



Community Experience Distilled

# Image Processing with ImageJ

Discover the incredible possibilities of ImageJ, from basic image processing to macro and plugin development

José María Mateos-Pérez  
Javier Pascau

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BIRMINGHAM - MUMBAI

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**Authors**

José María Mateos Pérez  
Javier Pascau

**Reviewers**

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**Cover Work**

Shantanu Zagade

# About the Authors

**José María Mateos Pérez** is a Spanish researcher and a Ph.D. student in the Medical Imaging Laboratory of the Hospital General Universitario Gregorio Marañón (<http://image.hggm.es>), in Madrid, where his main research lines deal with automatic segmentation and kinetic analysis modeling of dynamic nuclear imaging sequences. He has also been an experienced ImageJ user and has developed several macros and plugins. One of them, jClustering, has been published in PLOS ONE, a peer-reviewed journal. When he has enough time to procrastinate, he also likes to develop data analysis tools in Python and R.

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I would like to thank María for her support during the writing of this book. Also, I feel the need to mention The Army of Small Animals that live or lived in our house. They are a force for good.

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**Javier Pascau** received his Ph.D. from Polytechnic University in Madrid, in 2006, and is currently a visiting professor at Carlos III University in Madrid. He has been a part of the Biomedical Imaging and Instrumentation Group, a research laboratory with a multidisciplinary team of engineers, physicists, biologists, and physicians located both in the university and Hospital General Universitario Gregorio Marañón, ([biig.uc3m.es](http://biig.uc3m.es)). His research and teaching cover areas such as medical image processing, analysis, quantification, and multimodal registration, both in preclinical and clinical environments. He has been involved in the development of small animal PET and CT devices, and in the last few years he has led several projects on intraoperative radiation therapy and image guided surgery. He has authored more than 30 papers, published in peer-reviewed journals over the last 13 years.

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I want to thank all my colleagues at the university and the hospital, since my knowledge on image processing is the result of multiple interactions in this multidisciplinary environment. Special thanks to my family and to my tireless coauthor, who has lead this common work.

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# About the Reviewers

**Cristina Chavarriás** is a telecommunications engineer specialized in medical imaging, in general, and **magnetic resonance imaging (MRI)**, in particular. Her background reaches other imaging modalities and techniques such as nuclear imaging, computed tomography or spectroscopy, and ranges from data acquisition, preprocessing and correction to image processing. Despite being a junior researcher, she has been working for seven years in the Medical Imaging Laboratory at Hospital Gregorio Marañón, which offers a privileged view over the latest imaging challenges and allows direct contact with the clinical practice.

**Ron DeSpain** has been a physicist with over 45 years of experience working for major aerospace and defense companies. Ron has used ImageJ for advanced scientific algorithm development, since it was made available on Macintosh in the early 1990s. Since then it has been rewritten in Java and now runs on all major computers that support the Java virtual machine, making it his program of choice due to its powerful and versatile rapid development environment for signal imagery and video analysis applications. He has developed applications in intelligence analysis, missile guidance, target detection and recognition, 2D/3D imaging, automatic graph reading, remote sensing, sensor fusion, machine vision, image & video analysis, robotics, medical imaging, ultrasonic, x-ray, eddy current, and IR testing and manufacturing automation for more than 20 years.

**Dr M Partridge** did his BSc in biochemistry from Lancaster university before spending a number of years working for Mediwatch Biomedical, developing a range of point-of-care sensor systems. He then left Mediwatch to join the Cranfield University, where he obtained a Ph.D. in molecular coatings of fibre optic sensors and continued work as a researcher developing a number of optical sensors systems. Matthew's current research is focused on the development of optical sensors both biological applications such as point-of-care testing and industrial VOS sensor systems.

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# Preface

Welcome to *Image Processing with ImageJ*. Whether you are new to the world of image processing or an advanced researcher, we hope you will enjoy reading this book and find it useful for your analytic tasks.

The ImageJ imaging analysis software is becoming increasingly used among a vast array of different disciplines. As its user interface is far from a spectacular's view, a novel user may feel there are only a few things that this amazing program can add to its daily tasks. However, once the ImageJ basics are understood, it becomes a basic device in the toolbox of any scientist who needs to work with images on a daily basis.

This book covers briefly many basic image operations in ImageJ, and then proceeds to more complicated topics: advanced regions of interest delineation and management, filtering in spatial and frequency domains, or particle analysis.

One of the powers of ImageJ is the possibility of automating the different operations, so they can be replicated easily or applied to a large number of different images. This macro system is explained in detail through several exercises that help in showing the reader the potential of this system.

As ImageJ is a public domain software, many developers have contributed their own plugins in order to extend what ImageJ can do by itself. The last two chapters are dedicated to this topic from the perspective of the user who just wants to install new plugins, with a list consisting of our own selection, and also from the point of view of the developer who wants to use ImageJ as the platform to build powerful tools.

Independently of your background and objective, we hope this book has something for you.

## What this book covers

*Chapter 1, Getting Started with ImageJ*, introduces the ImageJ image analysis platform and guides the reader through the installation process.

*Chapter 2, Basic Image Processing with ImageJ*, introduces the concept of digital image and the different types of data that ImageJ can handle, and then presents the intensity histogram and some basic image operations.

*Chapter 3, Advanced Image Processing with ImageJ*, describes more advanced imaging analysis techniques, such as modifying the pixel values of different images and performing local measurements. It also covers image filtering in the spatial and frequency domains.

*Chapter 4, ImageJ Macros*, presents one of the most powerful features of ImageJ: its macro system. Here we introduce this concept and show the reader how different operations can be automatized by giving several examples.

*Chapter 5, ImageJ Plugins for Users*, is used to explain how ImageJ can be extended very easily. There are literally hundreds of different plugins that extend its native features. In this chapter, we explain the ImageJ plugin system from the point of view of a user who does not necessarily need to know how to program. We perform a sample installation and list some plugins that we have found useful.

*Chapter 6, ImageJ Plugins for Developers*, is addressed for you if you are a developer. You might not just want to stop at using whatever plugins others have coded for you, but might want to try and implement your own algorithms. We explain briefly the ImageJ plugin architecture, the main classes that you will have to deal with, and how to integrate ImageJ with Eclipse, a very powerful Java IDE.

## What you need for this book

There is not much material needed in order to follow this book. As ImageJ is a multi-platform public domain software package coded in Java, you just need a desktop computer or a laptop, optionally with the latest Java version installed. And if you don't have it, don't worry too much, as ImageJ can provide it for you.

In order to follow the last sections of the sixth chapter, you will also need the Eclipse IDE installed on your system. Please remember that this chapter is aimed at people with prior programming experience, so if that is not your case, you will not need it.

Also, you will probably need some images to keep practicing, apart from the ones we already provided, but that is up to you.

## Who this book is for

This book is intended for everyone who does scientific work with images and is interested in knowing what can be achieved with ImageJ. The introductory part is a very broad introduction to the field of digital image processing, while the latter chapters are devoted to more complex analysis techniques in addition to an introduction to the macro and plugin system, that we hope will clarify these concepts to everyone interested in automating their analysis procedures or implementing their own image analysis algorithms. We have tried to accomplish a good balance between a step-by-step guide for non-advanced users and a nice introduction for developers who might want to use ImageJ as the development platform of their choice.

## Conventions

In this book, you will find a number of styles of text that distinguish between different kinds of information. Here are some examples of these styles, and an explanation of their meaning.


Code words in text are shown as follows:


You can also send the `.class` files that will be placed in your `plugins` directory.

A block of code is set as follows:

```
run("Split Channels");
selectWindow("tuberculosis_full.tif (blue)");
close();
selectWindow("tuberculosis_full.tif (red)");
close();
selectWindow("tuberculosis_full.tif (green)");
run("Subtract Background...", "rolling=30");
```

**New terms** and **important words** are shown in bold. Words that you see on the screen, in menus or dialog boxes for example, appear in the text like this: "It can be done, as the error message states, by navigating to the **Options | Memory & Threads** command from the menu".

 Warnings or important notes appear in a box like this.

 Tips and tricks appear like this.