



# Super Resolution Imaging

**Alberto Diaspro, Marc A. M. J. van  
Zandvoort**

## **Super Resolution Imaging:**

*Super-Resolution Imaging* Subhasis Chaudhuri,2006-04-18 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 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

**Super-Resolution Microscopy** Udo J. Birk,2017-09-12 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.

*Iterative-Interpolation Super-Resolution Image Reconstruction* Vivek Bannore, 2009-03-21 To my wife Mitu Vivek Bannore Preface Preface In many imaging systems under sampling and aliasing occurs frequently leading to degradation of image quality. Due to the limited number of sensors available on the digital cameras the quality of images captured is also limited. Factors such as optical or atmospheric blur and sensor noise can also contribute further to the degradation of image quality. Super Resolution is an image reconstruction technique that enhances a sequence of low resolution images or video frames by increasing the spatial resolution of the images. Each of these low resolution images contain only incomplete scene information and are geometrically warped aliased and der sampled. Super resolution technique intelligently fuses the incomplete scene information from several consecutive low resolution frames to reconstruct a high resolution representation of the original scene. In the last decade with the advent of new technologies in both civil and military domain more computer vision applications are being developed with a demand for high quality high resolution images. In fact the demand for high resolution images is exponentially increasing and the camera manufacturing technology is unable to cope up due to cost efficiency and other practical reasons.

*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.

**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 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 Optical Imaging and Microscopy* Junle Qu,Zhigang Yang,2023-12-11 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 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 Super Resolution of Images and Video Aggelos Konstantinos Katsaggelos, Rafael Molina, Javier Mateos, 2007 Authors Katsaggelos Molina and Mateos present in a systematic way the building blocks of the Bayesian framework which is also used as a reference in reviewing and comparing Super Resolution SR approaches which have appeared in the literature This work should serve as a reference to the graduate student who would like to work in this area to the practicing engineer and scientists applying some of the tools and results to other related problems The authors present a case that there is a strong relationship between the tools and techniques developed for SR and a number of other inverse problems encountered in signal processing e g image restoration and motion estimation SR techniques can also be an integral part of an image and video codec and they can drive the

development of new coder decoders codecs and standards

### **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 Microscopy for Material Science* Lorenzo Albertazzi,Peter Zijlstra,2024-03-26 Optical microscopy is one of the most frequently used tools in chemistry and the life sciences However its limited resolution hampers the use of optical imaging to many other relevant problems in different disciplines Super Resolution Microscopy SRM is a new technique that allows the resolution of objects down to a few billionth of meters nanometers ten times better than classical microscopes opening up opportunities to use this tool in new fields This book describes the theory principles and practice of super resolution microscopy in the field of materials science and nanotechnology There is a growing interest in the applications of SRM beyond biology as new synthetic materials such as nanoscale sensors and catalysts nanostructured materials functional polymers and nanoparticles have nanoscopic features that are challenging to visualize with traditional imaging methods SRM has the potential to be used to image and understand these cutting edge man made objects and guide the design of materials for novel applications This book is an ideal guide for researchers in the fields of microscopy and materials science and chemistry as well as graduate students studying physics materials science biomedical engineering and chemistry Key Features Contains practical guidance on Super Resolution Microscopy SRM an exciting and growing tool that was awarded the Nobel Prize for chemistry in 2014 Provides a new perspective targeting materials science unlike existing books which target readers in chemistry life science and biology Targets students in its core chapters while offering more advanced material for professionals and researchers in later chapters

*Super-resolution Imaging with Metamaterials* Naomi Ariane Waterman,2018 *Super-Resolution Microscopy* Holger Erfle,2017 This volume presents current advanced technologies and methods used in super resolution microscopy The chapters in this book cover a wide range of topics such as introducing super resolution microscopy into a core facility two photon STED microscopy for nanoscale imaging of neural morphology in vivo correlative SIM STORM microscopy two color single molecule tracking in live cells and correlative single molecule

localization microscopy and confocal microscopy Written in the highly successful Methods in Molecular Biology series format chapters include introductions to their respective topics lists of the necessary materials and reagents step by step readily reproducible laboratory protocols and tips on troubleshooting and avoiding known pitfalls Cutting edge and comprehensive Super Resolution Microscopy Methods and Protocols is a valuable resource for both established and novel researchers and users in this field

*Super Resolution* Sahar Ismail,Hala Mansour,Mahmoud Allam,2014-02-14 Although imaging sensors are the dominant technologies for both user and industry applications they still have several physical limitations such as noise and limited spatial resolution These limitations can be overcome based on device electronics and physics technology However a promising solution is a signal processing approach that has been one of the most active research areas and it is called Super Resolution SR This work proposes SR algorithm that uses an affine block based with the Maximum Likelihood A number of experiments were performed with the proposed system to obtain reconstructed High Resolution HR images of different resolutions from the same set of Low Resolution LR images Also a number of experiments were performed to evaluate its behavior as a function of the number of available LR images The algorithm improves the accuracy of translational registration and accurately recovers HR image even in the case where just very a few input images are provided This work should be especially useful to professionals in Image Processing Signal Processing and Electronics fields or anyone else who may be considering utilizing Resolution Enhancement

*Image Mosaicing and Super-resolution* David Capel,2012-12-06 This book investigates sets of images consisting of many overlapping viewsofa scene and how the information contained within them may be combined to produce single images of superior quality The generic name for such techniques is frame fusion Using frame fusion it is possible to extend the fieldof view beyond that ofany single image to reduce noise to restore high frequency content and even to increase spatial resolution and dynamic range The aim in this book is to develop efficient robust and automated frame fusion algorithms which may be applied to real image sequences An essential step required to enable frame fusion is image registration computing the point to point mapping between images in their overlapping region This sub problem is considered in detail and a robust and efficient solution is proposed and its accuracy evaluated Two forms of frame fusion are then considered image mosaic ing and super resolution Image mosaicing is the alignment of multiple images into a large composition which represents part of a 3D scene Super resolution is a more sophisticated technique which aims to restore poor quality video sequences by mod elling and removing the degradations inherent in the imaging process such as noise blur and spatial sampling A key element in this book is the assumption of a completely uncalibrated camera No prior knowledge of the camera parameters its motion optics or photometric characteristics is assumed The power of the methods is illustrated with many real image sequence examples

**Motion-Free Super-Resolution** Subhasis Chaudhuri,Joshi Manjunath,2005-07-06 Motion Free Super Resolution is a compilation of very recent work on various methods of generating super resolution SR images from a set of low resolution images The current literature on this topic

deals primarily with the use of motion cues for the purpose of generating SR images These cues have it is shown their advantages and disadvantages In contrast this book shows that cues other than motion can also be used for the same purpose and addresses both the merits and demerits of these new techniques Motion Free Super Resolution supersedes much of the lead author s previous edited volume Super Resolution Imaging and includes an up to date account of the latest research efforts in this fast moving field This sequel also features a style of presentation closer to that of a textbook with an emphasis on teaching and explanation rather than scholarly presentation

### **Super-Resolution Microscopy Techniques in the**

**Neurosciences** Eugenio Fornasiero,Silvio Rizzoli,2014-02-28 [Multi-Frame Super-Resolution Techniques and Applications](#)

Shima Izadpanahi,2019-02-06 Image Resolution is the most important quality factor of videos and images Multi frame Super resolution SR is the process of creating a higher resolution image with finer details by using the information of multiple low resolution images taken from almost the same scene In recent years images with higher resolution became the most primary requirement in many of the image processing applications such as scientific applications medical imaging robotics video sequences and satellite imaging This book aimed at providing a good guide in analyzing the most appropriate multi frame super resolution methods based on spatial and frequency domain It also presents an optimized method which can be used for many image enhancement applications

### **Super-Resolution Imaging Technology** Kareem Soliman,2016

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