Heritage Preservation

Bhabatosh Chanda · Subhasis Chaudhuri
Santanu Chaudhury
Editors

Heritage Preservation

A Computational Approach

Springer

Editors
Bhabatosh Chanda
Electronics and Communication
Sciences Unit
Indian Statistical Institute
Kolkata, West Bengal
India

Santanu Chaudhury
CSIR-CEERI
Pilani, Rajasthan
India

Subhasis Chaudhuri
Department of Electrical Engineering
Indian Institute of Technology Bombay
Mumbai, Maharashtra
India

ISBN 978-981-10-7220-8 ISBN 978-981-10-7221-5 (eBook)
https://doi.org/10.1007/978-981-10-7221-5

Library of Congress Control Number: 2018935209

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Printed on acid-free paper

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part of Springer Nature
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

Heritage records the history of our world—social, religious, ecological, cultural, and political. It represents the footprint of the temporal evolution of civilizations and ecosystems. As it is inherited from the past, it should be bestowed on the future for the benefit of subsequent generations. It is the legacy of tangible artifacts (e.g., monuments, statues, manuscripts, and paintings) and intangible elements (e.g., customs, religion, culture, legends, and history). The vulnerability of heritage items to the harmful effects of climate change, pollution, natural and man-made disasters, neglect, infiltration of new ideas and practices, vandalism, and even mass tourism is becoming more and more evident over the years. Thus, preservation, renovation, restoration, and management of heritage items have become an important task nowadays. However, the physical renovation and restoration work may cause damage to otherwise undamaged part of the artifacts and may fail to provide the flavor of history. Sometimes, this loss may be irrecoverable. Second, the heritage artifacts may not be physically accessible for renovation and restoration work due to various reasons. So, a plausible solution might be restoring and reconstructing the damaged artifacts digitally using computational methods without any physical embodiment. Being re-rectifiable as well as inexpensive, the digital preservation, restoration, and reconstruction of heritage items have become an active research field. Heritage, both tangible and intangible, may also be recorded, represented, and archived in digital space conveniently by means of appropriate computational methods. This handling of heritage items in digital space is popularly known as *digital heritage preservation* and is an emerging area of research in *computational techniques*.

This book presents a balanced treatment of heritage preservation problems and state-of-the-art digital techniques to achieve their novel and useful solutions. It covers the methods starting from data acquisition and digital imaging to computational methods for recreation of original (pre-damaged) look of heritage artifacts. Case studies are almost equally drawn from the tangible and non-tangible heritage which is multi-dimensional as well as rich. Authors of the articles have been working in their respective fields for years and have presented their working

experience and methods so lucidly that these can be easily implementable. Both methods and results are illustrated with a large number of color images.

This book consists of sixteen articles covering five major aspects of digital heritage research, namely (i) digital system for heritage preservation including data acquisition, (ii) signal and image processing, (iii) audio and video processing, (iv) image and video database, and (v) architectural modeling and visualization. The first aspect is covered by the first three articles written by Georgopoulos (Article 1), MacDonald (Article 2), and Yao et al. (Article 3). In Article 1, technological advances in digital heritage preservation are briefly presented and explained. It also presents the currently available digital documentation techniques along with the contemporary nondestructive techniques for cultural heritage pathology diagnosis and conservation. Digital heritage requires the represented physical objects to look realistic when viewed on a display screen. Article 2 presents a new method for estimating the reflectance distribution function from a set of images taken in an illumination dome. Surface normal and albedo are calculated by regressing over a subset of the intensity at each pixel. Ground truth collection and large data analysis and evaluation are the important tasks for developing methods for digital heritage. Article 3 presents an open, cross-platform, effective, and extensible GUI annotation tool, known as Epix, for that purpose. This tool can also be used for multiple research purposes, including Euclidean epipolar error measurement and 3D distance measurement. Signal and image processing aspects are dealt in the next five articles written by Madhu and Joshi (Article 4), Kumar et al. (Article 5), Frohlich et al. (Article 6), Sreeni and Chaudhuri (Article 7), and Mukherjee and Sural (Article 8). The problems dealt here range from single-image super-resolution (SR) using deep learning framework (Article 4) to source-constrained exemplar-based inpainting for restoring images of old degraded cave paintings (Article 5), from fusion of 3D and 2D visual data for colorizing the point cloud from multiple cameras with application to old churches (Article 6) to haptic rendering of object described by a dense, oriented point cloud data without a pre-computed polygonal mesh (Article 7). Finally, Article 8 presents an ontology-based approach to retrieve structurally and semantically similar images from heritage image dataset. Articles 9, 10, 11, and 12 cover the audio and video processing aspects of digital heritage. Article 9 (written by Mandal et al.) develops a formal model for the *Ragas*, consequently classifies the *Ragas*, and evaluates music scores based on the *Ragas*. Like music, films are also important media for cultural heritage. A unified approach for detecting some of the most commonly appearing noise artifacts in heritage movies and restoring them to achieve a superior visual quality for viewing and archival is presented in Article 10 (written by Bhattacharya et al.). Next two articles written by Mohanty et al. (Article 11) and Mullik et al. (Article 12) deal with dance, more specifically Bharatanatyam, and its various components such as hand gestures, facial expressions, and dynamic body postures are called *Adavus*. Benchmark dataset is an essential part of evaluating computer vision algorithms. Articles 13 and 14, respectively, present two novel datasets: (i) an image dataset of different temples in Bishnupur suitable for evaluating computer vision techniques such as 3D reconstruction, image inpainting, texture classification, and content-specific figure spotting and retrieval (written by

Ghorai et al.) and (ii) a novel dataset for evaluating computer vision method for recognition of *Sattriya* dance hand gestures (written by Devi et al.). Finally, last two articles cover architectural modeling and visualization aspects. Article 15 outlines the process and methodology of arriving at visualizations of clothing style of Vijayanagara period through study and analysis of textual narratives, murals, stucco work, and relief work of this period, while Article 16 presents a thorough study, documentation, analysis of design elements, and 3D virtual modeling as well as reconstruction of the Krishna temple complex at Hampi, Karnataka, India.

In essence, this book is a comprehensive representation of various aspects and state-of-the-art methodologies suitable for heritage preservation through computational approach. We express our utmost gratitude to the contributors for sharing their experience through these articles. We are thankful to the reviewers without whose support it would not be possible to select the high-quality works for this book. We are thankful to Saurabh Kumar of IIT Bombay for helping us on handling the Web interface for all communication and review activities of the submitted manuscripts. Some of these articles are extended versions of the papers presented in the Workshop on Digital Heritage organized in association with Indian Conference on Computer Vision, Graphics and Image Processing held at Guwahati in December 2016. We are also thankful to the organizers of the conference and the workshop. Last but not least, we are grateful to the editorial team of Springer who has persuaded and helped to bring this book into existence. Editors gratefully acknowledge the support of DST, Ministry of Science and Technology, Government of India, in this endeavor.

Kolkata, India — Bhabatosh Chanda
Mumbai, India — Subhasis Chaudhuri
Pilani, India — Santanu Chaudhury

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About the Editors

Bhabatosh Chanda is a Professor at the Indian Statistical Institute, Kolkata, India. His research interests include image and video processing, pattern recognition, computer vision, and mathematical morphology. He has published more than 200 articles in refereed journals and conferences, authored 2 books, and edited 5 books. He received the Indian National Science Academy 'Young Scientist Medal' in 1989, the Institution of Engineers (India) 'Computer Engineering Division Medal' in 1998, the 'Vikram Sarabhai Research Award' in 2002, and the 'IETE-Ram Lal Wadhwa Gold Medal' in 2007. He is a Fellow of the Institute of Electronics and Telecommunication Engineers (FIETE), National Academy of Science, India (FNASc.), Indian National Academy of Engineering (FNAE), and the International Association of Pattern Recognition (FIAPR).

Subhasis Chaudhuri holds the KN Bajaj Chair Professorship at the Indian Institute of Technology Bombay and is a J.C. Bose national fellow. He works in the area of image processing, computer vision, and haptics. He has published 300 papers in various journals and conferences, as well as 6 monographs in his area of research. He has also served on the editorial board of several international journals, including *IEEE T-PAMI* and *IJCV*. He is a recipient of the Shanti Swarup Bhatnagar Prize in Engineering Sciences. He is a Fellow of the IEEE and the Science Academies in India.

Santanu Chaudhury is currently the Director of the CSIR-CEERI, Pilani, and a Professor in the Department of Electrical Engineering, Indian Institute of Technology Delhi (IIT Delhi). He was also the Dean of Undergraduate Studies at IIT Delhi. He was Schlumberger as well as Dhananjoy Chair Professor at IIT Delhi. His research interests include computer vision, robotics, embedded systems, and machine learning. He has published more than 250 research papers in international journals and conference proceedings and a number of patents. He has been on the program committee of a number of international conferences like ICCV, ACCV,

ICPR, ICVGIP, and PReMI. He was awarded the INSA Medal for Young Scientists in 1993 and received the CDAC-ACCS Award for his scientific achievements in 2012. He is a Fellow of the Indian National Academy of Engineering, the National Academy of Sciences, India, and the International Association of Pattern Recognition.