Mosaicing of acoustic camera images

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Abstract: An algorithm for image registration and mosaicing on underwater sonar image sequences characterised by a high noise level, inhomogeneous illumination and low frame rate is presented. Imaging geometry of acoustic cameras is significantly different from that of pinhole cameras. For a planar surface viewed through a pinhole camera undergoing translational and rotational motion, registration can be obtained via a projective transformation. For an acoustic camera, it is shown that, under the same conditions, an affine transformation is a good approximation. A novel image fusion method, which maximises the signal-to-noise ratio of the mosaic image is proposed. The full procedure includes illumination correction, feature based transformation estimation, and image fusion for mosaicing.

1 Introduction

The acquisition of underwater images is performed in noisy environments with low visibility. For optical images in those environments, often natural light is not available, and even if artificial light is applied, the visible range is limited.

For this reason, sonar systems are widely used to obtain images of seabed or other underwater objects.

An acoustic camera is a novel device that can produce a real time underwater image sequence. Detailed imaging methods of acoustic cameras can be found in [1]. Acoustic cameras provide extremely high resolution (for a sonar) and rapid refresh rates [1]. Despite those merits of acoustic cameras over other sonar systems, it still has shortcomings compared to normal optical cameras:

(i) Limitation of sight range: Unlike optical cameras which have a 2-D array of photosensors, acoustic cameras have a 1-D transducer array. 2-D representation is obtained from the temporal sequence of the transducer array. For this reason, it can collect information from a limited range.
(ii) Low signal-to-noise ratio (SNR): The size of the transducers is comparable to the wavelength of ultrasonic waves, so the intensity of a pixel depends not only on the amplitude, but also on the phase difference of the reflected signal. This is the reason for the Rician distribution of the ultrasound image noise. In addition, there is often a background ultrasound noise in underwater environments. It follows that the SNR is significantly lower than in optical images.
(iii) Low resolution with respect to optical images: owing to the limitation in the transducer size, the number of transducers that can be packed in an array is physically restricted, and so is the number of pixels in the horizontal axis. For example, a mine reacquisition and identification sonar (MIRIS) has 64 transducers [1].

(iv) Inhomogeneous insonification: The unique geometry of an acoustic camera requires the sonar device to be aligned parallel to the surface of interest, so that the whole surface falls within the vertical field of view of the acoustic camera [1]. This alignment is not always trivial, and the misalignment often makes dark areas in acoustic camera images.

The above limitations can be addressed by image mosaicing, which is broadly used to build a wider view image [2–4], or to estimate the motion of a vehicle [5, 6]. For ordinary images, mosaicing is also used for image enhancement such as denoising, deblurring, or super-resolution [7, 8].

There has been extensive research on image mosaicing, and its applications [9–13]. However, standard methods for image registration [14, 15] are not directly applicable to acoustic camera images, because of the discrepancy of image quality, inhomogeneous insonification profile, and different geometry. Marks *et al.* have described a mosaicing algorithm of the ocean floor taken with an optical camera [2]. Ruhnow *et al.* have also described a mosaicing algorithm of underwater optical images resulting in high resolution seabed maps [3]. Both of them deal with a similar problem of illumination, but use different methods: image matching by edge detection and Fourier based matching, which are not directly related to our work. In addition, since their mosaicing algorithms are not intended for image quality enhancement, we need to come up with a different mosaicing algorithm.

In this paper, we describe a mosaicing algorithm for a sequence of acoustic camera images. We show that an affine transformation is appropriate for images taken from an acoustic camera undergoing translational and rotational motion. We propose a method to register acoustic camera images from a video sequence using a feature matching algorithm. Based on the parameters of image registration, a mosaic image is built. During the mosaicing, the image quality is enhanced in terms of SNR and resolution.

2 Properties of acoustic camera images

Sonar image acquisition includes several steps, insonification, scattering, and detection of the returning signal. In this Section, we describe physical aspects of images acquired from acoustic lens sonar systems, or acoustic cameras.

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Image Mosaicing And Superresolution

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Image Mosaicing And Superresolution:

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 cam era 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 **Super-resolution and Image Mosaicing** David Peter Capel,2001 Super Resolution of Images and Video Aggelos K. Katsaggelos,Rafael Molina,Javier Mateos,2022-05-31 This book focuses on the super resolution of images and video The authors use of the term super resolution SR is used to describe the process of obtaining a high resolution HR image or a sequence of HR images from a set of low resolution LR observations This process has also been referred to in the literature as resolution enhancement RE SR has been applied primarily to spatial and temporal RE but also to hyperspectral image enhancement This book concentrates on motion based spatial RE although the authors also describe motion free and hyperspectral image SR problems Also examined is the very recent research area of SR for compression which consists of the intentional downsampling during pre processing of a video sequence to be compressed and the application of SR techniques during post processing on the compressed sequence It is clear that there is a strong interplay between the tools and techniques developed for SR and a number of other inverse problems encountered in signal processing e g image restoration motion estimation SR techniques are being applied to a variety of fields such as obtaining improved still images from video sequences video printing high definition television high performance color Liquid Crystal Display LCD screens improvement of the quality of color images taken by one CCD video surveillance remote sensing and medical imaging The authors believe that the SR RE area has matured enough to develop a body of knowledge that can now start to provide useful and practical solutions to challenging real problems and that SR techniques can be an integral part of an image and video codec and can drive the development of new coder decoders codecs and standards **Motion-Free**

Super-Resolution Subhasis Chaudhuri,Joshi Manjunath,2006-06-20 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 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 **COMPSTAT 2006 - Proceedings in Computational Statistics** Alfredo Rizzi,Maurizio Vichi,2007-12-03 International Association for Statistical Computing The International Association for Statistical Computing IASC is a Section of the International Statistical Institute The objectives of the Association are to foster world wide interest in e ective statistical computing and to change technical knowledge through international contacts and meetings tween statisticians computing professionals organizations institutions g ernments and the general public The IASC organises its own Conferences IASC World Conferences and

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Pattern Recognition and Image Analysis Sameer Singh,Maneesha Singh,Chid Apte,Petra Perner,2005-08-17 The two volume set LNCS 3686 and LNCS 3687 constitutes the refereed proceedings of the Third International Conference on Advances in Pattern Recognition ICAPR 2005 held in Bath UK in August 2005 The papers submitted to ICAPR 2005 were thoroughly reviewed by up to three referees per paper and less than 40% of the submitted papers were accepted The first volume includes 73 contributions related to Pattern Recognition and Data Mining which included papers from the tracks of pattern recognition methods knowledge and learning and data mining topics addressed are pattern recognition data mining signal processing and OCR document analysis The second volume contains 87 contributions related to Pattern Recognition and Image Analysis which included papers from the applications track and deals with security and surveillance biometrics image processing and medical imaging It also contains papers from the Workshop on Pattern Recognition for Crime Prevention *Image Restoration* Bahadir Kursat Gunturk,Xin Li,2018-09-03 Image Restoration Fundamentals and Advances responds to the need to update most existing references on the subject many of which were published decades ago Providing a broad overview of image restoration this book explores breakthroughs in related algorithm development and their role in supporting real world applications associated with various scientific and engineering fields These include astronomical imaging photo editing and medical imaging to name just a few The book examines how such advances can also lead to novel insights into the fundamental properties of image sources Addressing the many advances in imaging computing and communications technologies this reference strikes just the right balance of coverage between core fundamental principles and the latest developments in this area Its content was designed based on the idea that the reproducibility of published works on algorithms makes it easier for researchers to build on each other s work which often benefits the vitality of the technical community as a whole For that reason this book is as experimentally reproducible as possible Topics covered include Image denoising and deblurring Different image restoration methods and recent advances such as nonlocality and sparsity Blind restoration under space varying blur Super resolution restoration Learning based methods Multi spectral and color image restoration New possibilities using hybrid imaging systems Many existing references are scattered throughout the literature and there is a significant gap between the cutting edge in image restoration and what we can learn from standard image processing textbooks To fill that need but avoid a rehash of the many fine existing books on this subject this

reference focuses on algorithms rather than theories or applications Giving readers access to a large amount of downloadable source code the book illustrates fundamental techniques key ideas developed over the years and the state of the art in image restoration It is a valuable resource for readers at all levels of understanding *Regularization and Bayesian Methods for Inverse Problems in Signal and Image Processing* Jean-Francois Giovannelli,Jérôme Idier,2015-02-02 The focus of this book is on ill posed inverse problems These problems cannot be solved only on the basis of observed data The building of solutions involves the recognition of other pieces of a priori information These solutions are then specific to the pieces of information taken into account Clarifying and taking these pieces of information into account is necessary for grasping the domain of validity and the field of application for the solutions built For too long the interest in these problems has remained very limited in the signal image community However the community has since recognized that these matters are more interesting and they have become the subject of much greater enthusiasm From the application field s point of view a significant part of the book is devoted to conventional subjects in the field of inversion biological and medical imaging astronomy non destructive evaluation processing of video sequences target tracking sensor networks and digital communications The variety of chapters is also clear when we examine the acquisition modalities at stake conventional modalities such as tomography and NMR visible or infrared optical imaging or more recent modalities such as atomic force imaging and polarized light imaging **Intelligence Science and Big Data Engineering. Image and Video Data Engineering** Xiaofei He,Xinbo Gao,Yanning Zhang,Zhi-Hua Zhou,Zhi-Yong Liu,Baochuan Fu,Fuyuan Hu,Zhancheng Zhang,2015-10-13 The two volume set LNCS 9242 9243 constitutes the proceedings of the 5th International Conference on Intelligence Science and Big Data Engineering IScIDE 2015 held in Suzhou China in June 2015 The total of 126 papers presented in the proceedings was carefully reviewed and selected from 416 submissions They deal with big data neural networks image processing computer vision pattern recognition and graphics object detection dimensionality reduction and manifold learning unsupervised learning and clustering anomaly detection semi supervised learning *Computer Vision, Graphics and Image Processing* Prem Kalra,Shmuel Peleg,2007-01-01 This book constitutes the refereed proceedings of the Indian Conference on Computer Vision Graphics and Image Processing ICVGIP 2006 held in Madurai India December 2006 Coverage in this volume includes image restoration and super resolution image filtering visualization tracking and surveillance face gesture and object recognition compression content based image retrieval stereo camera calibration and biometrics *Medical Imaging and Augmented Reality* Hongen Liao,P.J. Eddie Edwards,Xiaochuan Pan,Yong Fan,Guang-Zhong Yang,2010-09-17 The 5th International Workshop on Medical Imaging and Augmented Reality MIAR 2010 was held at the China National Convention Center CNCC B jing China on September 19 20 2010 MIAR has remained a truly international meeting bringing together searchers from all elds related to medical image analysis visualization and targeted intervention In recent years technical advances in therapeutic delivery andagrowingdemandforpatient speci

ctreatmenthaveacceleratedtheclinical applications of MIAR related techniques Imaging plays an increasingly imp tant role in targeted therapy with interventions such as drug or gene therapy relying on more accurate delivery tailored to individual patients Rapid progress in surgical methodologies such as those with robot assistance demands p cise guidance from both preoperative and intraoperative imaging The volume of data available from existing and emerging imaging modalities leads to a sire for more automated analysis for diagnosis segmentation and registration Research in this rapidly developing area is highly multi disciplinary integrating research in life sciences physical sciences engineering and medicine **Pattern Recognition and Image Analysis** Joan Martí,José M. Benedí,Ana M. Mendonça,Joan Serrat,2007-07-04 Part of a two volume set this book constitutes the refereed proceedings of the Third Iberian Conference on Pattern Recognition and Image Analysis IbPRIA 2007 held in Girona Spain in June 2007 It covers pattern recognition human language technology special architectures and industrial applications motion analysis image analysis biomedical applications shape and texture analysis 3D and image coding and processing **Medical Image Computing and Computer-Assisted Intervention – MICCAI 2006** Rasmus Larsen,Mads Nielsen,Jon Sporring,2006-09-21 The two volume set LNCS 4190 and LNCS 4191 constitute the refereed proceedings of the 9th International Conference on Medical Image Computing and Computer Assisted Intervention MICCAI 2006 The program committee carefully selected 39 revised full papers and 193 revised poster papers for presentation in two volumes This first volume includes 114 contributions related to bone shape analysis robotics and tracking segmentation analysis of diffusion tensor MRI and much more **Digital Image Processing using SCILAB** Rohit M. Thanki,Ashish M. Kothari,2018-05-07 This book provides basic theories and implementations using SCILAB open source software for digital images The book simplifies image processing theories and well as implementation of image processing algorithms making it accessible to those with basic knowledge of image processing This book includes many SCILAB programs at the end of each theory which help in understanding concepts The book includes more than sixty SCILAB programs of the image processing theory In the appendix readers will find a deeper glimpse into the research areas in the image processing *Digital TV and Multimedia Communication* Guangtao Zhai,Jun Zhou,Ping An,Xiaokang Yang,2019-05-10 This book presents revised selected papers from the 15th International Forum on Digital TV and Multimedia Communication IFTC 2018 held in Shanghai China in September 2018 The 39 full papers presented in this volume were carefully reviewed and selected from 130 submissions They were organized in topical sections on image processing machine learning quality assessment telecommunications video coding video surveillance virtual reality **Advances in Visual Computing** Richard Boyle,Bahram Parvin,Darko Koracin,Fatih Porikli,Jörg Peters,James Klosowski,Laura Arns,Yu Ka Chun,Theresa-Marie Rhyne,Laura Monroe,2008-12-03 It is with greatpleasure that we present the proceedings of the 4th International Symposium on Visual Computing ISVC 2008 in Las Vegas Nevada ISVC o ers a common umbrella for the four main areas of visual computing including vision graphics visualization and virtual reality Its goal is to provide a forum for researchers

scientists engineers and practitioners throughout the world to present their latest research ndings ideas developments and applications in the broader area of visual computing This year ISVC grew signi cantly the programconsisted of 15 oralsessions 1 poster session 8 special tracks and 6 keynote presentations The response to the call for papers was very strong we received over 340 submissions for the main symposium from which we accepted 102 papers for oral presentation and 70 papers for poster presentation Special track papers were solicited separately through the Organizing and Program Committees of each track A total of 56 papers were accepted for oral presentation and 8 papers for poster presentation in the special tracks All papers were reviewed with an emphasis on potential to contribute to the state of the art in the eld Selection criteria included accuracy and originality of ideas clarity and signi cance of results and presentation quality The review process was quite rigorous involving two to three independent blind reviews followed by several days of discussion During the discussion period we tried to correct anomalies and errors that might have existed in the initial reviews **Computer Vision and Graphics** K. Wojciechowski,B. Smolka,H. Palus,R.S. Kozera,W. Skarbek,L. Noakes,2006-03-11 As the speed capabilities and economic advantages of modern digital devices c tinue to grow the need for ef cient information processing especially in computer sion and graphics dramatically increases Growth in these elds stimulated by eme ing applications has been both in concepts and techniques New ideas concepts and techniques are developed presented discussed and evaluated subsequently expanded or abandoned Such processes take place in different forms in various elds of the c puter science and technology The objectives of the ICCVG are presentation of current research topics and d cussions leading to the integration of the community engaged in machine vision and computer graphics carrying out and supporting research in the eld and nally pro tion of new applications The ICCVG is a continuation of the former International Conference on Computer Graphics and Image Processing called GKPO held in Poland every second year in May since 1990 organized by the Institute of Computer Science of the Polish Academy of Sciences Warsaw and chaired by the Editor of the International Journal of Machine Graphics and Vision Prof Wojciech S Mokrzycki **Advanced Concepts for Intelligent Vision Systems** Jacques Blanc-Talon,Rudi Penne,Wilfried Philips,Dan Popescu,Paul Scheunders,2017-11-22 This book constitutes the refereed proceedings of the 18th International Conference on Advanced Concepts for Intelligent Vision Systems ACIVS 2017 held in Antwerp Belgium in September 2017 The 63 full papers presented in this volume were carefully selected from 134 submissions They deal with human computer interaction classification and recognition navigation mapping robotics and transports video processing and retrieval security forensics surveillance and image processing **Cloud Computing, Smart Grid and Innovative Frontiers in Telecommunications** Xuyun Zhang,Guanfeng Liu,Meikang Qiu,Wei Xiang,Tao Huang,2020-05-22 This book constitutes the refereed proceedings of the 9thInternational Conference on Cloud Computing CloudComp 2019 and the 4th International Conference on Smart Grid and Innovative Frontiers in Telecommunications SmartGIFT 2019 both held in Beijing China in December 2019 The55 full papers of both conferences were selected from 113

submissions CloudComp 2019 presents recent advances and experiences in clouds cloud computing and related ecosystems and business support The papers are grouped thematically in tracks on cloud architecture and scheduling cloud based data analytics cloud applications and cloud security and privacy SmartGIFT 2019 focus on all aspects of smart grids and telecommunications broadly understood as the renewable generation and distributed energy resources integration computational intelligence applications information and communication technologies

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