

### Motivations

For many researchers at a medical imaging department like nuclear medicine, it is common practice to process a collection of image data in additional applications; be it for the extra functionality, comparison of results, reproducibility or quality improvement.

Such innocent data transitions frequently pose unexpected difficulties which further deviate the researcher from his or her regular work schedule. Some of the problems often encountered are:

- lack of or incompatibilities between mutual supported formats
- export limited to dubious or obsolete standards
- too high costs for current standards support
- conversion tools inaccessible on outdated camera platforms
- loss of valuable medical information after study export or import
- successful data transition requires local but unavailable tweaks.

If you are faced with one of the aforementioned troubles, then read on because this project could be of assistance to you.

### Objectives

The project is about a framework specifically designed to resolve the complexities involved with conversion of medical image formats. It hereby offers:

- *xmedcon*: its graphical user interface (GUI) is to assist novices, given the immediate visual control on selected options.
- *medcon*: the command line interface (CLI) is directed to the more experienced user, who is in need of batch conversion or usage within scripted environments.
- *library*: the application programming interface (API) makes it possible for coders of existing tools, to easily increase the number of supported image formats.
- *source*: as released under the (L)GPL license, the availability thereof allows developers to adjust the library for site specific requirements. [1]

Eventually, the ultimate endeavour is to reach for a jointly approach where it comes to manage medical image data transition in general.

### Principles

Two major principles sustain the project's consistent usability:

- to *serve anybody*

In order to handle diverse situations, all possible features that manipulate the data in any way, are implemented as user selectable options only. There are no assumptions on the preferences of a certain processing tool, nor on the requirements of a particular imaging modality. In other words all major decisions are put at the user level. This flexibility, although complicating the usage, does keep the project fit for various kinds of transition purposes.

- to *preserve data*

The attention to previous principle immediately implies the assurance that the default output represents the pixel data as retrieved from the original study. Besides image data, other valuable info for medical application is kept in separate dedicated structures related to for example dynamic, static or gated acquisitions.

### Features

- *platforms*
  - UNIX (Solaris, AIX, HP-UX, IRIX, Tru64)
  - BSD & Linux
  - MS Windows
  - MacOS X
- *supported image formats*
  - medical
    - Interfile 3.3 (including GSPECT proposal, PET dialects) [2]
    - Analyze (AVW, Mayo & SPM) [3]
    - DICOM 3.0 (uncompressed, loss less JPEG or RLE) [4]
    - CTI ECAT 6 and 7 [5]
    - ACR/NEMA 2.0 [6]
    - Concorde microPET
  - desktop
    - animated GIF89a [7]
    - PNG [8]
- *unsupported formats*
  - interactive procedure to retrieve uncompressed raw pixel data
  - loadable predefined settings
- *pixel value related*:
  - scale factors: quantified (camera specific) + calibrated (real units)
  - enable or disable negative pixel values
  - preferred pixel type (regular integer, float, forced 8-bit or 16-bit)
- *files related*:
  - allow loading and saving of big or little endian
  - alias filenames into a descriptive form
- *simple image processing*:
  - flip images horizontal or vertical
  - reverse the slice order
  - square image dimensions
  - crop image arrays
  - remap colour to greyscale

- *volume manipulations*:
  - transverse, coronal or sagittal reslicing
  - extract selected images
  - stack or split slices and time frames
- *format specific*:
  - DICOM
    - enable contrast remapping
    - read (definable) mosaic layout
    - allow writing of implicit transfer syntax
    - apply different slope/intercept or centre/width value pairs
  - Analyze
    - enable support for SPM dialect (scale + offset)
  - Interfile:
    - ignore absolute path names
    - skip confusing preview slice

- *extra's*:
  - batch conversion
  - remove or identify patient/study info
  - alter GIF89a animation parameters
  - display retrieved medical info
  - transform acquisition type and associated entries

### Validations

The validation tests regularly performed on the toolkit are:

- *reciprocal self-test*

The first sanity check for any implemented format concerns a reciprocal self-test on the respective import and export functions. Simply put, the succession of a read and write exercise shouldn't expose any major differences between the entries of the dedicated info structures.

- *conversion verification*

Another validation aspect is to verify the correctness by which image data and medical info have been preserved after a format conversion.

- *format comparison*

A final validation process involves the use of different software packages to examine the results of format input or output. Following is a small sample of tools and systems used during the past years of development:

	Analyze	DICOM	ECAT	Interfile
Nuclear Diagnostic		x	x	x
Philips Medical		x		
Siemens/CTI PET	x		x	
Matlab/SPM	x			
DCMTK, CTN, Osiris		x		
MRlcro	x	x	x	x

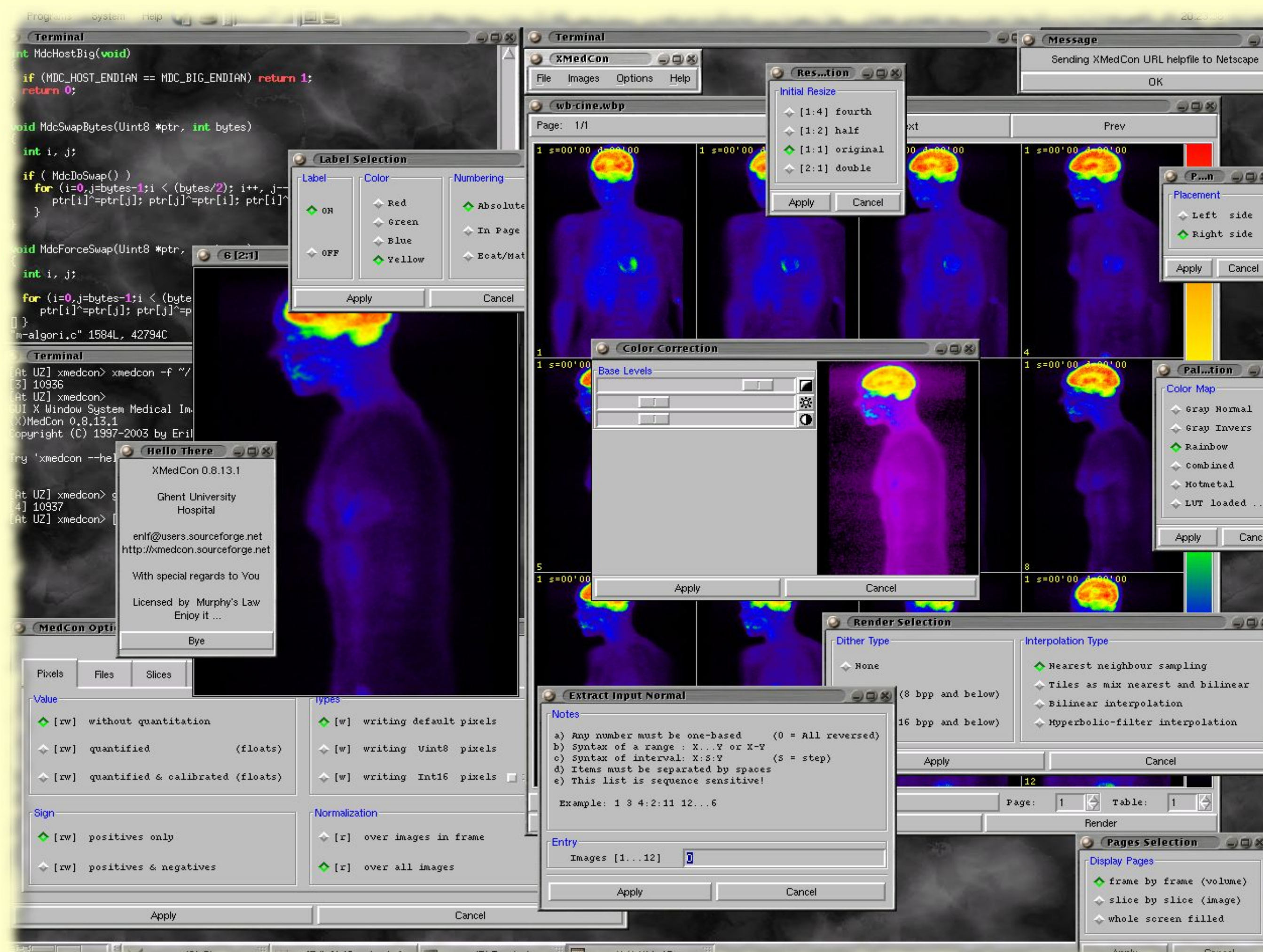
### Conclusions

It should be clear that image data transitions between medical applications still cause interfering issues, despite the existence of vendor neutral standards. The steady download statistics and the widespread deployment seem to confirm the proposition that this toolkit can be an appropriate answer to such griefs.

Moreover, the project should facilitate a collaborative development to conduct medical image data transition effectively. The increasing user feedback and received contributions do show this growing understanding.

### References

- [1] Free Software Foundation, copyleft & licenses: <http://www.gnu.org/copyleft/>
- [2] Interfile resources: <http://www.keston.com/interfile/interfile.htm>
- [3] Analyze resources from SPM: <http://www.fil.ion.ucl.ac.uk/spm/distrib.html#AzeFmt>
- [4] Home of the DICOM standard: <http://medical.nema.org/>
- [5] ECAT C-library resources: [http://www.topo.ucl.ac.be/ecat\\_Clib.html](http://www.topo.ucl.ac.be/ecat_Clib.html)
- [6] David Clunie, Medical Image Format FAQ: <http://www.dclunie.com/medical-image-faq>
- [7] Graphics Interchange Format specifications: <http://members.aol.com/royalef/gif89a.txt>
- [8] Portable Network Graphics resources: <http://www.libpng.org/>



A colourful "show as much windows" session with (X)MedCon's graphical front end.