimes engineering solution and sometimes scientific solutions. In engineering solution, engineers derived straight from textbook or publication material. Whereas, in scientific solutions, where scientifically new approach is used to solve a real world problem.

There are some drawbacks of ImageJ. For installation and first step, program requires minimal computer knowledge, whereas a commercial vendor provides us with on-site installation and training. As there is continuous development, Bugs and un-featured documents can also move secretly or quietly in the distributed version. This can create a problem for the researchers who are unaware and who compares the data gained with the new and old version.

5. Conclusion

Usually user can easily identify the problem and updates version is posted immediately .There is a myth that imaging programs that are written in java cannot be fast. This is completely wrong and could also divert potential users of ImageJ. Dr Michael D. Abramoff was very much worried because of the myth and he even tested its validity by implementing programs, which he has written in java originally, in C++ and then calling these routines by using a plugin ImageJ Java Native Interface API. Yes there was a decrease in processing time of about 30% but this could not weigh up to increase development time for the routines.

6. Acknowledgment

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