Strategic Theme 2

SCD is committed to deliver and further develop its expertise in scientific analysis, data science, modelling and simulation, to support STFC's commitment to: Establish the Ada Lovelace Centre, an integrated, cross disciplinary, data-intensive science centre, to transform the use of real time data processing, computer simulation and data analytics to deliver more effective research at our national facilities.

Building Better Tools for Tomography

The Visual Analytics and Imaging Systems group supports two Collaborative Computational Projects (CCPs) for tomography (imaging by sections) in material science and medical imaging. Through the work at these CCPs we are building capacity in advanced software infrastructure for the material science and medical tomography communities.

The Collaborative Computational Project in Tomographic Imaging (CCPi) aims to provide the UK tomography community with a toolbox of algorithms that increases the quality and level of information that can be extracted by computer tomography (neutron or x-ray tomography).

The Collaborative Computational Project in PET/MR aims to exploit the recent integration of positron emission tomography (PET) and magnetic resonance (MR) imaging into a single simultaneous imaging system. The aim is to provide enabling infrastructure for research in PET-MR by development and promotion of a common software framework to tackle the specific challenges of this imaging modality. This will be achieved by standardisation of data formats, creating tools to export data in these data formats and development of a software platform for integrated PET-MR image reconstruction.

Core Imaging Library

The CCPi Core Imaging Library (CIL) is a set of modules for each process involved in the data analysis workflow for Computed Tomography datasets: image pre-processing, reconstruction, quantification, segmentation and visualization.

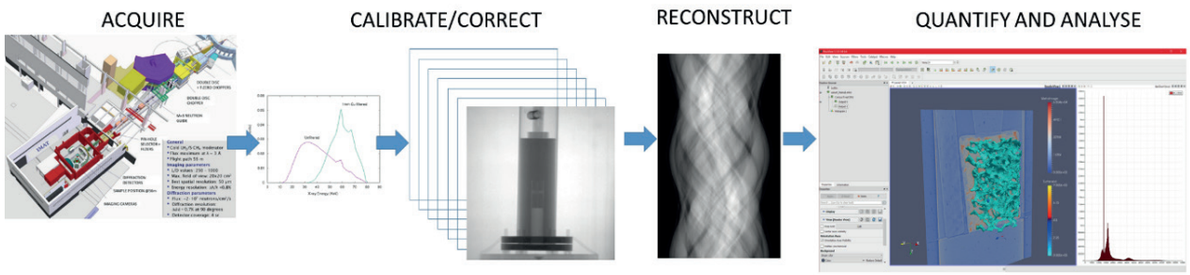

Figure 1. A Computed Tomography pipeline

The algorithms are contributed by the CCPi community and are engineered to make them scalable, optimized, accessible, maintainable and documented. While the core of the library is developed in C++, our aim is to give programmers and scientists more flexible ways to explore and integrate these algorithms into high level languages, such as Python.

Currently there are 5 available modules:

- Pre-processing: Beam hardening[1]
- Iterative reconstruction algorithms[2] (CGLS, SIRT, MLEM and CGLS with 3 regularization methods) for parallel beam
- Topological Segmentation based on Contour Tree [3]
- Quantification: Accessible Volume[4] and Label Quantification[5] algorithms
- Interactive Viewer for 3D volumes and surfaces

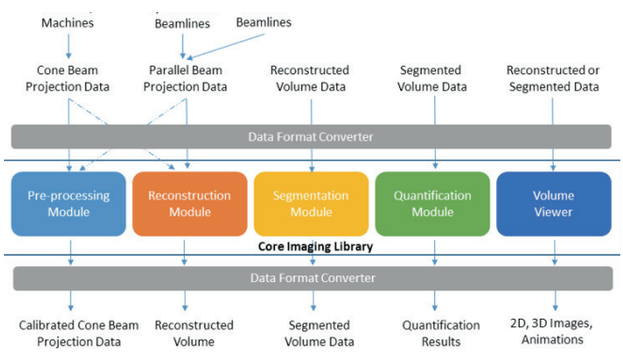

Figure 2. Available modules in the Core Imaging Library and how they fit the CT pipeline

The CCPi Core Imaging Library is distributed as a Python module via the CCPi conda channel https://anaconda.org/ccpi. To increase software usage and user engagement there is a mailing list and a documentation website with explanation and examples. Additionally, plugins for a number of image analysis software platforms such as Paraview, Avizo and Fiji are distributed.

The Core Imaging Library was launched in June 2017 with a bi-yearly stable release plan.

Synergistic Image Reconstruction Framework

The Synergistic Image Reconstruction Framework (SIRF) software is an Open Source toolkit for the reconstruction of PET and MRI raw data. The aim is to provide code simple enough to easily perform a reconstruction, yet powerful enough to be able to handle real, full-size datasets. Our strategy in achieving this aim is to employ available Open Source reconstruction software written in advanced programming languages such as C++ and provide basic-user-friendly interfaces to it written in script languages, primarily Matlab and Python. The code builds upon existing Open Source software packages for medical image reconstruction. Currently, SIRF uses STIR for PET reconstruction and Gadgetron for MRI.

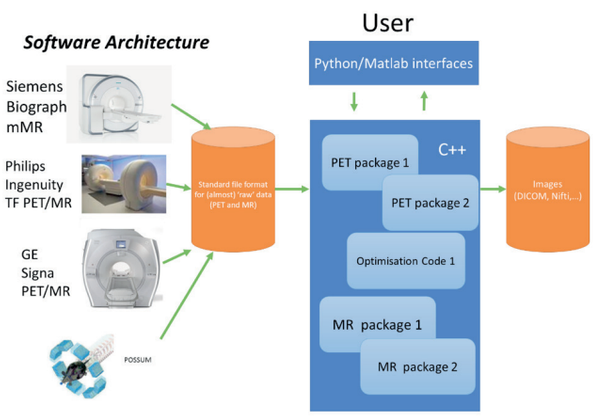

Figure 3. Synergistic Image Reconstruction Software architecture.

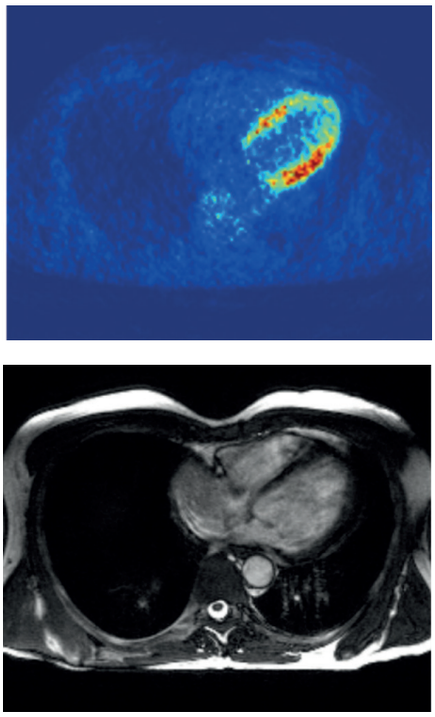

Figure 4. Example images of cardiac patient data acquired with Siemens mMR reconstructed with SIRF. Data: Kolbitsch et al., Fully integrated 3D High-Resolution Multicontrast Abdominal PET-MR with High Scan Efficiency, MRM 2017.

A pre-release of the Synergistic Image Reconstruction Framework was launched at the PSMR2017 conference followed by the first release 0.9.0 on the 14th of June 2017.

Summary

The Visual Analytics and Imaging Systems (VAIS) group has contributed to the development and distribution of two major advanced software frameworks for the analysis, quantification and visualization of tomographic data in the field of material science and medical imaging. With the release of the Core Imaging Library and Synergistic Image Reconstruction Framework VAIS delivered and is committed to further develop advanced software solutions for the handling, analysis, visualization and interpretation of experimental data for more effective research at our national facilities.

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