



Super Resolution Imaging Super Resolution Imaging

Qian Ma

Super Resolution Imaging **Super Resolution Imaging:**

Super-Resolution Imaging Subhasis Chaudhuri,2001-09-30 Super Resolution Imaging serves as an essential reference for both academicians and practicing engineers It can be used both as a text for advanced courses in imaging and as a desk reference for those working in multimedia electrical engineering computer science and mathematics The first book to cover the new research area of super resolution imaging this text includes work on the following groundbreaking topics Image zooming based on wavelets and generalized interpolation Super resolution from sub pixel shifts Use of blur as a cue Use of warping in super resolution Resolution enhancement using multiple apertures Super resolution from motion data Super resolution from compressed video Limits in super resolution imaging Written by the leading experts in the field Super Resolution Imaging presents a comprehensive analysis of current technology along with new research findings and directions for future work

Super-Resolution Imaging Peyman Milanfar,2017-12-19 With the exponential increase in computing power and broad proliferation of digital cameras super resolution imaging is poised to become the next killer app The growing interest in this technology has manifested itself in an explosion of literature on the subject Super Resolution Imaging consolidates key recent research contributions from eminent scholars and practitioners in this area and serves as a starting point for exploration into the state of the art in the field It describes the latest in both theoretical and practical aspects of direct relevance to academia and industry providing a base of understanding for future progress Features downloadable tools to supplement material found in the book Recent advances in camera sensor technology have led to an increasingly larger number of pixels being crammed into ever smaller spaces This has resulted in an overall decline in the visual quality of recorded content necessitating improvement of images through the use of post processing Providing a snapshot of the cutting edge in super resolution imaging this book focuses on methods and techniques to improve images and video beyond the capabilities of the sensors that acquired them It covers History and future directions of super resolution imaging Locally adaptive processing methods versus globally optimal methods Modern techniques for motion estimation How to integrate robustness Bayesian statistical approaches Learning based methods Applications in remote sensing and medicine Practical implementations and commercial products based on super resolution The book concludes by concentrating on multidisciplinary applications of super resolution for a variety of fields It covers a wide range of super resolution imaging implementation techniques including variational feature based multi channel learning based locally adaptive and nonparametric methods This versatile book can be used as the basis for short courses for engineers and scientists or as part of graduate level courses in image processing

Super-Resolution Imaging in Biomedicine Alberto Diaspro,Marc A. M. J. van Zandvoort,2016-11-03 This book encompasses the full breadth of the super resolution imaging field representing modern techniques that exceed the traditional diffraction limit thereby opening up new applications in biomedicine It shows readers how to use the new tools to increase resolution in sub nanometer scale images of living cells and tissue which leads

to new information about molecules pathways and dynamics The book highlights the advantages and disadvantages of the techniques and gives state of the art examples of applications using microscopes currently available on the market It covers key techniques such as stimulated emission depletion STED structured illumination microscopy SSIM photoactivated localization microscopy PALM and stochastic optical reconstruction microscopy STORM It will be a useful reference for biomedical researchers who want to work with super resolution imaging learn the proper technique for their application and simultaneously obtain a solid footing in other techniques

Label-Free Super-Resolution Microscopy

Vasily Astratov,2019-08-31 This book presents the advances in super resolution microscopy in physics and biomedical optics for nanoscale imaging In the last decade super resolved fluorescence imaging has opened new horizons in improving the resolution of optical microscopes far beyond the classical diffraction limit leading to the Nobel Prize in Chemistry in 2014 This book represents the first comprehensive review of a different type of super resolved microscopy which does not rely on using fluorescent markers Such label free super resolution microscopy enables potentially even broader applications in life sciences and nanoscale imaging but is much more challenging and it is based on different physical concepts and approaches A unique feature of this book is that it combines insights into mechanisms of label free super resolution with a vast range of applications from fast imaging of living cells to inorganic nanostructures This book can be used by researchers in biological and medical physics Due to its logically organizational structure it can be also used as a teaching tool in graduate and upper division undergraduate level courses devoted to super resolved microscopy nanoscale imaging microscopy instrumentation and biomedical imaging

Super-Resolution Microscopy

Udo J. Birk,2017-12-04 This unique book on super resolution microscopy techniques presents comparative in depth analyses of the strengths and weaknesses of the individual approaches It was written for non experts who need to understand the principles of super resolution or who wish to use recently commercialized instruments as well as for professionals who plan to realize novel microscopic devices Explaining the practical requirements in terms of hardware software and sample preparation the book offers a wealth of hands on tips and practical tricks to get a setup running provides invaluable help and support for successful data acquisition and specific advice in the context of data analysis and visualization Furthermore it addresses a wide array of transdisciplinary fields of applications The author begins by outlining the joint efforts that have led to achieving super resolution microscopy combining advances in single molecule photo physics fluorophore design and fluorescent labeling instrument design and software development The following chapters depict and compare current main standard techniques such as structured illumination microscopy single molecule localization stimulated emission depletion microscopy and multi scale imaging including light sheet and expansion microscopy For each individual approach the experimental setups are introduced the imaging protocols are provided and the various applications illustrated The book concludes with a discussion of future challenges addressing issues of routine applications and further commercialization of the available methods Guiding users in how to make choices

for the design of their own experiments from scratch to promising application this one stop resource is intended for researchers in the applied sciences from chemistry to biology and medicine to physics and engineering Plasmonics and Super-Resolution Imaging Zhaowei Liu,2017-06-26 Plasmonics is an emerging field mainly developed within the past two decades Due to its unique capabilities to manipulate light at deep subwavelength scales plasmonics has been commonly treated as the most important part of nanophotonics Plasmonic assisted optical microscopy techniques especially super resolution microscopy have shown tremendous potential and attracted much attention This book aims to collect cutting edge studies in various optical imaging technologies with advanced performances that are enabled or enhanced by plasmonics The basic working principles development details and potential future direction and perspectives are discussed Edited by Zhaowei Liu a prominent researcher in the field of super resolution microscopy this book will be an excellent reference for anyone in the field of nanophotonics plasmonics and optical microscopy

On Learning and Regularization in Super-Resolution Imaging Muhammad Ali Muhammad Rushdi,2013 Advances in super resolution imaging have been made by reconstruction interpolation and example based algorithmic techniques drawn from the fields of signal and image processing machine learning biologically inspired computer vision and psychology However the performance of super resolution algorithms has been limited by constraints of sampling frequency sensor dimensions sensor noise focus and motion blurring and alignment between low resolution input data samples In this dissertation we propose several techniques to improve the performance of state of the art super resolution techniques Firstly a concise introduction and literature survey of super resolution imaging research is given Secondly novel dictionary learning techniques for super resolution are presented Thirdly non uniform image super resolution over deformed image domains is approached using patch redundancy as well as resolution independence image models Experimental results are good in visual quality and compare well with other state of the art techniques Future work should explore the extension of the proposed methods to video and stereoscopic imaging

Super Resolution Optical Imaging and Microscopy Junle Qu,Zhigang Yang,2023-12-15 Super Resolution Optical Imaging and Microscopy Extremely comprehensive resource containing cutting edge and practical knowledge of super resolution optical imaging This book covers both the basic principles and specific technical details of super resolution microscopy techniques It covers the criteria to choose different fluorophores for various SRM methods and critically assesses the nitty gritty of associated problems that are often encountered in practical applications A progressive guide to designing the next generation of advanced fluorophores to meet the goal of advanced SR imaging studies is also put forward Written by two well qualified authors the book contains exclusive content to enhance readers understanding on innovation of newer SRM technologies Sample topics covered in the book include Optical techniques fluorescent probe design and algorithm development Recent highlight and breakthroughs in biology using SRM methods The overall success of SRM in biological inventions The future direction and scope of the field This book is an invaluable resource for chemists and researchers

scientists involved in designing newer fluorescent materials for SRM studies It can also assist biologists engaged in advanced biological studies using SRM by guiding them through sample preparation image processing and precautions to be taken in practical imaging studies Super-resolution Imaging with Metamaterials Naomi Ariane Waterman,2018

Super Resolution Technique and Its Potential Usage in Medical Imaging Yiu-Chuen Chang, 2017-01-26 This dissertation Super Resolution Technique and Its Potential Usage in Medical Imaging by Yiu chuen Chang was obtained from The University of Hong Kong Pokfulam Hong Kong and is being sold pursuant to Creative Commons Attribution 3.0 Hong Kong License The content of this dissertation has not been altered in any way We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation All rights not granted by the above license are retained by the author Abstract Purpose Medical imaging systems are used to scan patients to obtain valuable information for diseases diagnosis and assisting treatment An ideal scanner should be sensitive enough to detect any trace amount of abnormal tissue at its early stage With the continuous development of high tech treatment systems such as Tomotherapy manufactured by Tomo HD the high resolution imaging system is favorable to reduce the damage of normal tissue due to the image guidance of Mega voltage beam before treatment In this study a software approach was presented to improve image resolution without hardware upgrade of a scanner Methodology A programming technique Super Resolution Technique was used and demonstrated in an example of CT It utilized several similar images with known relative shifts between them They can be positional or angular shifted and taken at the same time frame as far as possible Those images are of low resolution and can be reconstructed to form a higher resolution image A Super Resolution program was written by MATLAB to prove the method The experiments 1 to 4 were purely computer based simulations and experiment 5 used a LightSpeed VCT scanner for real scans For the computer based experiments a few low resolution images have been attempted and registration steps were explored for image reconstruction A resolution target USAF1951 was called from MATLAB and used to examine the resolving power before and after image processing based on Super Resolution algorithm Image image subtraction was used to compare pre processing and post processing images The number of non zero pixels was used to access the percentage of similarity For the experiment using LightSpeed VCT scanner a GE VCT QA phantom was used to test the performance of the technique Result From the experiments using USAF1951 it was found that the minimum resolvable line pairs had improved from family 1 element 6 to family 0 element 2 2 elements improvement after applying Super Resolution Technique as shown in the experiment 1 An xy directional shifting of the pre processing images resulted in a better reconstructed image than x axis shifting or y axis shifting in terms of resolution shown in the experiment 2 The experiment 3 concluded that the more the pre processing images the better the reconstructed image would be The experiment 4 showed that the shifts of pre processing images greater than the detector size could still result in a higher resolution image The experiment 5 revealed that applying Super Resolution Technique to a real CT scanner could not give an obvious improvement in resolution but the

image background noise had reduced Conclusion It was concluded that the Super Resolution Technique could improve the image resolution and reduce the background noise at expense of more imaging time and more dose from the additional view In case of hardware upgrade of imaging device is not practicable Super Resolution could help improve the image quality DOI 10.5353/th_b5204647 Subjects Diagnostic imaging **Superresolution Imaging**  Chin-Ko Yau, 2017-01-27 This dissertation Superresolution Imaging Models and Algorithms by Chin ko Yau was obtained from The University of Hong Kong Pokfulam Hong Kong and is being sold pursuant to Creative Commons Attribution 3.0 Hong Kong License The content of this dissertation has not been altered in any way We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation All rights not granted by the above license are retained by the author Abstract Abstract of thesis entitled SUPERRESOLUTION IMAGING MODELS AND ALGORITHMS Submitted by YAU Chin Ko for the degree of Doctor of Philosophy at The University of Hong Kong in January 2008 In this thesis two types of super resolution imaging models were presented a linear type model using Laplacian matrix as a regularization and a non linear type model using total variation TV term as a regularization In the literatures two types of imaging systems are usually considered a near eld imaging and a far eld imaging In the near eld imaging system the blur ring from optical devices is considered whereas in the far eld imaging system the blurring from the environmental factors is considered In this thesis two new models called medium eld models which generalize both of the above imaging systems were presented In these new models the high resolution restored image was obtained by using a maximum a posteriori MAP estimation technique with a Gaussian prior The linearity of this model comes from the use of the Laplacian matrix in the regularization In the rst medium model the observed low resolution images were assumed to be rst blurred by the environmental factors then downsampled and nally blurred by the optical devices In the second medium model the observed low resolution images were assumed to be blurred by the environmental factors then blurred by the optical devices and nally down sampled The observed images were all assumed to contain noises The periodic boundary condition and the zero boundary condition were considered in the blur ringmatrix

By using a suitable trigonometric transform to simplify the coefficient matrix the Neumann boundary condition which gives better results than these boundary conditions can be also considered in all these four models which are Laplacian based models For the TV based model a unified super resolution model was presented The idea is based on that missing pixels of the observed images can be found if they are mapped into the high resolution image grid and the total variation TV inpainting technique is used to find them So roughly speaking a super resolution imaging model was combined with a TV inpainting model Furthermore an extra missing region such as scratches in observed images was allowed in this model Several observation models which have been considered by some other researchers were included by this unified model Then a nonlinearity comes from the TV regularization A fast algorithm based on the hexed point iterations and preconditioning technique with factorized sparse inverse preconditioner FSIP was developed to solve the

problem The proposed algorithm is faster than the time marching scheme commonly used to solve the TV type regularization problem Furthermore the TV super resolution model was modified to obtain a super resolution image by using a sequence of zoomed images Numerical results were presented to illustrate the proposed algorithm in different models They reveal that high quality of the super resolution images can be obtained by the proposed models DOI 10.5353/th_b3955904 Subjects

Resolution Optics Imaging systems Laplacian operator Algorithms **Plasmonics and Super-resolution Imaging**

Zhaowei Liu, 2017 This book aims to collect cutting edge studies in various optical imaging technologies with advanced performances that are enabled or enhanced by plasmonics The basic working principles development details and potential future direction and perspectives are discussed Edited by Zhaowei Liu a prominent researcher in the field of super resolution microscopy this book will be an excellent reference for anyone in the field of nanophotonics plasmonics and optical microscopy

Super Resolution Imaging Applied to Scientific Images, 2007 Super resolution refers to the process of producing a high spatial resolution image than what is afforded by the physical sensor through post processing means It includes up sampling the image thereby increasing the maximum spatial frequency and removing degradations that arise during the image capture viz aliasing and blurring Various methods have been explored for super resolution of material surface images as well as other images in the report Based on observations it is recommended to use either the contourlet based method or TV based approach for super resolving optical microscope data To super resolve the AFM data it is recommended to use either TV based approach or PG method

Super-Resolution Imaging Technology Kareem Soliman, 2016 **Recent Advances in Fluorescent Probes for Super-Resolution Microscopy** Chayan Kanti Nandi, Fan Wang, Xusan Yang, Qiuqiang Zhan, 2021-07-21

Super-Resolution Imaging by Metamaterial-Assisted Illumination Qian Ma, 2018 This thesis presents theoretical and experimental demonstrations of using hyperbolic metamaterial illumination to go beyond the diffraction limit of optical microscopy This technique named as metamaterial assisted illumination nanoscope MAIN combines near field patterned illumination generated by hyperbolic metamaterial HMM and far field detection of an optical microscope to achieve super resolution A few designs of hyperbolic metamaterial to projects series of sub wavelength patterned illumination as well as a few optical detection configurations are studied An ideal HMM that is homogenous and highly dispersive is studied by simulation By implementing well designed nanostructures the HMM is capable to project a series of near field wavelength dependent patterns with ultrahigh resolution Those patterns are then utilized to imaging an object by a compressive sensing single pixel imager configuration in which 12 nm resolution is numerically demonstrated A practical HMM consisting of composite Ag SiO₂ multilayers is studied in experiment The dispersion property and resolution limit of such a multilayer HMM are experimentally measured The HMM shapes the beam into a thin line which can be scanned laterally by tuning wavelength Proof of concept experiment demonstrates the super resolution capability of MAIN and 80 nm resolution along one dimension of a 2D image is presented By replacing the line illumination to speckle

illumination at near field of the HMM Speckle MAIN can achieve 2D super resolution Speckle MAIN prototypes a super resolution microscope down to 50 nm with a metamaterial substrate and a low cost easy implemented optical system

Superresolution Optical Microscopy Barry R. Masters, 2021-08-26 This book presents a comprehensive and coherent summary of techniques for enhancing the resolution and image contrast provided by far field optical microscopes. It takes a critical look at the body of knowledge that comprises optical microscopy, compares and contrasts the various instruments, provides a clear discussion of the physical principles that underpin these techniques, and describes advances in science and medicine for which superresolution microscopes are required and are making major contributions. The text fills significant gaps that exist in other works on superresolution imaging, firstly by placing a new emphasis on the specimen, a critical component of the microscope setup, giving equal importance to the enhancement of both resolution and contrast. Secondly, it covers several topics not typically discussed in depth, such as Bessel and Airy beams, the physics of the spiral phase plate, vortex beams, and singular optics, photoactivated localization microscopy (PALM), stochastic optical reconstruction microscopy (STORM), structured illumination microscopy (SIM), and light sheet fluorescence microscopy (LSFM). Several variants of these techniques are critically discussed. Noise, optical aberrations, specimen damage, and artifacts in microscopy are also covered. The importance of validation of superresolution images with electron microscopy is stressed. Additionally, the book includes translations and discussion of seminal papers by Abbe and Helmholtz that proved to be pedagogically relevant as well as historically significant. This book is written for students, researchers, and engineers in the life sciences, medicine, biological engineering, and materials science who plan to work with or already are working with superresolution light microscopes. The volume can serve as a reference for these areas while a selected set of individual chapters can be used as a textbook for a one-semester undergraduate or first-year graduate course on superresolution microscopy. Moreover, the text provides a captivating account of curiosity, skepticism, risk-taking, innovation, and creativity in science and technology. Good scientific practice is emphasized throughout, and the author's lecture slides on responsible conduct of research are included as an online resource which will be of interest to students, course instructors, and scientists alike.

Fluorescence Microscopy
Anda Cornea, P. Michael Conn, 2014-02-24 Fluorescence Microscopy: Super Resolution and other Novel Techniques delivers a comprehensive review of current advances in fluorescence microscopy methods as applied to biological and biomedical science. With contributions selected for clarity, utility, and reproducibility, the work provides practical tools for investigating these ground-breaking developments. Emphasizing super-resolution techniques, light sheet microscopy, sample preparation, new labels and analysis techniques, this work keeps pace with the innovative technical advances that are increasingly vital to biological and biomedical researchers. With its extensive graphics, inter-method comparisons and tricks and approaches not revealed in primary publications, Fluorescence Microscopy encourages readers to both understand these methods and to adapt them to other systems. It also offers instruction on the best visualization to derive quantitative information about cell

biological structure and function delivering crucial guidance on best practices in related laboratory research Presents a timely and comprehensive review of novel techniques in fluorescence imaging as applied to biological and biomedical research Offers insight into common challenges in implementing techniques as well as effective solutions Recent Progress in Surface Electromagnetic Modes Lin Chen,Fei Gao,Wei E. I. Sha,Zhi Ning Chen,2021-07-08 **Theory and Methods for Efficient Spatio-temporal Super-resolution Imaging** Meghna Singh,2009

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Super Resolution Imaging Super Resolution Imaging Introduction

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