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ITK Software Guide: Design and Functionality

4.7

The ITK Software Guide

Design and Functionality

ITK 4.7

Hans J. Johnson,

Matt McCormick, Luis Ibáñez

and the Insight Software Consortium

Kitware

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Document created with LaTeX, using CMake as configuration manager, with a Python script to extract examples from the `ITK/Examples` directory. All code in this document compiled at the time of publication.

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The ITK Software Guide
Book 2: Design and Functionality
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and the *Insight Software Consortium*

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The purpose of computing is Insight, not numbers.

Richard Hamming

ABOUT THE COVER

The cover image consists of a photograph of ABS plastic anatomical objects printed with a MakerBot Replicator 2X 3D printer. Mesh STL files were generated from the images with VTK.

Skull. Given that the origins of ITK are with the Visible Human Project, it is appropriate that the skull was derived from the Visible Woman dataset. The skull was segmented with ITK from the Visible Woman head CT images with simple thresholding[1].

Brain. The brain model was segmented with ITK as described in the open science publication:

McCormick M, Liu X, Jomier J, Marion C and Ibanez L. ITK: enabling reproducible research and open science. Front. Neuroinform. 8:13. 2014. doi: 10.3389/fninf.2014.00013

[1] `https://github.com/XiaoxiaoLiu/3D-printing`

ABSTRACT

The Insight Toolkit (ITK) is an open-source software toolkit for performing registration and segmentation. *Segmentation* is the process of identifying and classifying data found in a digitally sampled representation. Typically the sampled representation is an image acquired from such medical instrumentation as CT or MRI scanners. *Registration* is the task of aligning or developing correspondences between data. For example, in the medical environment, a CT scan may be aligned with a MRI scan in order to combine the information contained in both.

ITK is a cross-platform software. It uses a build environment known as CMake to manage platform-specific project generation and compilation process in a platform-independent way. ITK is implemented in C++. ITK's implementation style employs generic programming, which involves the use of templates to generate, at compile-time, code that can be applied *generically* to any class or data-type that supports the operations used by the template. The use of C++ templating means that the code is highly efficient and many issues are discovered at compile-time, rather than at run-time during program execution. It also means that many of ITK's algorithms can be applied to arbitrary spatial dimensions and pixel types.

An automated wrapping system integrated with ITK generates an interface between C++ and a high-level programming language Python. This enables rapid prototyping and faster exploration of ideas by shortening the edit-compile-execute cycle. In addition to automated wrapping, the SimpleITK project provides a streamlined interface to ITK that is available for C++, Python, Java, CSharp, R, Tcl and Ruby.

Developers from around the world can use, debug, maintain, and extend the software because ITK is an open-source project. ITK uses a model of software development known as Extreme Programming. Extreme Programming collapses the usual software development methodology into a simultaneous iterative process of design-implement-test-release. The key features of Extreme Programming are communication and testing. Communication among the members of the ITK community is what helps manage the rapid evolution of the software. Testing is what keeps the software stable. An extensive testing process supported by the system known as CDash measures the quality of ITK code on a daily basis. The ITK Testing Dashboard is updated continuously, reflecting the quality of the code at any moment.

The most recent version of this document is available online at http://itk.org/ItkSoftwareGuide.pdf. This book is a guide to developing software with ITK; it is the second of two companion books. This book covers detailed design and functionality for reading and writing images, filtering, registration, segmentation, and performing statistical analysis. The first book covers building and installation, general architecture and design, as well as the process of contributing in the ITK community.

CONTRIBUTORS

The Insight Toolkit (ITK) has been created by the efforts of many talented individuals and prestigious organizations. It is also due in great part to the vision of the program established by Dr. Terry Yoo and Dr. Michael Ackerman at the National Library of Medicine.

This book lists a few of these contributors in the following paragraphs. Not all developers of ITK are credited here, so please visit the Web pages at http://itk.org/ITK/project/parti.html for the names of additional contributors, as well as checking the GIT source logs for code contributions.

The following is a brief description of the contributors to this software guide and their contributions.

Luis Ibáñez is principal author of this text. He assisted in the design and layout of the text, implemented the bulk of the LaTeX and CMake build process, and was responsible for the bulk of the content. He also developed most of the example code found in the `Insight/Examples` directory.

Will Schroeder helped design and establish the organization of this text and the `Insight/Examples` directory. He is principal content editor, and has authored several chapters.

Lydia Ng authored the description for the registration framework and its components, the section on the multiresolution framework, and the section on deformable registration methods. She also edited the section on the resampling image filter and the sections on various level set segmentation algorithms.

Joshua Cates authored the iterators chapter and the text and examples describing watershed segmentation. He also co-authored the level-set segmentation material.

Jisung Kim authored the chapter on the statistics framework.

Julien Jomier contributed the chapter on spatial objects and examples on model-based registration using spatial objects.

Karthik Krishnan reconfigured the process for automatically generating images from all the examples. Added a large number of new examples and updated the Filtering and Segmentation chapters for the second edition.

Stephen Aylward contributed material describing spatial objects and their application.

Tessa Sundaram contributed the section on deformable registration using the finite element method.

YinPeng Jin contributed the examples on hybrid segmentation methods.

Celina Imielinska authored the section describing the principles of hybrid segmentation methods.

Mark Foskey contributed the examples on the AutomaticTopologyMeshSource class.

Mathieu Malaterre contributed the entire section on the description and use of DICOM readers and writers based on the GDCM library. He also contributed an example on the use of the VTKImageIO class.

Gavin Baker contributed the section on how to write composite filters. Also known as minipipeline filters.

Since the software guide is generated in part from the ITK source code itself, many ITK developers have been involved in updating and extending the ITK documentation. These include **David Doria**, **Bradley Lowekamp**, **Mark Foskey**, **Gaëtan Lehmann**, **Andreas Schuh**, **Tom Vercauteren**, **Cory Quammen**, **Daniel Blezek**, **Paul Hughett**, **Matthew McCormick**, **Josh Cates**, **Arnaud Gelas**, **Jim Miller**, **Brad King**, **Gabe Hart**, **Hans Johnson**.

Hans Johnson, **Kent Williams**, **Constantine Zakkaroff**, **Xiaoxiao Liu**, **Ali Ghayoor**, and **Matthew McCormick** updated the documentation for the initial ITK Version 4 release.

Luis Ibáñez and **Sébastien Barré** designed the original Book 1 cover. **Matthew McCormick** and **Brad King** updated the code to produce the Book 1 cover for ITK 4 and VTK 6. **Xiaoxiao Liu**, **Bill Lorensen**, **Luis Ibáñez**,and **Matthew McCormick** created the 3D printed anatomical objects that were photographed by **Sébastien Barré** for the Book 2 cover. **Steve Jordan** designed the layout of the covers.

Lisa Avila, **Hans Johnson**, **Matthew McCormick**, **Sandy McKenzie**, **Christopher Mullins**, **Katie Osterdahl**, and **Michka Popoff** prepared the book for the 4.7 print release.

CONTENTS