BM751

- Informatic Tools

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Objectives:

- In this course, we try to see some software and libraries used for medical images processing,…

- C# is used to create applications as ***.exe, *.apk** using the ***.dll libraries.**

- Make small applications are used on a PC or Smartphone

Content of the material:

Chapter 1: Existing Medical Image Processing Software

Chapter 2: Syntax of C#

Chapter 3: Library Installation: Aforge, EMGU

Chapter 4: Phyton & OpenCV

Introduction:

- Computer science occupies an important role in the field of medicine.

- Digital medical imaging has developed very gradually.

-nuclear medicine (1960),

-the appearance of X-ray tomography (1970).

- This development has been made possible by the development of minicomputers (digital radiology, ultrasound, and magnetic resonance imaging (MRI)).

Introduction:

- All these techniques continue to develop: increasingly thin slices acquired more and more quickly with the new multibar tomographs, more and more rapid MRI sequences, image quality, etc…

- The image and the computer is one of the key elements used by doctors to seek all the relevant parameters in order to understand the pathology, and to choose the most suitable therapeutic approach.

- In this course, we present all softwares and libraries used to create a digital image and for the interpretation of medical images.

Introduction:

- Mobility, open source software. The software code is made public and anyone who wishes can contribute to the evolution and enrichment of this code.

- (http://www.sourceforge.net).

- However, to create applications "using Open source", requires that the user has a good command of programming language

Introduction:

- Open Source is a cooperative development mode, for example we will cite Linux for operating systems, Mozilla ……
- We can find OsiriX, a PACS software developed in Open Source
- Some more specialized DICOM object manipulation tools can be found in Open Source.

Introduction:

- In recent years, we have seen a set of tools used helping the radiologist in their task: the interpretation and preparation of reports
- computer-aided detection and diagnosis (CAD):These systems were born in the field of mammography then they applied to the detection and evolution monitoring of lung nodules..

- You can see a CAD almost everywhere: pulmonary embolism, colon polyps (CT)…

Introduction:

- Mammo CAD for multimodal system (to integrate informations of the ultrasound and MRI).

- Mammo CAD to detect the calcifications and masses (the distortions architectural).

- For the digestive system, in this case the CAD systems look the detection of polyps using the virtual colonography.
- CAD system for detecting hemorrhagic and ischemic lesions

Introduction:

Mobility

- For most researchers, handheld computers are used for imaging applications.

- With laptops or handheld computers including a wireless network card, and the data arrives directly to the professional.

- Integration of the IHE system (Hospital Information System) into hospital to gain the workstations and time.
- Development of the mobility liberates the radiologist from the necessity of remaining in close proximity to a stationary terminal, while enabling data to directly arrive the location where they are situated.
- Open Source aims to deliver innovative and high-quality solutions with minimal costs for installation and upkeep
- Any computer-aided system should not aim to replace the radiologist
- As medical imaging techniques advance, the need for digital processing becomes essential. To address this need, researchers utilize a range of processing software, including both specialized tools tailored to the medical domain and more general software designed for image processing across various applications.

Medical image analysis software

- Medical imaging is one of the health sectors that is experiencing fastest growing. Over the past few decades, it has evolved to include multiple imaging modalities, including CT, MRI, ultrasound, and nuclear medicine. In addition to the hardware and devices used, several software programs are used to generate and analyze these images.

- The use of the DICOM (Digital Imaging and Communications in Medicine) standard has helped to ensure the quality of medical images. The processes of capturing, storing, and exchanging medical images are exclusively conducted in the DICOM format.

Medical image analysis software

- Every hospital needs a DICOM workstation and with the Picture Archiving and Communications System (PACS), which is a virtual space for digital DICOM images, storing and retrieving these images.

- Any software that can "analyze" of data obtained from of medical images : is called medical image analysis software.

- Analysis can take the form of aiding diagnosis, comparing images between patients or within the same patient at different times to assess the progression of the disease..

What is the need for medical image analysis software?

- Analysis is generally a cognitive function that is performed by the radiologist.

- With advancements in healthcare, the number of scans requested for each day is increasing.

- Interpretation by a radiologist requires not only enormous skill, but also a lot of time. The workload of radiologists has multiplied (depending of the patients number). The proposed solution : is using of machines to interpret medical images and detect anomalies.

What are the limitations of medical image analysis software?

- The medical image analysis software is based on computer algorithms and image processing.

- The generated results are based on the algorithms with which it was programmed.

- The technology is not yet ready to completely replace the radiologist.

Medical image processing software

- Medical image processing software transforms the images after their acquisition. The treatment of medical images are based on three steps : image segmentation, recording images and viewing images.

- **Image segmentation**

- Segmentation is the division of an image into small parts. Ideally, these segments should be represent a different structure or Anatomical structure "organ".

Medical image processing software

- **Image segmentation**
- **Localization of the region of interest:** Localization of the region of interest: The software can identify abnormalities in the region of interest, including tumors……
- **Challenging anatomical boundaries:** Segmentation software helps identify boundaries of structures such as blood vessels.
- **Volume measurement:** Medical image segmentation software can be used to calculate volumes of specific structures such as anatomical cavities or tumors.

- **Image save**
- **Image Merge:**
- **Study of change :**
- **Characterization of objects :**
- **Image visualization : 2D, 3D reconstruction**

Medical image management software

- The increase in patient numbers, resulting in substantial data files, and give a significant data volume for hospitals.

- The storage, retrieval and handling of this enormous volume of imaging data is presented a challenge. The medical image management software facilitates this process by organizing and integrating all datasets.

Medical image management software

The medical image management software is composed of a PACS server that can be integrated into a standard DICOM workstation. Standard medical image management software should have the following characteristics :

- Archiving by storing all medical image datasets
- Allows radiologists to access medical imaging data from any location.
- Allows transform of images to other file formats,
- Allows the integration of medical image data with patient data in other folder, such as electronic health folder, health information system and radiology information system (RIS).

Specialized software

- There are specialized software that provide a variety operations for digital image processing. They are very simple for non-expert users, and effective for specialist users

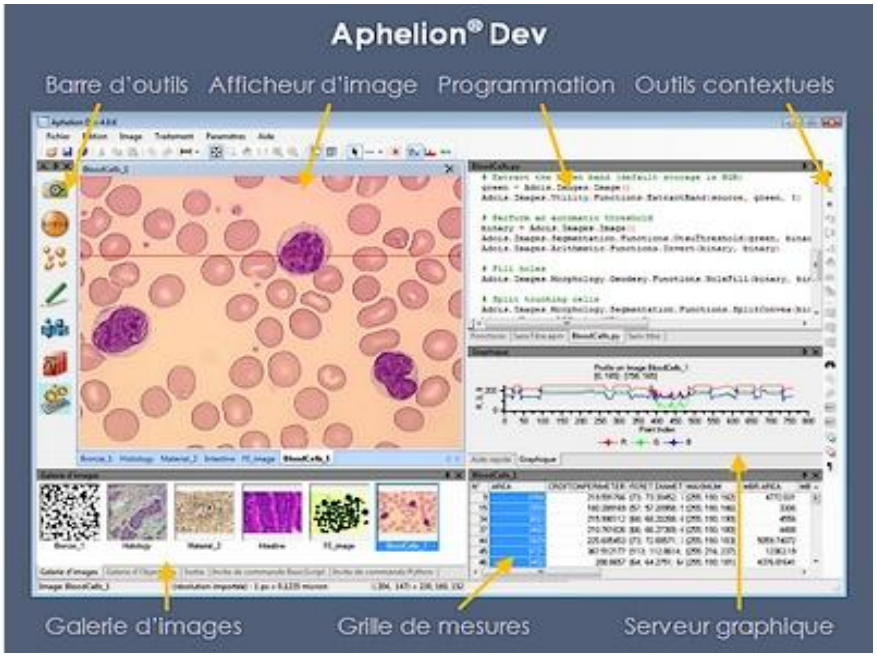
1. Visilog

Visilog is the reference environment for creating image processing applications. It is based on a library of image processing algorithms proven and enriched for more than 20 years.

- **Visualization**: It gives access to the usual zoom functions, graphic annotations…
- **Processing, analysis and automation**: dedicated to image analysis and processing. It has many algorithms in image processing through the use of several libraries. Its scripts are made with Visual Basic.
- **Development of dedicated products:** It offers the possibility of enriching the library of Visilog functions with specific programs developed in C++.

2. Aphelion

- Aphelion provides a set of 2D, 3D image processing tools and extremely complete. These algorithms including of image processing, algorithms for mathematical morphology and classification tools.
- All these processing and analysis functions are available with rich libraries.



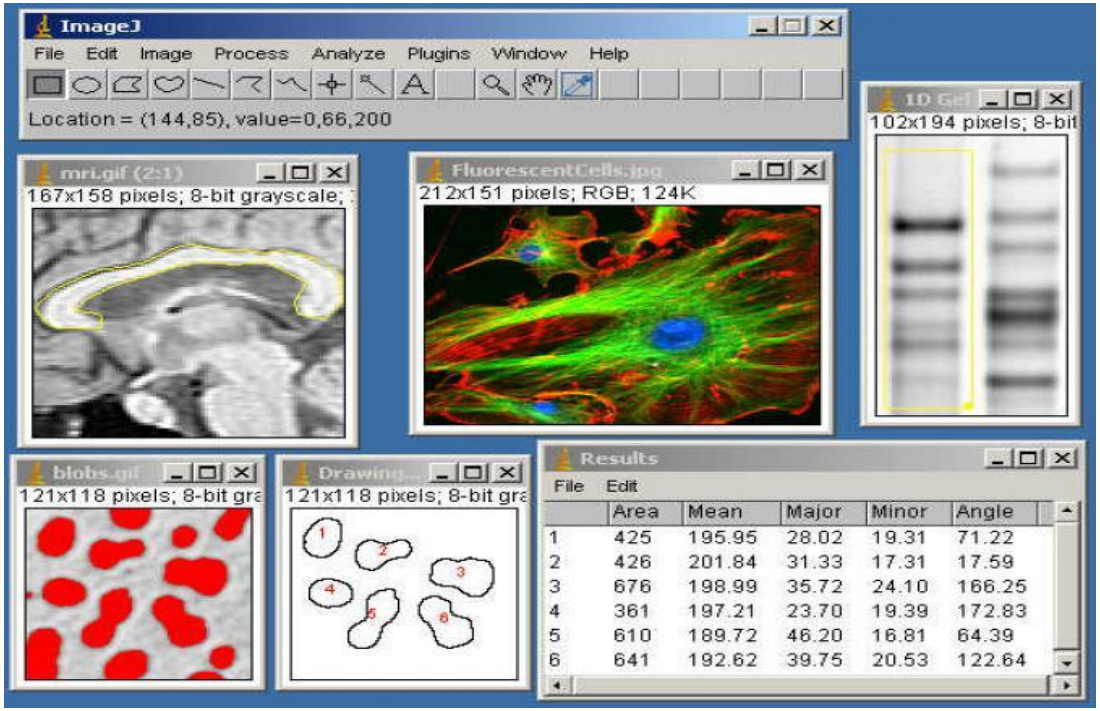
3. ImageJ

- Software of processing and image analysis adapted in biology. This software is developed by the National Institutes of Health.

- Multiplatform software: it works in Java language and are used by Microsoft and Linux environments,

- Open source software: it is public domain software “available free”; does not require a license; The source code is open access and can be modified.

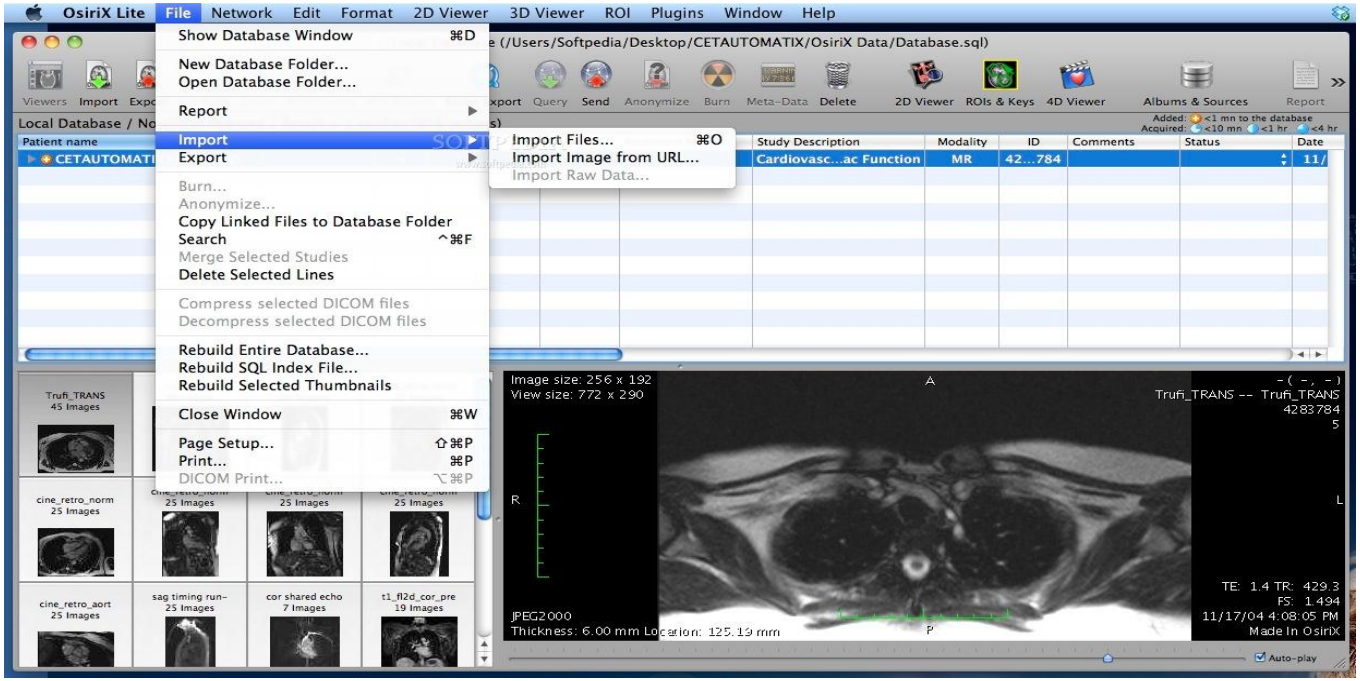
- Software of image processing and analysis is used in biology applications (Java language and Microsoft and Linux environments)
- Open-source software.



- ImageJ can view, edit, to treat many file formats: TIFF,. GIF, JPEG, BMP, PNG, DCM…
- It is used to display, edit, analyze, etc.
- Note that ImageJ is very useful in addition with MATLAB or ITK to visualize the results of processing or to realize a simple mathematical filtering and morphology mathematical.

4. OsiriX

- OsiriX is an image processing software dedicated to images DICOM produced by imaging equipment (MRI, CT, PET, PET-CT, SPECT-CT, ultrasound, …).



- OsiriX: 2D, 3D, 4D (3D series with temporal dimension) and 5D (3D series with temporal and functional dimensions).
- Multiplanar reconstruction (MPR), surface rendering, volume rendering and maximum intensity projection (MIP).
- All of these modes treat 4D data and are capable the production of images merged between two different series (PET-CT and SPECT-CT ….).
- OsiriX is a PACS DICOM workstation and image processing software for medical research (radiology and nuclear imaging), functional imaging, 3D imaging and molecular imaging.

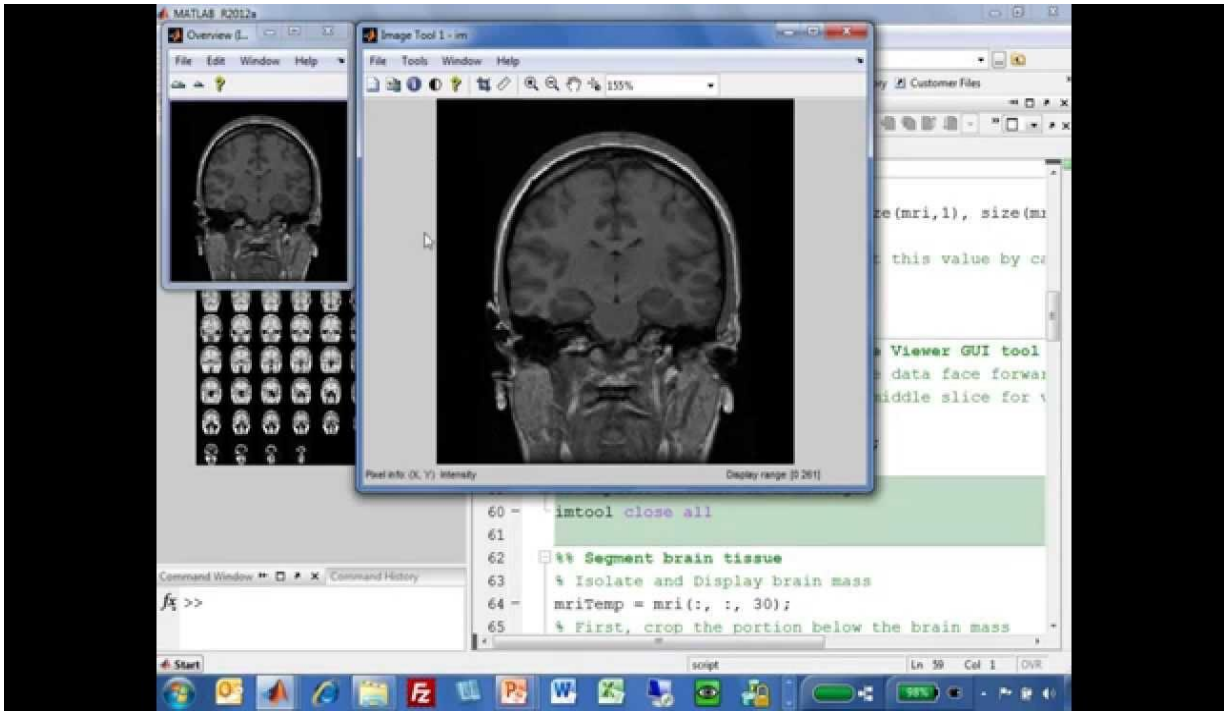
5. MediPy

- MediPy is a software platform for visualization and processing medical images.
- It is intended for clinicians and researchers
- Clinicians will be benefit from pre-programmed tasks (e.g. example segmentation, registration or detection of lesions) and the ability to adapt the software to their own needs.
- Many file formats can be read (DICOM, NIfTI, Analyze, etc.), and data recovery from a PACS..

II. General Softwares

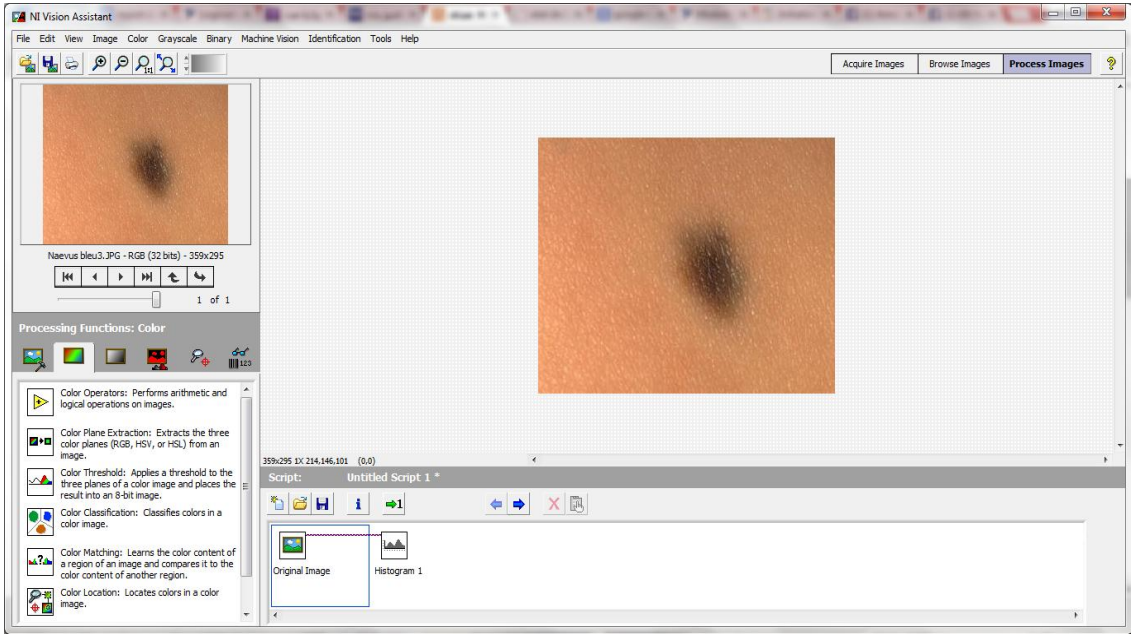
1. Matlab

Image Processing Toolbox is the MATLAB toolbox dedicated to processing images; It contains the classic algorithms for image processing, segmentation and it is "easily" usable via the MATLAB (graphic interface) GUI.



2. Labview

- Labview (Laboratory Virtual Instrument Engineering WorkBench) is application program development software.
- LabView uses a graphical programming language dedicated to control, acquisition, analysis and presentation of data



3. Python

- Python is a programming language, its syntax and method of use are more similar to Matlab. There is Toolbox for image processing, called PIL (for Python Imaging Library), are using for low-level processing and high-level processing.

- With Python, you can install many libraries to do classification (Keras, OpenCV …: open-source libraries to do classification with deep learning algorithm)..

https://www.anaconda.com/download/

Programming libraries

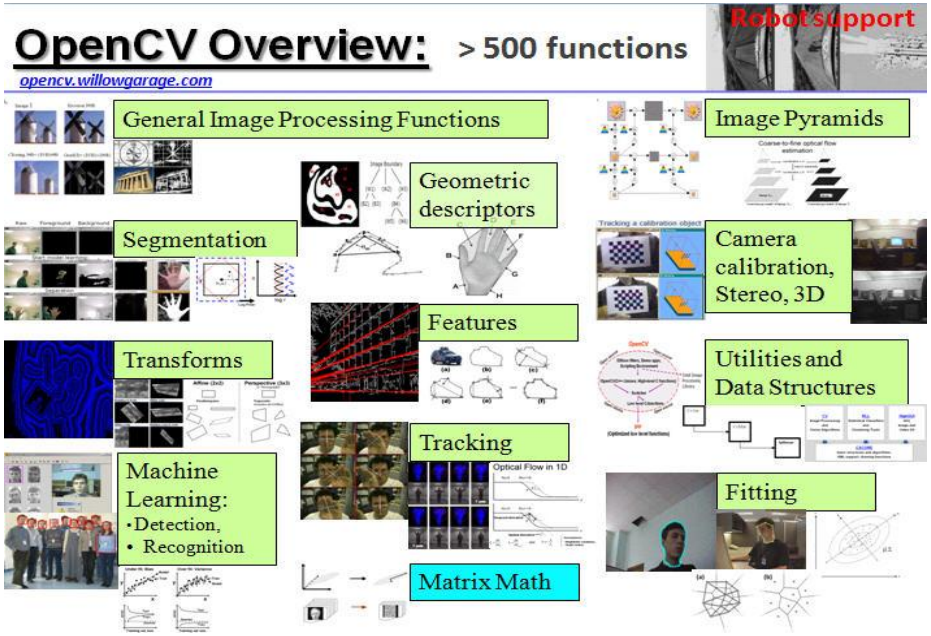
- For classic programming languages like : C/C++/C# or Java, there are a variety of specialized libraries.

Insight ToolKit (ITK)

- Insight ToolKit ITK (USA) is an American project intended to obtain a solid library for image processing developments.
- ITK uses C++ mechanism.
- Several languages to install ITK: Python, Java, Matlab

2. Open CV

- OpenCV (Open Source Computer Vision) is a library offering a set of more than 2500 algorithms for images processing, available for the languages C, C++, and Python.
- It is distributed in the form a free license for Windows, GNU/Linux, and Android platforms.



- **Core** : This library allows to manipulate the structures of base, ….
- **Imgproc** : for images processing.

- **features2d** : Descriptors.

  This phase concerns the extraction of descriptors
- **Objdetect** : Objets detection.

This library allows to recognize objects in an image

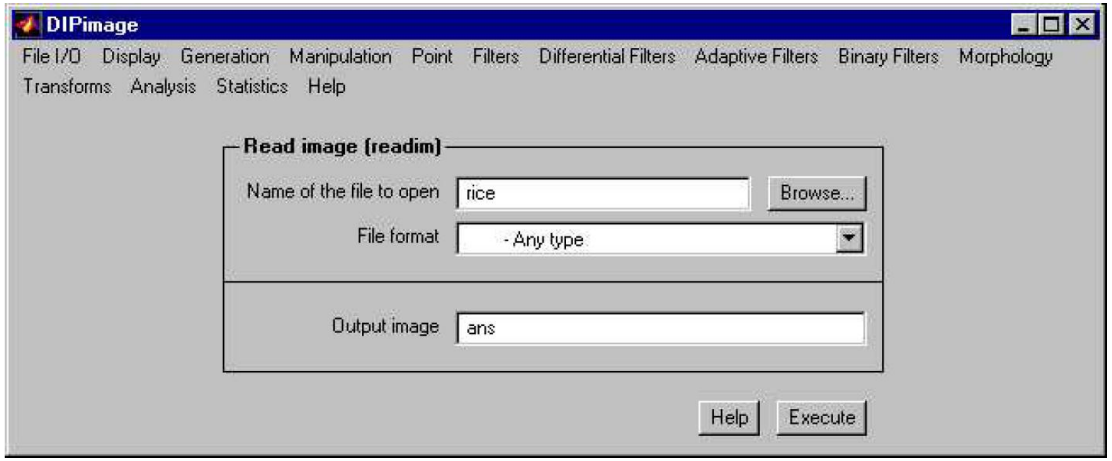
- **video** : video processing.

- **calib3d** : calibration, estimate of displacement…

3.DIPLib

- DIPLib : is an image processing library written in C, we can obtain a direct interface with Matlab

- This allows to manipulate images with the image processing toolbox, to benefit some additional features



Exemple : 3D-DOCTOR

- Install the 3D-DOCTOR software, choose an image and realize all possible processing.

- **TP : Aforge et Emgu**

Thank you