Deblurring Images: Matrices, Spectra, and Filtering (Fundamentals of Algorithms 3)

By Per Christian Hansen, James G. Nagy, Dianne P. O'Leary

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"The book's focus on imaging problems is very unique among the competing books on inverse and ill-posed problems. …It gives a nice introduction into the MATLAB world of images and deblurring problems."
— Martin Hanke, Professor, Institut für Mathematik, Johannes-Gutenberg-Universität. When we use a camera, we want the recorded image to be a faithful representation of the scene that we see, but every image is more or less blurry. In image deblurring, the goal is to recover the original, sharp image by using a mathematical model of the blurring process. The key issue is that some information on the lost details is indeed present in the blurred image, but this "hidden" information can be recovered only if we know the details of the blurring process. Deblurring Images: Matrices, Spectra, and Filtering describes the deblurring algorithms and techniques collectively known as spectral filtering methods, in which the singular value decomposition—or a similar decomposition with spectral properties—is used to introduce the necessary regularization or filtering in the reconstructed image. The concise MATLAB® implementations described in the book provide a template of techniques that can be used to restore blurred images from many applications. This book's treatment of image deblurring is unique in two ways: it includes algorithmic and implementation details; and by keeping the formulations in terms of matrices, vectors, and matrix computations, it makes the material accessible to a wide range of readers. Students and researchers in engineering will gain an understanding of the linear algebra behind filtering methods, while readers in applied mathematics, numerical analysis, and computational science will be exposed to modern techniques to solve realistic large-scale problems in image processing. With a focus on practical and efficient algorithms, Deblurring Images: Matrices, Spectra, and Filtering includes many examples, sample image data, and MATLAB codes that allow readers to experiment with the algorithms. It also incorporates introductory material, such as how to manipulate images within the MATLAB environment, making it a stand-alone text. Pointers to the literature are given for techniques not covered in the book. Audience
This book is intended for beginners in the field of image restoration and regularization. Readers should be familiar with basic concepts of linear algebra and matrix computations, including the singular value decomposition and

orthogonal transformations. A background in signal processing and a familiarity with regularization methods or with ill-posed problems are not needed. For readers who already have this knowledge, this book gives a new and practical perspective on the use of regularization methods to solve real problems. Preface; How to Get the Software; List of Symbols; Chapter 1: The Image Deblurring Problem; Chapter 2: Manipulating Images in MATLAB; Chapter 3: The Blurring Function; Chapter 4: Structured Matrix Computations; Chapter 5: SVD and Spectral Analysis; Chapter 6: Regularization by Spectral Filtering; Chapter 7: Color Images, Smoothing Norms, and Other Topics; Appendix: MATLAB Functions; Bibliography; Index.

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Editorial Review

Review
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About the Author
Per Christian Hansen is Professor of Scientific Computing at the Technical University of Denmark. He has also worked at the University of Copenhagen, Denmark, and the Danish Computing Center for Research and Education (UNI•C). His publications include a research monograph, several MATLAB packages, and many papers on inverse problems, matrix computations, and signal processing. He is a member of SIAM. James G. Nagy is Professor of Mathematics and Computer Science at Emory University. In 2001 he was selected to hold the Emory Professorship for Distinguished Teaching in the Social and Natural Sciences. He has published many research papers on scientific computing, numerical linear algebra, inverse problems, and image processing. He is a member of SIAM and AWM. Dianne P. O'Leary is Professor of Computer Science at the University of Maryland and a mathematician at the U.S. National Institute of Standards and Technology. She was awarded an honorary Doctorate of Mathematics from the University of Waterloo. She is the author of over 75 publications on numerical analysis and computational science and over 25 publications on education and mentoring. She is a member of SIAM, AWM, and ACM.

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