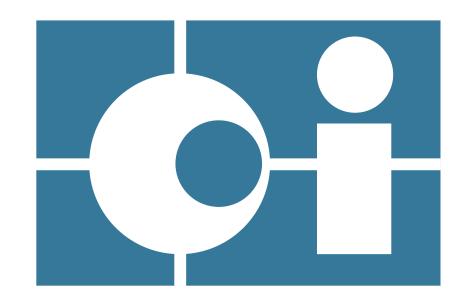# AMIDE: A Completely Free System for Medical Imaging Data Analysis
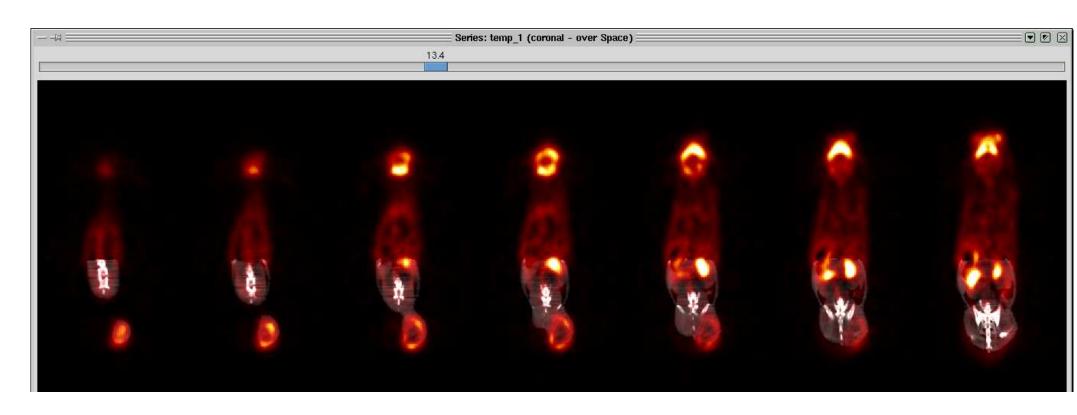
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1 INTRODUCTION

Medical image analysis software has traditionally been commercial and/or encumbered by closed-box software distribution. AMIDE (Amide's a *M*edical *I*mage *D*ata *E*xaminer) has been developed for the purpose of providing a free to use and open source tool for viewing and registering medical images, and for performing three dimensional quantitative analyses of these data sets.

2 FEATURES

AMIDE:

- Generates slices from a data set of arbitrary orientation, thickness, zoom, and time period.

- Handles and displays multiple data sets simultaneously, with independent rotations, color-maps, and thresholds for each image. This allows manual registration between data sets.

- Draws and computes statistics from volumetric regions of interest (ROIs). Currently, ellipsoids, elliptic cylinders, and boxes are supported.

- Renders single and multiple data sets concurrently using software based volume rendering.

- Views series of slices from the data set generated over time or space.

- Implements a wide range of color-maps [black-white, white-black, NIH, hot metal, etc.] and several interpolation methods [nearest neighbor, bilinear, trilinear, etc.].

- Imports CTI 6.4, CTI 7.0, Acr/Nema 2.0, Analyze (SPM), DICOM 3.0, InterFile3.3, Gif87a/89a, and raw data [floats, doubles, signed or unsigned 8/16/32 bit, big and little endian].

- Has a native XML based file format.

3 WALK THROUGH

AMIDE session

An example AMIDE session is shown to illustrate some of the program's interacting elements. Specific elements are elaborated upon below.

Main Window

The main window is quite simple, and serves only as a spring board for creating new studies and loading up previous ones.

Study Window

The study window is the main interface to the program. Multiple image data sets can be imported into a study and worked with simultaneously. Objects that have been selected in the study item list (on the left side of the window) are displayed in the three view windows. In this example, a microCT and a microPET (^{18}FDG) image of the same mouse have been imported and manually aligned. An elliptical ROI has been drawn over the tumor, which is located on the dorsal surface of the right hip.

Serial slice viewing

The serial viewer allows looking at slices of a study that have been generated by serially slicing over space or over time.

Modification Dialogs

The data set modification dialog allows changing parameters specific to a data set including name, color-map, thresholds, orientation, offset, voxel-size, and the data conversion factor. The ROI modification dialog performs similar functions for regions of interest.

Volume rendering dialog

The volume rendering dialog allows three-dimensional renderings of the data sets to be created. The rendering classification parameters shown here can be set independently of the image thresholds.

4 DESIGN CHOICES

- The C programming language was chosen because of the ready availability of free, high quality C compilers and because of the large number of people who are versed in this language. Other programming languages considered (C++, Java, IDL, Matlab, etc.) suffer from a limited subset of programmers who understand the language, execution time penalties, and/or dependencies on expensive proprietary software.

- The user interface of AMIDE is implemented using the GTK+/GNOME toolkit. This toolkit is unencumbered by restrictive licensing, exhibits a modern look and feel with theme capabilities, exports a C language interface, and is available on the majority of Unix systems.

- AMIDE is licensed under the GPL (GNU General Public License [1]). This license ensures that AMIDE is both free to use (free as in free beer) and free to distribute and modify (free as in free speech), along with ensuring that work contributed to the program by others will remain free and available.

- Floating point is used as the internal representation for all image data. The computational and programming simplifications gained were felt to override concerns about increased memory usage, especially in light of current memory prices. Either 32 (default) or 64 bit floating point can be chosen as a compile time option.

- The native file format is composed of a separate directory for each study containing XML and raw data files. The XML files encode the study and data set parameters. The file format of the raw data files containing the image data is arbitrary and is noted in the corresponding XML parameter file (default is 32 bit float, little endian). This approach is machine independent, non-proprietary, extensible, and relatively future proof, as parameter files can be edited with standard text editors.

- AMIDE interfaces directly with the xmedcon/libmdc package [2] in order to provide support for importing Acr/Nema 2.0, Analyze (SPM), DICOM 3.0, and InterFile3.3 file formats. Xmedcon is a fairly advanced project by Erik Nolf and others that freely provides file conversion utilities for most of the more commonly used medical image data formats. CTI 6.4 and 7.0 support is provided using the z_matrix_70/libecat library [3]. Importing of raw data is provided natively by AMIDE.

- Instead of having the user's view of the data dictated by the underlying format of the image data, it was decided to divorce the user as much as possible from the discrete internal representation of the data set. Thus, all distances and times are provided in terms of continuous real-world units (millimeters and seconds) rather than their discrete equivalents (voxels and frames). As an example, the thickness of the
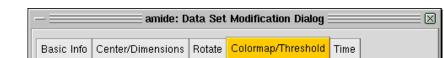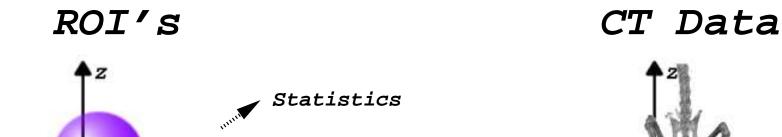
image slices can be set from a continuous range rather than being an integer function of the number of voxels used.

- Non-orthogonal reslicing, zooming, and scaling of the data is done continuously and automatically as described in Figure 1. This allows the underlying image data to be kept in its original format, while enabling the user to view the data from any angle and position desired, with any scaling constant and threshold applied..
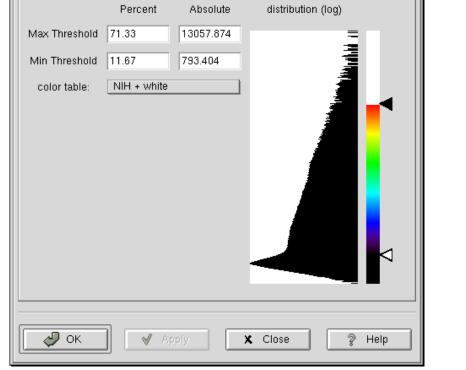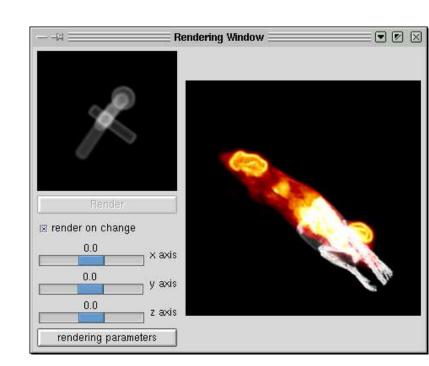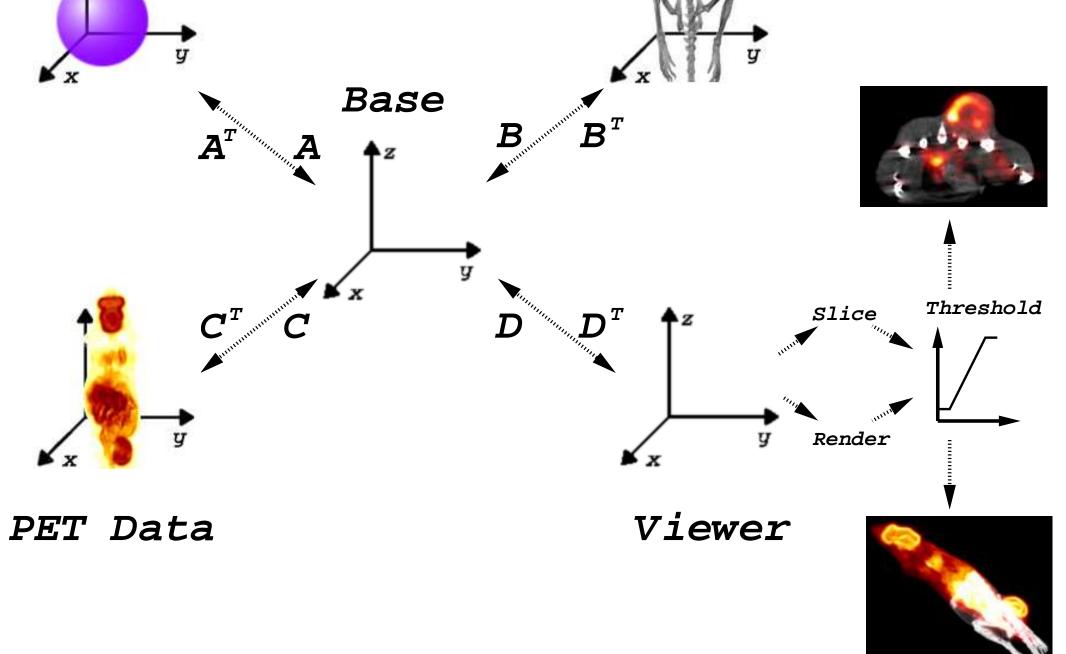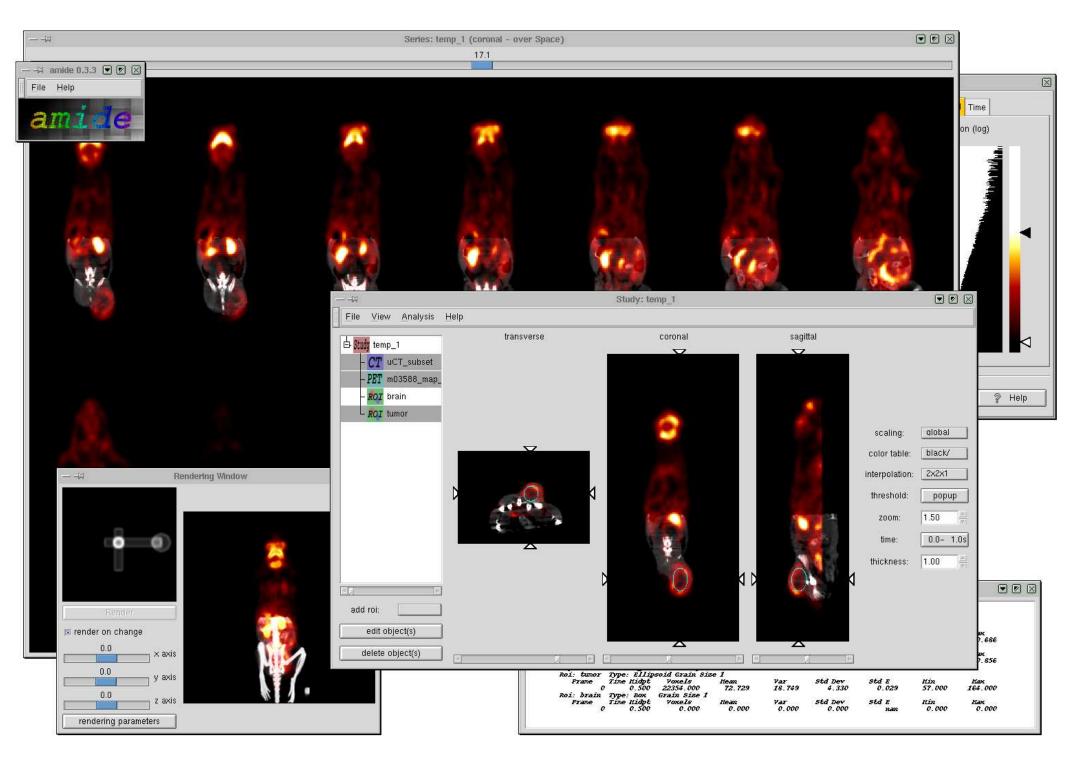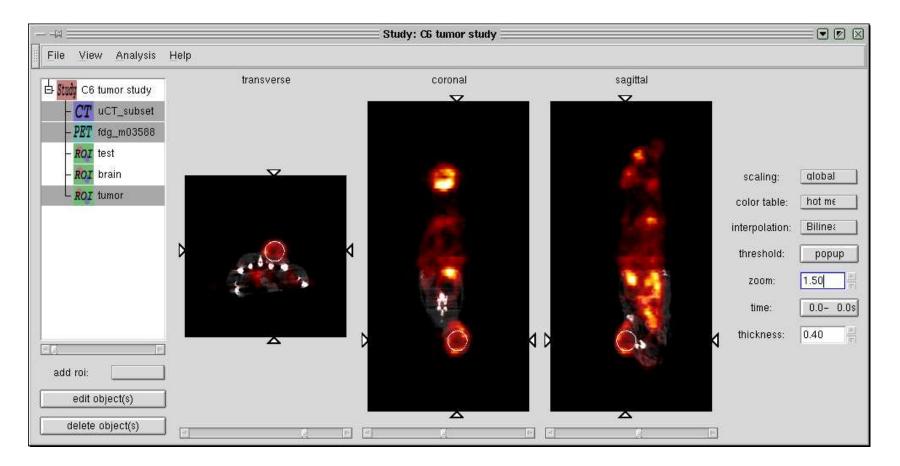

Figure 1: Multiple objects and views are handled by the use of multiple coordinate frames, with translation and interpolation of data between frames done as needed. The interpolation method can be switched to optimize for speed or quality.

- Volume rendering support is provided using the volpack software rendering library [4]. While not as fast as techniques using proprietary graphics hardware, volpack performs true volume rendering, does not require the purchasing of additional hardware, and, with modern processors, can render most data sets in times on the order of 1 second.

5 VALIDATION

In order to validate AMIDE's calculation of ROI statistics, similar ROIs were drawn on the same features in three different data sets using AMIDE and three additional image analysis packages . The three additional packages were Siemens's Clinical Applications Programming Package (CAPP), Mediman [5], and CRIIISP (an IDL based image package developed previously in our laboratory).

Mean Image Units±SEM	AMIDE	CAPP	CRIIISP	Mediman
Cylinder (^{18}FDG) - center	1.44±.00	1.46	1.43	1.46±.00
microPET Scan (^{18}FDG) - tumor	0.42±.01	0.44	0.41	0.39±.01
microPET Scan (^{18}FHBG) - colon	2.02±.10	1.87	2.08	2.01±.05

6 AVAILABILITY

AMIDE is provided as freely available source code via SourceForge [http://amide.sourceforge.net]. Binaries of AMIDE are also available from the website for Linux/i386 and Linux/PowerPC. Although no support services for AMIDE can be promised, users are invited to post comments, questions, bug reports, and feature requests on the web site.

7 CONCLUSION

AMIDE is a fully capable medical image data analysis tool that has found use in our own laboratory in analyzing microPET data and in registering microPET and microCT data sets. We believe that other labs will also find this software useful for their own imaging and data analysis needs. Additionally, since the source code is freely available, it is hoped that others will choose to contribute extensions to the capabilities of this program.

References

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