ARCHIVING 2023
Oslo 19-23 June
General Chair: Sony George, NTNU (Norway)

www.imaging.org/archiving
Sponsored by the Society for Imaging Science and Technology
The papers in this volume represent the program of Archiving 2023, held June 19–23, 2023 in Oslo, Norway.

Copyright 2023

Society for Imaging Science and Technology
7003 Kilworth Lane • Springfield, VA 22151 USA
703/642-9090; 703/642-9094 fax
info@imaging.org; www.imaging.org

All rights reserved. The abstract book with full proceeding on flash drive, or parts thereof, may not be reproduced in any form without the written permission of the Society.

ISSN Print: 2161-8798
ISSN Online: 2168-3204

Manuscripts are reproduced from PDFs as submitted and approved by authors; no editorial changes have been made.

Cover image courtesy of Michael B. Toth.
WELCOME TO ARCHIVING 2023

On behalf of the conference committee, it is with immense pleasure that I welcome you to another edition of the Archiving conference. The interest and motivation of the community to stay connected during the past three years and actively participate in discussions around cultural heritage imaging has been inspiring. And now we are in-person again, in Europe, and for the first time in Norway, within the finest location in Oslo, The Aula.

The quality of the submitted papers is excellent, which indicates that the research in the community was not only active, but even more innovative during the pandemic period. This is a good indication that the topics the conference addresses are relevant to more people, and we are excited to many new participants this year. The digiTips topical meetings and the monthly Grab-a-Cup have undoubtedly played a major role in increasing expanded visibility to more regions and institutions. Now with a physical meeting, the networking opportunities, discussions, and sharing of ideas and initiatives are sure make a long-lasting impact in our respective communities and beyond.

The cultural heritage institutions in Oslo happily agreed to offer Behind-the-Scenes Tours—surely an enriching experience for the participants—and for that we thank them. As with past years, we are fortunate to have three interesting keynote talks, along with many oral and poster presentations. Technological advancements for cultural heritage digitization, access, and preservation is on a fast pace these days and the community requires trained young researchers to keep advancements moving. Some of the most recent research being undertaken will be presented during Archiving by early stage researchers from the European CHANGE-ITN training network. These talks are found throughout the program, as well as during a special event on Friday.

Again, I extend my warm welcome to Archiving and to Norway, the land of the midnight sun where we will share new, interesting knowledge and experience during this solstice season. Together, let us strive to create a future that cherishes and sustains our past.

My warmest regards,

—Sony George, General Conference Chair, Archiving 2023
CONFERENCE COMMITTEE

General Chair
Sony George, NTNU (Norway)

Program Chair
Robert Kastler, MOMA (US)

Short Course Chairs
Martina Hoffmann, Swiss National Library (Switzerland)
Kristin Phelps, US Copyright Office (US)

Past Chair
Fenella France, Library of Congress (US)

AV Chairs
Alexandre Leão, Universidade Federal de Minas Gerais (Brazil)
Mogens Bech, Sortehest (Denmark)

PAPER REVIEWERS

Ottar A.B. Anderson, Intermunicipal Archive of Møre og Romsdal (Norway)
Michael J. Bennett, University of Connecticut (US)
Roy S. Berns, Gray Sky Imaging Inc. (US)
Peter Burns, Burns Digital Imaging (US)
Antenie Carstens, National Library of South Africa (retired) (South Africa)
Elizabeth Chiang, George Eastman Museum (US)
Terrance D’Ambrosio, Northeast Document Conservation Center (US)
Lavinia de Ferri, University of Oslo (Norway)
Hilda Deborah, Norwegian University of Science and Technology (Norway)
Daniel Dennenby, Minneapolis Institute of Art (US)
Denis Doorly, Museum of Modern Art (US)
Roger Easton, Rochester Institute of Technology (US)
Chris Edwards, J. Paul Getty Trust (US)
Susan Farnand, Rochester Institute of Technology (US)
Rebecca Frank, University of Michigan (US)
Jérémie Gerhardt, DNEG (Canada)
Lei He, Library of Congress (US)
Kurt Heumiller, The Museum of Modern Art (US)
Martina Hoffmann, Schweizerische Nationalbibliothek (Switzerland)
Michael Horsley, National Archives and Records Administration (US)
Chrisy Huhn, University of California Berkeley Library (US)
Anssi Jääskeläinen, South Eastern Finland University of Applied Sciences (Finland)
Robert Kastler, The Museum of Modern Art (US)
Olivia Kuzio, Getty Conservation Institute (US)
Alexandre Leão, Universidade Federal de Minas Gerais (Brazil)
Claire Lovell, South Central Library Regional Council (US)

Hana Lukesova, University Museum of Bergen (Norway)
Giacomo Marchioro, University of Verona (Italy)
Anne Mason, National Archives and Records Administration (US)
Kit Messick, Getty Research Institute (US)
Phil Michel, Library of Congress (US)
Jeanine Nault, Smithsonian Institution (US)
Adam Neece, Museum of Modern Art (US)
Taren Ouellette, Library of Congress (US)
Snehal Padhye, Rochester Institute of Technology (US)
Marius Pedersen, Norwegian University of Science and Technology (Norway)
Laura Margaret Ramsey, Toronto Metropolitan University (Canada)
Thomas Rieger, Library of Congress (US)
Jamie Rogers, Florida International University (US)
Carla Schroer, Cultural Heritage Imaging (US)
David Schuster, Binghamton University (US)
Bethany Scott, University of Houston Libraries (US)
H. David Sheets, Canisius College (US)
Raju Shrestha, Oslo Metropolitan University (Norway)
Steven Simske, Colorado State University (US)
Dina Sokolova, Columbia University (US)
Todd Swanson, Getty Research Institute (US)
Giorgio Trumpy, Norwegian University of Science and Technology (Norway)
Eva Maria Valero, University of Granada (Spain)
Carine van Dongen, Koninklijke Bibliotheek (the Netherlands)
Marie Vans, HP Inc. (US)
Christopher Voges, consultant (Germany)
David Walls, US Government Publishing Office (US)
Meghan Wilson, Library of Congress (US)
David R. Wyble, Gray Sky Imaging Inc. (US)

COOPERATING SOCIETIES

- American Institute for Conservation (AIC)
- Coalition for Networked Information (CNI)
- ISCC – Inter-Society Color Council

SOCIETY FOR IMAGING SCIENCE AND TECHNOLOGY

IS&T BOARD OF DIRECTORS: JULY 2023 – JUNE 2024

President
Nicolas Bonnier, Apple Inc.

Executive Vice President
Marius Pedersen, NTNU

Conference Vice President
Sophie Triantaphillidou, University of Westminster

Publications Vice President
Gaurav Sharma, University of Rochester

Secretary
Peter Morovic, HP Inc.

Treasurer
Ramon Borrell, borrell.uk Technology

Vice Presidents
Paul Hubel, Apple Inc.
Minjung Kim, Meta
Timo Kunkel, Dolby Laboratories, Inc.
Teruaki Mitsuya, Ricoh Company, Ltd.
Ricardo Motta, Google Inc.

Immediate Past President
Susan Farnand, Rochester Institute of Technology

Chapter Directors
Rochester: Roger Triplett, Xerox Corporation (retired)
Tokyo: Atsushi Tomotake, Konica Minolta, Inc.

IS&T Executive Director
Suzanne E. Grinnan
TECHNICAL PAPERS PROGRAM
CONFERENCE SCHEDULE AND TABLE OF CONTENTS

MONDAY 19 JUNE 2023

SHORT COURSE PROGRAM

8:00 – 10:00
SC03: Exploring Multimodal and Spectral Imaging, from Simple to Complex
Instructors: Fenella France and Meghan Wilson, Library of Congress

SC04: Setup and Calibration of Digital Cameras to ISO – FADGI or Metamorfaze Image Quality Requirements
Instructor: Volker Jansen, Zeutschel GmbH

8:00 – 12:15
SC01: Fundamentals of Cultural Heritage Digitization: Essential Steps to Planning and Managing a Program
Instructor: Thomas Rieger, Library of Congress

10:15 – 12:15
SC05: Introduction to Color Measurement for Archiving
Instructor: David R. Wyble, Gray Sky Imaging, Inc.

SC06: Spectral Image Processing
Instructors: Fenella France and Meghan Wilson, Library of Congress

SC07: Tips and Tricks for Motion Picture Film Digitization
Instructors: Alice Platino, Università degli Studi di Milano, and Giorgia Trumpy, Norwegian University of Science and Technology

13:30 – 15:30
SC08: Scanner & Camera Imaging Performance: Ten Commandments
Instructor: Peter D. Burns, Burns Digital Imaging

SC09: Advanced Concepts in Color Measurement
Instructor: David R. Wyble, Gray Sky Imaging, Inc.

SC10: From Image Capture to Archival Submission: Creating Submission Information Packages (SIPs) with the Digital Lab Notebook (DLN)
Instructors: Carla Schroer and Mark Mudge, Cultural Heritage Imaging

SC11: Now That You Have Digitized Your Documents, What’s Next?
Instructor: Elisa H. Barney Smith, Luleå Technical University

15:45 – 17:45
SC12: OpenDICE for Imaging Quality Assessment
Instructor: Lei He, Library of Congress

SC13: Appearance Measurement and Characterisation for Cultural Heritage
Instructor: Yoko Arteaga, Centre of Research and Restoration of the Museums of France

SC14: Scanner & Camera Imaging Performance: Evaluation and Interpretation
Instructor: Peter D. Burns, Burns Digital Imaging

SC15: Designing and Managing an Outsourced Digital Imaging Project
Instructor: David Walls, US Government Publishing Office

EXHIBITS VIEWING AND WELCOME RECEPTION
17:30 – 19:30

Join colleagues at the Museum of Cultural History/Historical Museum, Frederiks gate 2, for a non-alcoholic aperitivo and snack. The museum, housed in a beautiful art nouveau building from 1902, opens to attendees at 17:30 to allow you time to explore some of their collections, specifically Vikingr: Viking Age and Fabulous Animals: From the Iron Age to the Vikings. Food and drink commence at 18:00.

TUESDAY 20 JUNE 2023

WELCOME AND OPENING KEYNOTE
Session Chair: Sony George, Norwegian University of Science and Technology (Norway)
09:00 – 10:00

A Cathedral of N-dimensional Data and Multidisciplinary Knowledge in Heritage Science, Livio De Luca, research director, CNRS, and director, MAP Laboratory (France)

Cultural heritage research makes the confrontation between material objects and multidisciplinary studies the arena for the production of collective knowledge. Integrating computational modelling with multidimensional digitization, our project benefits from the scientific framework for the restoration of Notre-Dame de Paris involving 175 researchers from various disciplines. The research aim is to shift the focus of digitization from physical objects to the knowledge surrounding them, to analyze the interdependence of complex morphological features and associated knowledge, and to experiment with innovative semantically-driven data production and analysis methods.

3D / VISUALIZATION
Session Chair: Pedro Santos, Fraunhofer IGD (Germany)
10:00 – 12:30

10:00 Taking a Technical Leap: 3D Imaging of New Guinea Bisj Poles, Heather Johnson and Deepa Paulus, Metropolitan Museum of Art (US)

In 2021, the Michael C. Rockefeller Wing (MCRW) in the Metropolitan Museum of Art, which focuses on the regions of Asia, Africa, and the Oceana, began the process of deinstalling its collection to start renovations on their galleries. The Imaging Department coordinated closely with the curatorial, collections and conservation teams to develop a comprehensive 2 and 3D imaging campaign. This paper centers around the unique challenges our team faced when asked to record, completely and accurately, four monumental New Guinea Ancestor (Bisj) Poles, carved out of the wood of mangrove trees by the Asmat people, on an extremely tight timeline. The decision to employ 3D digitization is always a difficult one because technology is constantly evolving and there are few standards for image quality metrics. This paper documents our team’s approach to solving technical challenges.
A multimodal optomechatronics system is presented for measuring and monitoring change in cultural heritage objects exposed to environmental condition fluctuations or conservation treatments. It combines structured light, 3D colour digital image correlation and multispectral imaging, delivering information about an object’s 3D shape, displacements, strains and reflectivity. The high functionality and applicability of the system are presented with the example of historical parchment subject to changes in relative humidity.

Reflectance Transformation Imaging (RTI) is a technique that provides an enhanced visualization experience. The current acquisition methods for Reflectance Transformation Imaging (RTI) are time consuming and computationally expensive. This work investigates the idea of getting best light positions for RTI acquisition using surface topography. We propose automating the RTI acquisition by estimating the surface topography using deep learning method followed by estimating light positions using unsupervised clustering method. This is one shot method which only needs one image. We also created RTI Synthetic dataset in order to carry out experiments. We found that surface topography alone is not sufficient to estimate best light positions for RTI without putting constraints.

This paper addresses the concerns of the digital heritage field by setting out a series of recommendations for establishing a workflow for 3D objects, increasingly prevalent but still lacking a standardized process, in terms of long-term preservation and dissemination. We build our approach on interdisciplinary collaborations together with a comprehensive literature review. We provide a set of heuristics consisting of the following six components: data acquisition, data preservation, data description, data curation and processing, data dissemination, as well as data interoperability, analysis and exploration. Each component is supplemented by suggestions for standards and tools, which are either already common in 3D practices or represent a high potential component seeking consensus to formalize a 3D environment fit for the Humanities, such as efforts carried out by the International Image Interoperability Framework (IIIF). We then present a conceptual high-level 3D workflow which highly relies on standards adhering to the Linked Open Usable Data (LOUD) design principles.

11:00 – 11:30
MORNING BREAK / EXHIBITS OPEN / POSTERS AVAILABLE FOR VIEWING

11:30 Statistical Evaluation of 3D Manifolds Shape Retention during Simplification Stages, Markus Sebastian Bakken Storeide, Sony George, Aditya Sole, and Jon Yingve Hardeberg, Norwegian University of Science and Technology (Norway) 18

Simplification of 3D meshes is a fundamental part of most 3D workflows, where the amount of data is reduced to be more manageable for a user. The unprocessed data includes a lot of redundancies and small errors that occur during a 3D acquisition process which can often safely be removed without jeopardizing is function. Several algorithmic approaches are being used across applications of 3D data, which bring with them their own benefits and drawbacks. There is for the moment no standardized algorithm for cultural heritage. This investigation will make a statistical evaluation of how geometric primitive shapes behave during different simplification approaches and evaluate what information might be lost in a HBIM (Heritage-Building-Information-Modeling) or change-monitoring process of cultural heritage if each of these are applied to more complex manifolds.

11:50 A Pipeline for Monitoring the External and Inner Structure of Cultural Heritage Objects, Evdokia Saiti and Theoharis Theocharis, Norwegian University of Science and Technology (Norway) 16

The problem of monitoring and tracking the changes that Cultural Heritage (CH) objects undergo is of high importance. A key task in this workflow is the initial registration of the data in a common reference frame. However, challenges arise when data to be aligned have been acquired in different timeframes (cross-time) and by different imaging techniques (multimodal). This paper addresses these challenges and proposes a pipeline for monitoring both the surface and the inner structure of CH objects. Taking as an input two different sets of 3D models and 3D Volumes acquired in different time slots from 3D surface and CT scanning respectively, the pipeline registers both modalities in a multitemporal way. The results show the possibilities of this methodology for accurate multitemporal documentation of both surface and inner structure. This approach has the potential to facilitate the monitoring through time and change detection of CH objects in a more holistic way.

12:10 Recommended 3D Workflow for Digital Heritage Practices, Marian Manz, Julien Raemy, and Peter Fornaro, University of Basel (Switzerland) 23

This paper addresses the concerns of the digital heritage field by setting out a series of recommendations for establishing a workflow for 3D objects, increasingly prevalent but still lacking a standardized process, in terms of long-term preservation and dissemination. We build our approach on interdisciplinary collaborations together with a comprehensive literature review. We provide a set of heuristics consisting of the following six components: data acquisition, data preservation, data description, data curation and processing, data dissemination, as well as data interoperability, analysis and exploration. Each component is supplemented by suggestions for standards and tools, which are either already common in 3D practices or represent a high potential component seeking consensus to formalize a 3D environment fit for the Humanities, such as efforts carried out by the International Image Interoperability Framework (IIIF). We then present a conceptual high-level 3D workflow which highly relies on standards adhering to the Linked Open Usable Data (LOUD) design principles.
The presence of handwritten text and annotations combined with type-written and machine-printed text in historical archival records make them visually complex, posing challenges for OCR systems in accurately transcribing their content. This Paper is an extension of a previous paper, reporting on improvements in the separation of handwritten text from machine-printed text (including typewriters), by the use of FCN-based models trained on datasets created from different data synthesis pipelines. Results show a significant increase of about 20% in the intrinsic evaluation on artificial test sets, and 8% improvement in the extrinsic evaluation on a subsequent OCR task on real archival documents.

This paper examines two new methodological approaches exploring Reflectance Transformation Imaging (RTI) data processing for detecting, documenting, and tracking surface changes. The first approach is unsupervised and applies per-pixel calculations on the raw image stack to extract information related to specific surface attributes (angular reflectance, micro-geometry). The second method proposes a supervised segmentation approach that, based on machine learning algorithms, uses coefficients of a fitting model to separate the surface’s characteristics and assign them to a class. Both methodologies were applied to monitor coating failure, in the form of filiform corrosion, on low carbon steel test samples, mimicking treated historical metal objects’ surfaces. The results demonstrate the feasibility of creating accurate cartographies that depict the surface characteristics and their location. Additionally, they provide a qualitative evaluation of corrosion progression that allows tracking and monitoring changes on challenging surfaces.

**INTRODUCING CHANGE**

Session Chair: Sony George, Norwegian University of Science and Technology (Norway)

15:00 – 17:30

An Overview of CHANGE: Cultural Heritage Analysis for New Generations, Jon Y. Hardeberg, NTNU (Norway)

15:30 – 16:00

AFTERNOON BREAK / EXHIBITS OPEN / POSTERS AVAILABLE FOR VIEWING

IS&T would like to extend a special thank you to the University of Oslo and its staff for their support of Archiving 2023.

**IMPLEMENTATION UPDATES**

Session Chair: Ulla Bøgvad Kejser, Royal Danish Library (Denmark)
16:00 – 17:45

16.00 Beyond RGB 1.5: Improvements to a Free, Opensource, Spectral Image Processing Software Application for Cultural Heritage Studio Photography, Leah Humenuck and Susan P. Famand, Rochester Institute of Technology (US)

Beyond RGB is a free, opensource, software application providing colorimetric and spectral processing of a 6-channel spectral image. The software has an input of two sets of RAW RGB images, one set for each of two different lighting conditions. These sets include a dark current, flatfield, target, and item. The outputs are an RGB image that is color calibrated with data on the accuracy of the calibration and user-selected spectral reflectance estimations of regions of interest. The improvements created for this version of the software include an updated user interface, auto-sorting of files, improved color difference calculation and visualization, a userfriendly website, and the inclusion of various RAW file types.

16.20 Pivan: A Web Platform for Document Annotation, Thomas Constum, Florian Bebin, Pierrick Tranouez, and Thierry Paquet, University of Rouen Normandie (France)

The Pivan web platform is an open-source tool for managing different stages of automatic document processing, such as layout analysis, transcription, and named entity recognition. It allows for the visualization of document segmentation, transcription at the line or paragraph level, and annotation of named entities. Pivan’s web-based nature makes it perfectly suited for collaborative annotation and offers a smooth experience, even for small machines or connections. It is based on up-to-date web technologies, it includes a comprehensive API, and it can be easily deployed via Docker.

16.40 Improving Color Accuracy When Imaging Cultural Heritage Using a Bi-color LED Source, Roy Berns and David Wyble, Gray Sky Imaging Inc. (US)

Cultural-heritage imaging is a critical aspect of the efforts to preserve world treasures. This field is so demanding of color accuracy that the inherent limitations of RGB imaging can often be an issue. Various imaging systems of increasing complexity have been proposed, up to and including those that report full spectral reflectance for each pixel. These systems improve color accuracy, but their complexity and slow operational speed hamper their widespread use in this field. A simpler and faster bi-color lighting and dual-RGB processing system is proposed that improves the color accuracy of profiling and verification targets. The system can be used with any off-the-shelf RGB camera, including prosumer models.

17.00 How It All Came Together: Building a Local App to Keep Track of the Digitization Workflow, Natalia Hernández Mejías, Hilda Ayala Gonzalez, and Victor Ramirez; ’General Archives of Puerto Rico and ©National Library of Puerto Rico (Puerto Rico)

Thanks to an Andrew W. Mellon Foundation grant, the General Archives of Puerto Rico started a mass digitization project in 2020. The goal was to establish a digitization center and implement FADGI guidelines. As the project developed and the volume of work grew, a fast and simple way to track the items through their different stages was needed. Although several software options were available, they required more resources than we had on hand at the time. Understanding our needs and goals, our team’s IT technician built an app tailored to the project’s requirements. In the past year, we have not only successfully kept track...
of the objects through the digitization workflow, but the app also proved effective for maintaining team communication, collecting technical metadata, and recording relationships between objects and their collections.


The Federal Agencies Digital Guidelines Initiative (FADGI) Technical Guidelines for Digitizing Cultural Heritage Materials: Third Edition was published in May 2023 as a comprehensive revision of the 2016 Technical Guidelines. The latest edition of the guidelines expands on earlier versions and incorporates new material reflecting advances in imaging science and cultural heritage digitization best practices. This paper presents an overview of the document history, the FADGI Still Image Working Group’s motivations and approach for this revision project, the updates to the document, and future applications.

17:40 Closing remarks / evening on own

WEDNESDAY 21 JUNE 2023

CHANGE KEYNOTE AND IS&T AWARD PRESENTATIONS

Session Chair: Jon Y. Hardeberg, Norwegian University of Science and Technology (Norway)
9:00 – 10:10

Why Are We Surrounded by Edvard Munch’s Aula Commission?, Tine Frøysaker, University of Oslo (Norway)
Munch’s Aula Frieze is the only set of monumental Expressionist canvas paintings in Europe that are still preserved in situ. The 11 Aula’s paintings cover approximately 220-square meters. This vast commission was paid by subscriptions during the end of the first decade of the 20th century and the first years of WWI. There are at least two answers to the question why we are in this listed assembly hall of Oslo University. The first addresses why the EU-HTN project named CHANGE has its final session right here. The second discusses why the Munch Aula Project, called MAP, never seems to end.

TWO-MINUTE INTERACTIVE PAPER PREVIEWS I

Session Chair: Hana Beckerle, Library of Congress (US)
10:10 – 10:30

Al Powered Tools for Improving Usability in Digital Archiving, Tuomo Räisänen, South-Eastern Finland University of Applied Sciences, and Mikko Lupsanen and Atte Föhr, National Archives of Finland (Finland) ................................................................. 71

A software package and PoC to help usability in various cases like quality issues and metadata collecting after digitization is introduced. Here usability means the improvement of the process using AI based automation as much as possible and providing easy-to-use interfaces for the end user. This is done with the help of existing open source tools.

A Benchmark Dataset and Evaluation for Best Light Configuration in Reflectance Transformation Imaging, Ramamoorthy Luxman¹, Hermine Chatoux¹, Gaetan Le Goic¹, Jon Yriage Hardeberg², Franck Marzani¹, and Alamin Mansouri¹, “Université de Bourgogne (France) and “Norwegian University of Science and Technology (Norway) .......... 75*

Reflectance Transformation Imaging (RTI) is a non-invasive technique that enables the analysis of materials. Recent advancements in this technology, along with the availability of software for surface analysis through relighting, have improved the restoration and conservation of cultural heritage objects. However, there is a lack of appropriate benchmark data and reference light configurations, which makes it difficult to quantitatively compare and evaluate RTI data acquisitions. To address this, we have developed a dataset that can be used to assess the effectiveness of different surface light configurations for RTI acquisition. Additionally, we introduce methods to derive an ideal reference light configuration for a surface from its dense RTI acquisition. This dataset provides a standardized set of dense RTI acquisitions, accompanied by their corresponding reference light configurations that were obtained using our methods. This dataset can help researchers and developers to compare the performance of their approaches in solving the “Next Best Light Position” problem in RTI acquisition, which can ultimately improve the accuracy and efficiency of RTI acquisition and broaden its applicability in various fields.


The Digital Archives went in 2019 from being The National Archives of Norway’s own digital platform to become Norway’s joint national digital platform for receiving, preserving, and publishing digitized/media-converted historical archives. Regardless if you represent state, municipal, or private actors, small or large, the platform is free of charge and use for the Norwegian archive institutions. The digital platform was first published in 1998, marking 25 years in 2023.

On the Lookout for Sustainability and Efficiency, Carolina Gustafsson, The Centre for Conservation of Cultural Property (Sweden) .......... 86

In 2017 the Swedish government launched a new Digital Strategy, with the overall goal for Sweden to be the best in the world in use of digitalization opportunities. Museums, archives and libraries are important organizations when it comes to fulfilling that goal. The interest for the museum collections is increasing and with that, the need to explore the collections increases. The Centre for Conservation of Cultural Property in Kiruna is a part of the national digitalization of Sweden’s cultural heritage. The department of Digitization offers Sweden’s museums and archives digitization of a wide range of photographic material – glass negatives, slides and plastic film. Nordiska Museet is Sweden’s largest museum of cultural history and stories about the life and people of the Nordic region. It is home to over one and a half million exhibits. The collections reflect nordic lifestyle from the 16th century to the present day.

Collecting and Archiving Modern Cultural Heritage, Judith Andrews, Smithsonian Institution National Museum of African American History and Culture (US) ................................................. 89

As digital collecting by museums, libraries, and archives has increased over recent years, the types and complexity of digital objects has also multiplied. The lessons learned and solutions created by the Digitization and Cataloging team at the Smithsonian’s National Museum of African American History and Culture (NMAAHC) in acquiring, processing, cataloging and preserving these new types of digital collections can assist others in identifying processes and workflows to preserve and make accessible the ever-expanding amount of digital collections that will grow into tomorrow’s digital cultural heritage.

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.
The presentation showcases an innovative preservation project for engineering data based on the work of the E-ARK project. Together with Airbus, Piql engaged in developing an amended version of existing specifications towards a more industrial type, helping Airbus to become compliant with the eArchiving standards. We will highlight main findings from the project and present a path for other data owners of engineering data on how to overcome their preservation challenges. The paper presents a new and innovative preservation project of archiving complex engineering information packages based on the established best practices and standards in the E-ARK project.

**Incorporating High Dynamic Range into Multispectral Imaging for Cultural Heritage Documentation**, Gabrielle Brogle and Susan Farnand, Rochester Institute of Technology (US) .................................................. 94

The dynamic range that can be captured using traditional image capture devices is limited by their design. While an image sensor cannot capture the entire dynamic range in one exposure that the human eye can see, imaging techniques have been developed to help accomplish this. By incorporating high dynamic range imaging, the range of contrast captured is also increased, helping to improve color accuracy. Cultural heritage institutions face limitations when trying to capture color accurate reproductions of cultural heritage objects and materials. To mitigate this, a team of software engineers at RIT have developed a software application, BeyondRGB, to enable the colorimetric and spectral processing of six-channel spectral images. This work aims to incorporate high dynamic range imaging into the BeyondRGB computational pipeline to improve color accuracy further.

**Toward an Ontological Model for Audiovisual Archive Datafication**, Yuchen Yang, École Polytechnique Fédérale de Lausanne (Switzerland) .................................................. 97

With the initiatives like Collections as Data and Computational Archival Science, archives are no longer seen as a static documentation of objects, but evolving sources of cultural and historical data. This work emphasizes the potential updates in preserving and documenting digital audiovisual (AV) content from a data perspective, considering the recent developments in natural language processing and computer vision tasks, as well as the emergence of interactive and embodied experiences and interfaces for innovatively accessing archival content. As part of Swiss national scientific fund Sinergia project, this work was able to work end-to-end with real-world AV archives like Télévision Suisse Romande (RTS). Resorting to an updated narrative model for mapping data that can be obtained from the content as well as the consumer, this work proposed an experimental attempt to build an ontology to formally sum up the potential new paradigm for preservation and accessibility from a data perspective for modern archives, in the hope for nurturing a digital and data-driven mind-set for archive practices.

**10:30 – 11:05**

**COFFEE BREAK / EXHIBITS OPEN / POSTERS AVAILABLE FOR VIEWING**

**ACCESS / PRESERVATION I**


The main objective of this research is to think about the cultural heritage of “Ningunismo” and its definitions through the preservation and cataloging of materials from different media, contained in a horizontal and communal archive with free online access. The focus is mainly on the hermeneutic conflict, originated after the death of the founders and how the mass media distorted its existence. The archive is composed of 500 items, 170 agents, and 30 places. The creation of a tree of elements helped to relate the different formats. From newspaper notes, to abandoned web pages, to papers at sociology conferences, any publication about or mentioning “Ningunismo” was included. Virtual material pertaining to discarded web pages turned out to be the most numerous.

**11:25 How to Digitally Preserve UNESCO Intangible Cultural Heritage? A Web-archive for Ephemeral Events at the Basler Carnival**, Vera Chiquet, University of Basel, and Virtual Culture GmbH (Switzerland) .................................................. 105

In recent years, awareness of the importance of safeguarding intangible cultural heritage (ICH) to protect humanity’s cultural diversity has increased. However, much remains to be done to document and archive this heritage for future generations. This proposal outlines an implemented solution for the digital preservation of intangible cultural heritage. For the living culture of the Schnitzelbänke, a part of the UNESCO world cultural heritage, the Basler Fasnacht, we implemented an archive that functions simultaneously as an archive, digital news portal and basis for the documentation of future events. This living web archive combines digitization, registration, meta dating, contextualizing and storytelling. It acts as a digital archive by providing documents of past times, as a broadcast by almost direct transmission during the event taking place and as a news platform by announcing venues, members and performers, because the same technological solution offers a flexible stage for all of these digital practices.

**11:45 Amplifying Access to Feminist Art: Cross-institutional Collaboration to Create the Judy Chicago Research Portal**, Binky Lush and Sharon Mizota, Penn State University Libraries (US) .................................................. 107

This paper presents a case study in developing an online portal aggregating the archives of Judy Chicago, a contemporary feminist artist, held in multiple institutions. The project represents a model for collaboration, iterative development, and improving access and discoverability for both feminist art archives and for collections at smaller institutions. The project partners are two academic libraries, two museums, two foundations, and the artist’s studio.

**12:05 A Participatory Interface for a Photo Archives**, Vera Chiquet¹, Ulrike Felsing²,³ and Peter Fornaro¹; ¹University of Basel, ²Bern Academy of the Arts at Bern University of Applied Sciences, and ³The Walter Benjamin Kolleg of the University of Bern (Switzerland) .................................................. 109

GLAM institutions have continuously digitised their analogue material since the beginning of the 21st century. Also, the number of digital repositories has grown, and the pressure for open or FAIR data has increased. However, most digital assets need more visibility and usage. This is particularly problematic because storage and continuous migration are cumulative and expensive tasks. To improve this situation, we design a participatory web platform with tools to make annotating,
contextualising, and organising images and their meta information easier. The project “Participatory Knowledge Practices in Analogue and Digital Image Archives” is developed in cooperation with the photo archives of the Swiss Folklore Society (SFFS, Basel, Switzerland). The Swiss National Science Foundation funds it from 2021 to 2025, and here, we present an intermediate project status. The interdisciplinary research team consists of scholars from the Bern Academy of the Arts, the Cultural Studies and European Ethnology, and the Digital Humanities Lab of the University of Basel. The PIA team (Participatory Image Archives) aims to make the platform available to researchers and the general public to conduct Citizen Science research.

12:25 Archiving: Vendor Lock-in or “Complicated” Conformance?, Ansu Jaakkelainen¹, Karin Oolu²,³, and Andres Uueni⁴; ¹South-Eastern Finland University of Applied Sciences (Finland), ²Tallinn University (Estonia), and ³Estonian Academy of Arts (Estonia) National archives set and implement national policies, recommendations and legislation for archiving standards which governmental and public actors need to obey. However, smaller actors in the field do not have this obligation and often they do not possess the resources or know-how to follow the set guidelines or to implement their own digital preservation workflows. This easily leads to the utilization of commercial information management solutions, which might lead to a vendor lock-in situation. In the worst case scenario, the software is merely a CMS or ERMS without any adherence to digital preservation standards. The OneClick SIP creator presented in this paper responds to this challenge. As a very welcome side effect, it also makes it easier to disengage from vendor lock-in situations by simplifying the creation of compliant information packages.

12:45 – 14:00 LUNCH ON OWN

CALIBRATING TOOLS
Session Chair: Kurt Heumiller, National Gallery of Art (US)
14:00 – 15:20

14:00 A Simple Ultraviolet-induced Visible Fluorescence Target or a Low-cost Alternative to a Spectralon, Yossi Pozelnov, Los Angeles County Museum of Art (US) A prevailing question among conservators and imaging professionals producing cultural heritage documentation and research is how to obtain an ultraviolet-induced visible fluorescence (luminescence) image that allow us to assess the quality of the filtration used and the environment in which the image is being captured. The literature on this topic generally recommends use of delicate and expensive control targets. This article describes a simple low-cost method to create and use a target that can aid in capturing images that are consistent and thus raising the confidence level of the images created.

14:20 A Lens Characterization Method for Low-budget High-quality Museum Photography, Alessandra Marrocchesi and Robert Erdmann, University of Amsterdam and Rijksmuseum (the Netherlands) Image sharpness is strongly dependent on lens aperture and camera position at capture. As high-end equipment is out of the reach of many museums, these choices are often mostly based on visual evaluations of image sharpness, which—though still possible resulting in good quality images—is highly subjective and can lead to inconsistency. In the context of a broader effort to provide low-cost solutions for consistent high-quality museum photography, we propose a methodology for the characterization of the performance of a lens in terms of sharpness that enables the selection of the appropriate lens aperture and camera position for the capture of a sharp image of an object without the need for expensive equipment.

14:40 Do-It-Yourself LUT-based Linearization of Image Sensors, Maximilian Czech, Giorgio Trampy, and Ali Reza Syed, Norwegian University of Science and Technology (Norway) Imaging sensors are linear over a large part of their operational range. Nevertheless, their behavior becomes non-linear when approaching saturation. This is undesired if such sensors are used for scientific measurements. In this work, a simple and efficient off-chip method is proposed for image sensor linearization. First, the sensor response is characterized with a constant irradiance and a sequence of captures at several integration times. Then a 1D look-up table is calculated to compensate for the nonlinear range. This LUT can be applied to the raw sensor data before further postprocessing. The higher signal-to-noise ratio of captured data is used to demonstrate the benefit of the extended linear range. The proposed method can restore linearity while being easy to implement and computationally efficient.

15:00 Color Calibration based on Mosaic Stitching of a Color Target as an Alternative to a Single-shot Approach, Tarek Abu Hail¹, Felix Schneider², Reimar Tausch¹, Martin Ritz¹, Pedro Santos¹, and Dieter Fellner¹,²,³; ¹Fraunhofer Institute for Computer Graphics Research IGD (Germany), ²Darmstadt University of Technology (Germany), and ³Graz University of Technology (Austria) Color targets come in different designs, sizes and surface finishes. A high quality color target such as the Next Generation Target (NGT), designed for the Library of Congress, has a glossy finish that makes it sensitive to the light-setup geometry. When the NGT color target is to be captured orthogonally, i.e. both the camera and the light share the same plane and lie on the normal of the target’s surface, even with cross-polarization in place it is not possible to completely eliminate the high reflections caused by the camera/light geometry—unlike for less glossy color targets such as the X-Rite SG CC—not even if the camera/light setup were to be tilted at different angles. We are demonstrating in this paper that it is possible, however, to deploy a mosaic approach to capture the NGT color target at a tilted angle, masking out the reflections, and composing a rectified mosaic image out of only the clear parts of the target. The resultant ICC color correction profile for the mosaic image is proved to be viable to put in use and it satisfies all the necessary metrics for ISO level “A” when it comes to color calibration and color accuracy.

BEHIND-THE-SCENES TOURS
Tour times vary.

CONFERENCE RECEPTION
19:30 – 22:30 After a tour or exploring Oslo, join colleagues at the conference reception.

SOCIETY FOR IMAGING SCIENCE AND TECHNOLOGY
From Smells of Collections to Collections of Smells, Matija Stric, Heritage Science Lab, University of Ljubljana (Slovenia)

The vast majority of objects in collections are only ever appreciated visually. Yet, archival and library visitors often refer to the smell of paper as one of the major sources of enjoyment: the heady mix of aromas of hay, bitter almonds, and vanilla is universally appreciated. While perfumes themselves are perhaps the most evident objects that are meant to be enjoyed affectionately, the smell of old books is a consequence of their active chemical degradation. Yet other smells are associated with object use or are perhaps the result of conservation treatments. One aspect is certain: olfactory experiences are valuable to the public and make learning experiences more memorable. We have only recently started developing clearer guidelines for introduction of smells into exhibitions where a variety of issues need to be considered, from conservation to health-related. Similarly, guidelines are being developed on how to preserve smells in their own right: it is not just the chemical composition that needs to be archived but also the broader social and historical significance of a smell, as this can change through time as well. The recent establishment of archives of perfumes and smells is a testament to the fact that olfactory engagement is here to stay.

Texture-based Clustering of Archaeological Textile Images,

Davit Gigilashvili¹, Ha Thu Nguyen¹, Casper Fabian Gulbrandsen¹, Margrethe Havgar², Marianne Vedeler², and Jon Yngve Hardeberg¹; ¹Norwegian University of Science and Technology and ²University of Oslo (Norway) ........................................ 139

Archaeological textiles are often highly fragmented, and solving a puzzle is needed to recover the original composition and respective motifs. The lack of ground truth and unknown number of the original artworks that the fragments come from complicates this process. We clustered the RGB images of the Viking Age Oseberg Tapestry based on their texture features. Classical texture descriptors as well as modern deep learning were used to construct a texture feature vector that was subsequently fed to the clustering algorithm. We anticipated that the clustering outcome would give indications to the number of original artworks. While the two clusters of different textures emerged, this finding needs to be taken with care due to a broad range of limitations and lessons learned.

IS&T would like to thank the following Behind-the-Scenes Tour providers

MUNCH Museum
Museum of Cultural History
National Library of Norway
The National Museum

Application of Reflectance Transformation Imaging for Visualizing Early Signs of Corrosion in Historical Glass Corrosion, Deepshikha Sharma¹,², Marvin Nunt²,³, Ulikke Rohdenhausler¹, Katharina Schmidt-Ort¹, Edith Joseph⁴, Sony George⁵, and Tiziana Lombardo⁶; ¹Swiss National Museum (Switzerland), ²Aliment (France), ³Université de Bourgogne Franche-Comté (France), ⁴South Brittany University (France), ⁵HES-SO University of Applied Sciences and Arts Western Switzerland (Switzerland), ⁶University of Neuchâtel (Switzerland), and ⁷Norwegian University of Science and Technology (Norway) ........................................ 143

Reflectance Transformation Imaging (RTI) is a multi-light imaging technique using a camera on a fixed position and orthogonal to the studied surface, while varying the light position for each image captured. This allows for the reconstruction of a surface’s visual appearance and the characterization of the surface by providing additional information on surface deformations and local micro-geometry. RTI was applied on historical model glass corroded in the presence of volatile organic compounds (VOCs) to visualize early stages of corrosion. RTI was used to create relighting visualizations and generate maps based on statistical descriptors derived from the local reflectance distribution of the pixels. Selected maps were able to assist in the quantification of corrosion signs i.e., fine cracks and salt neocrystallizations (SN), on a more global scale as compared to digital microscopy (DM). Therefore, RTI could provide an imaging solution for the characterization of corrosion signs on transparent colourless glass surfaces, which could not be visualized using simple RGB photography neither with transmitted nor reflected light.

Measuring and Modelling the Appearance of Gilded Surfaces: Applications in Conservation and Restoration, Yoko Arteaga¹,², Clotilde Boust¹,³, and Jon Yngve Hardeberg²; ¹Centre of Research and Restoration of the Museums of France (France), ²Norwegian University of Science and Technology (Norway), and ³PSL/CMTH UMR8247 CNRS (France) ........................................ A-10

In this paper, the appearance of gilded surfaces is measured and modelled, to guide conservation and restoration. Three types of gilding are studied, water gilding, oil gilding, and “imitation” gilding. The three materials present an appearance related to their manufacturing method. An imaging based acquisition system is used to measure the bidirectional reflectance of the materials and its BRDF is modelled. Using perceptual metrics, the appearance of the three different materials is analyzed and used to guide conservation and restoration treatments.

The Possibilities of Making Copies of Wooden Historical Objects by CNC Milling based on Digital Three-dimensional Models, Eryk Bunsch, Museum of King Jan III’s Palace at Włodzów (Poland) ........................................ 149

Among people working with cultural heritage objects, the ability to make the best possible copies has always been one of the important topics. In recent years, the development of techniques that make it possible to make three-dimensional documentation of heritage objects and the capabilities of software that controls cutter machines have made it possible to make material copies in wood, among other things. Unfortunately, the lack of standards for the creation of three-dimensional documentation, as well as the relatively unique nature of this type of release, translate into a lack of common understanding of the real possibilities and limitations of these technologies. What is needed is an analysis of the path of execution of this type of project, which would discuss the planned exhibition or educational goals, the assumed technological parameters achieved in the course of implementation and an evaluation of the results achieved. The accumulation of such results will not only help facilitate the implementation of future projects, but will also be the first step towards the creation of standards and quality norms for this type of product.

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.
Character-based Writer Verification of Ancient Hebrew Square-script Manuscripts: On Edge-direction Feature, Tabita Lumban Tabing¹, Pavel Škrabánek², Sule Y. Yayilgan¹, Sony George¹, and Torleif Elgvin³; ¹Norwegian University of Science and Technology (Norway), ²Bno University of Technology (Czech Republic), and ³NjU University College (Norway) 159

Handwriting significantly contributes to the task of the writer identification and verification of modern and historical documents. This work developed a writer verification system for ancient Hebrew square-script manuscripts, mainly based on the edge-direction feature. Two configurations within the proposed system are carried out, i.e., character-based edge-direction feature extraction and extraction techniques of handwriting shape representation that may drive the system performance. A classification-based verification approach, utilizing Support Vector Machine (SVM) as the classifier, is employed to evaluate the performance of the two configurations. This study has confirmed that the skeleton-based shape representation technique outperforms the edge detection technique used in the predecessor approach. Furthermore, a character-based writer verification system provides the corresponding scholars and experts with an alphabetical investigation to identify the uniqueness of each writer’s handwriting.

INTERACTIVE POSTER PAPER SESSION

11:00 – 12:15
Join the interactive paper authors in the Aula foyer to discuss their work. Coffee/tea available in the Aula courtyard.

ACCESS / PRESERVATION II

12:15 Preservation Equity: Decision Making and Data, Fenella France and Andrew Davis, Library of Congress (US) 159

One of the continued challenges for preservation resources is the demand for objective data to make informed retention and withdrawal decisions. Discussions within the shared print and print repository communities have circled around the integral question pertaining to the selection process of books to be incorporated into a national shared print system, namely the minimum number of copies such a system must maintain. The challenge has been knowing the condition of those volumes that are withdrawn or retained, since all decisions have been based solely upon a shared catalog where partners do not have data to know the condition of others’ volumes. This conundrum led to a national research initiative funded by the Mellon Foundation “Assessing the Physical Condition of the National Collection” to create a baseline of understanding of the actual condition of the national collection in research libraries and collections. The project undertook an extensive assessment capturing data from 500 “identical” volumes each from 5 different research libraries and analyzing the dataset to answer the following questions: What is the general condition of library collections in the 1840-1940 period? Can the condition of collections be predicted by catalog or physical parameters? What collection assessment tools help determine a book’s life expectancy? Filling the gaps in knowledge for understanding the physicality of our collections is helping us identify at-risk collections and explain the high percentage of dis-similar “same” volumes due to the impact of paper composition. Predictive modelling and simple assessment tools allow more accurate prediction of good and poor-quality copies of books, as well as what is typical and atypical for specific decades.

12:35 Benchmarking Lossless Still Image Codecs: Perspectives on Selected Compression Standards From 1992 through 2022, Michael Bennett, University of Connecticut (US) 165

As complementary technologies evolve, data compression continues to be a foundational aspect of growing digital collections. In this study, selected lossless still image codecs from 1992 through 2022 were benchmarked across a variety of efficiency and performance measures using reference images from cultural heritage. Additionally, entropy estimates were calculated by source image to assist in characterizing image information and evaluating encoder efficiency against assessed feasible compression limits. Encoder designs and compression techniques were also examined in the context of the study’s measured results.

12:55 – 14:00
LUNCH BREAK ON OWN

OPTIMIZING WORKFLOW

Session Chair: Michael J. Bennett, University of Connecticut (US) 172

14:00 Gimme Three Steps: A Mass Digitization Method at the Smithsonian, Nathan Anderson, Jeanine Nault, and Luis Villanueva, Smithsonian Institution (US) 177

The Smithsonian Institution Digitization Program Office’s Collection Digitization team develops and designs a “three-pronged” workflow approach to mass digitization of museum collections, called the Physical, Imaging, and Virtual Workflows. This approach addresses proper handling of objects, optimizing capture throughputs, and streamlines the processing and delivery of images through automation. The Physical Workflow Design defines the production space and safe movement of objects from storage to the digitization production space; the Imaging Workflow Design defines the technical specifications, file deliverables, and the results of our “Item Driven Image Fidelity” (IDIF) testing; and finally, the Virtual Workflow Design defines the lifecycle of the digital file, from creation to online access, describing the various data processes required for success.

14:20 Digitization Information Objects: The Case for Standardized Digitization Project Specifications, Jim Studnicki, Creekside Digital (US) 177

While we now have mature, proven guidelines (FADGI) which provide solid recommendations on how to create proper master files, beyond targets and the ability to measure them, the cultural heritage community lacks easily consumable, flexible specifications for conducting actual projects. Moreover, there is a general lack of examples of FADGI-compliant Statements of Work, leading to much reinvention of the wheel and even to library and archival personnel deciding to not use FADGI
14:40 Current and Anticipated Digitization Competencies,
Sari Jain and Sina Westman, South-Eastern Finland University of
Applied Sciences (Finland) 182
Digitization is a key process in preserving, protecting and providing
continued long-term access to archival materials. The competencies
required in digitization pose challenges to individuals and organiza-
tions engaging in digitization activities. We take a competency map-
ning approach to support digitization skills anticipation. Current and
anticipated digitization competencies in public and private organiza-
tions in Finland were surveyed using a digital preservation competency
framework. Results show that organizations see digitization requiring a
wide set of competencies ranging from policies and legal issues to prac-
tical organization and technical delivery of digitization. There is antic-
pated need to optimize organizational and service capabilities in near
future. The desired target state is quite advanced overall, regardless of
current capabilities. The largest self-identified competency gaps exist in
strategical and technical approaches to digital archiving and digital
access to archives. Our results inform continued professional develop-
ment and planning for future digitization efforts.

MULTISPECTRAL APPROACHES
13:00 – 17:35
Session Chair: Yossi Pozeilov, Los Angeles County Museum of Art (US)

15:00 Build, Select, Reshuffle: Uncovering Distinct Features of Cultural Heritage
Objects with Multispectral Imaging, James Fallico,
Kyla Schultz, Elia Arnold, Izzy Moyer, Marteza Madii Amiri,
Juilee Decker, David Messinger, and Roger Easton, Rochester
Institute of Technology (US) 188
Some cultural heritage collections such as manuscripts, scrolls, books,
sheet and folia that are faded, damaged, or otherwise unreadable pres-
ent challenges for curators, collections professionals, scholars, and
researchers looking to understand collections more fully. Seeking to
uncover distinct features of objects, they have employed modern imaging
tools, including sensors, lenses, and illumination sources and thus posi-
tioned multispectral imaging as a critical tool for cultural heritage
imaging. However, cost and ease-of-use have been prohibiting factors.
To address this, Rochester Institute of Technology received a grant from
the National Endowment for the Humanities (PR-268783-20) to fund an
interdisciplinary collaboration to develop a low-cost, portable imaging
system with processing software that could be utilized by scholars
accessing collections in library, archive, and museum settings, as well as
staff working within these institutions. This article addresses our open
source and extensible software applications, from the first iteration of
software in 2020 to our current effort in 2022-23 which seeks to simplify
both processes. An overview of the image capture and processing soft-
ware to capture and visualize the spectral data offers a basis for demon-
strating the possibilities for low-cost, low barrier-to-entry software on cul-
tural heritage imaging, research, preservation, and dissemination.

15:20 Full VNIR-SWIR Hyperspectral Imaging Workflow for the
Monitoring of Archaeological Textiles, Federico Grillini1,
Jean-Baptiste Thomas1,2, and Sony George1; 1Norwegian
University of Science and Technology (Norway) and 2University
of Burgundy (France) 192
A practical workflow to capture and process hyperspectral images in
combined VNIR-SWIR ranges is presented and discussed. The pipeline
demonstration is intended to increase the visibility of the possibilities
that advanced hyperspectral imaging techniques can bring to the study
of archaeological textiles. Emphasis is placed on the fusion of data from
two hyperspectral devices. Every aspect of the pipeline is analyzed,
from the practical and optimal implementation of the imaging setup to
the choices and decisions that can be made during the data processing
steps. The workflow is demonstrated on an archaeological textile
belonging to the Paracas Culture (Peru, 200 BC – 100 AD ca.) and dis-
plays an example in which an inappropriate selection of the processing
steps can lead to a misinterpretation of the hyperspectral data.

ARCHIVING 2023 FINAL PROGRAM AND PROCEEDINGS
process of re-opening the frame for the analysis of the glazed manuscript is not always desirable, given their fragile state of preservation. Therefore, microimaging with IR and UV light sources above the glass frame is a frequently used method for the preliminary (qualitative) classification of the inks applied on the manuscripts. Building on this well-established methodology, this study explores the potential of spectral imaging technology for the quantitative analysis of glazed manuscripts. The present research focuses on the colorimetric analysis of iron-gall and carbon black inks applied on a papyrus substrate, aiming to the quantitative analysis of the effect of glass frames to the acquired images. The obtained results show that the quantitative colorimetric analysis of the inks above the glass frame can be used for the preliminary classification of the inks, hence minimizing the need to open the glass frames for further analysis.

17.10 JIST-first: An Experiment-based Comparative Analysis of Pigment Classification Algorithms using Hyperspectral Imaging, Dipendra Mandal, Marius Pedersen, Sony George, and Hilda Deborah, Norwegian University of Science and Technology (Norway), and Clotilde Bois, Centre of Research and Restoration of the Museums of France (France). See JIST 67(3)/DOi: 10.2352/J.ImagingSci.Technol.2023.67.3.030403

Hyperspectral imaging techniques are widely used in cultural heritage for documentation and material analysis. A pigment classification of an artwork is an essential task. Several algorithms have been used for hyperspectral data classification, which are more appropriate than each other, depending on the application domain. However, very few have been applied for pigment classification tasks in the cultural heritage domain. Most of these algorithms work effectively for spectral shape differences and might not perform well for spectra having a difference in magnitude or for spectra that are nearly similar in shape but might belong to two different pigments. In this work, we evaluate the performance of different supervised-based algorithms and some machine learning models for the pigment classification of a mockup using hyperspectral imaging. The result obtained shows the importance of choosing appropriate algorithms for pigment classification.

17.30 Closing remarks

FRIDAY 23 JUNE 2023

WELCOME AND CHANGE OVERVIEW, Sony George, Norwegian University of Science and Technology (Norway)

5-MINUTE EARLY STAGE RESEARCHER PRESENTATIONS

9:20 – 10:30

MULTISCALE AND MULTIMODAL STRATEGIES AND SYSTEMS FOR CHANGE CAPTURE AND TRACKING OF CH ASSETS

Imaging techniques for change documentation and monitoring of stained-glass windows, Agnese Babini, Norwegian University of Science and Technology (Norway)

Quality evaluation in CH digitization, Dipendra Mandal, Norwegian University of Science and Technology (Norway)

Portable multimodal system for CH surface measurement and monitoring, Athanasia Papanikolaou, Warsaw University of Technology (Poland)

Microscopic 3D imaging and conservation, Yoko Arteaga, Centre of Research and Restoration of the Museums of France (France)

COMPUTATIONAL METHODS CHANGE STUDYING (CHARACTERIZATION, VISUALIZATION, AND MONITORING)

Registration techniques for differential and multimodal data, Evdokia Saiti, Norwegian University of Science and Technology (Norway)

Analysis and visualization of multi modal image data in CH surfaces monitoring, Sunita Saha, Warsaw University of Technology (Poland)

Capture and characterization of change in the appearance of CH objects surface, Ramamoorthy Luxman, Universidade de Bourgogne Franche-Comté (France)

APPLICATIONS: CHANGE DURING THE ALTERATION AND CONSERVATION OF ARTEFACTS

Imaging-based documentation and analysis for change monitoring of novel dry-cleaning restoration/conservation methods for unvarnished canvas paintings, Jan Cutajar, University of Oslo (Norway)

Analysis and assessment of degradation of polychrome metal artworks, Laura Brambilla, HES-So University of Applied Sciences and Arts Western Switzerland (Switzerland)

Analysis and monitoring of degradation of historical glasses, Deepshikha Sharma, Swiss National Museum (Switzerland)

Low-budget portable device for technical imaging of cultural heritage artifacts, Alessandra Marrocchesi, University of Amsterdam (the Netherlands)

Characterization of surface change of historical metals by employing imaging and computer vision, Amalia Siatou, HES-So University of Applied Sciences and Arts Western Switzerland (Switzerland) and Université de Bourgogne Franche-Comté (France)

POSTER SESSION

10:30 – 11:00

Explore the posters and discuss the work with the Early Stage Researchers.

INVITED PAPERS

11:00 – 12:00

11:00 Digital color reconstructions of cultural heritage using color-managed imaging and small-aperture spectrophotometry, Roy S. Beren, Gray Sky Imaging (US)

11:30 Telling humanity’s story: Democratizing technology to empower cultural narratives, Mark Mudge, Cultural Heritage Imaging (US)

PANEL: NEEDS OF THE SECTOR

12:00 – 13:00

GROUP LUNCH
A Pipeline for Monitoring the External and Inner Structure of Cultural Heritage Objects

Evdokia Saiti¹, Theoharis Theoharis¹
¹ Norwegian University of Science and Technology (NTNU), Department of Computer and Information Science, Norway

Abstract
The problem of monitoring and tracking the changes that Cultural Heritage (CH) objects undergo is of high importance. A key task in this workflow is the initial registration of the data in a common reference frame. However, challenges arise when data to be aligned have been acquired in different timeframes (cross-time) and by different imaging techniques (multimodal). This paper addresses those challenges and proposes a pipeline for monitoring both the surface and the inner structure of CH objects. Taking as an input two different sets of 3D models and 3D Volumes acquired in different timeslots from 3D surface and CT scanning respectively, the pipeline registers both modalities in a multitemporal way. The results show the possibilities of this methodology for accurate multitemporal documentation of both surface and inner structure. This approach has the potential to facilitate the monitoring through time and change detection of CH objects in a more holistic way.

1. Introduction

2. Problem statement
3. Approach

Figure 1: The presented pipeline for digital monitoring of external and internal structure of CH objects

Cross-Time Registration Stage

Multimodal Registration Stage

4. Results

Figure 2 shows the results for the stone slab named ‘Nidaros Bad Small 01’, which is created from grytdal quarry, the same material that was used in the construction of Nidaros Cathedral in Trondheim, Norway. The stone had Small 01’, which is created from grytdal quarry, the same material...
5. Conclusions

The approach presented enables the accurate detection of changes in CH objects over time, without any reference points or invasive procedures. Although the interpretation of the results is still ongoing, our preliminary analysis indicates that the presented pipeline can give an insight into the changes occurring in both the surface and the inner structure of the material of CH objects. This approach can potentially facilitate the monitoring and detection of changes or type of damage in a holistic way for CH objects.

6. Acknowledgments

This work has received funding from the European Union’s Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 813789. Additionally, the authors would like to thank the PRESIOUS project (European Union’s Seventh Framework Program for research, technological development, and demonstration under grant no. 600533) for giving access to the datasets used in this work.

5. References


Author Biography

Evdokia Saiti received her B.Sc. in Computer Science, from Department of Informatics and Telecommunications, University of Athens in 2008. Subsequently, she received her M.Sc. from the same Department in the field of Computational Science in 2010. Evdokia Saiti is currently a PhD Candidate at the Department of Computer & Information Science, Norwegian University of Science and Technology (NTNU), Trondheim and a Marie Curie ITN fellow at the EU Project CHANGE. Her main interests lie in the areas of Computer Vision, 3D Registration, CH Monitoring, and CH Visualization.

Theoharis Theoharis received his B.Sc. in Computer Science, from the Queen Mary College, in 1984. Subsequently, he received his M.Sc. from the same Institution in the field of Computation in 1985. Finally, he received his
D.Phil. in computer graphics and parallel processing from the University of Oxford, U.K., in 1988. Dr. Theoharis is currently a Professor at the Department of Computer & Information Science, Norwegian University of Science and Technology (NTNU) and a part time Professor at the Department of Informatics & Telecommunications, University of Athens. His main research interests lie in the fields of Biometrics, 3D Object Retrieval and Reconstruction.
eArchiving for Engineering

Bendik Bryde, Director of Client Projects, Piql AS, Drammen, Norway
Roberto Gonzalez, Product Manager, Piql AS, Barcelona, Spain

Abstract

The presentation showcases an innovative preservation project for engineering data based on the work of the E-ARK project. Together with Airbus, Piql engaged in developing an amended version of existing specifications towards a more industrial kind, helping Airbus to become compliant with the eArchiving standards. We will highlight main findings from the project and present a path for other data owners of engineering data on how to overcome their preservation challenges. The paper presents a new and innovative preservation project of archiving complex engineering information packages based on the established best practices and standards in the E-ARK project.

Motivation

Following the EU Commission’ agency HaDEA call for new applied fields of digital archiving in 2021, Piql together with Airbus decided to join forces and collaborate to enhance the understanding of how to practically be able to create standardized and coherent archival information packages for engineering data and industrial material, such as 3D modulations.

One of the main motivations behind the project was to be able to elaborate on the work done by the E-ARK project in order to develop new specifications that follow the E-ARK guidelines and core specifications and apply this to a context of engineering and industrial data, often more complex. As a domain, the field also is somewhat immature when it comes to long-term preservation and digital archiving, even though the needs for protecting valuable digital documentation for decades seems evident and has been a main driver for why Airbus liked to be part of the project to explore a new approach to their challenges of information management.

The problem

The domain of engineering data is a complex field with lots of heavy file formats and a level of complexity which makes it difficult to maintain, not only from one software version to another and when talking about archiving this for a couple of decades to ensure accessibility to content has proven to be a hazard that often leads to numerous hours of trying to figure out how to read the models with software that is currently not accessible or maintained.

Further, a major challenge is the lack of standards for information packages from a digital archival point of view, and lots of different, often customized formats from a different time, makes it a daunting task for many document managers and content managers trying to navigate in the forest of misplaced files and formats.

The approach

The goal of the project was initially to help participants from other streams of digital archiving, outside the traditional national archives and public institutions, understand how to face the challenges of file format obsolescence, complex metadata structuring of engineering data as well as having a plan for how to be able to digitally archive their different assets, and a vast bouquet of different formats and information packages.

As part of the approach the project needs to conduct a thorough assessment of the current “as-is” situation and identify specific formats and source of data that seemed natural to start with. The level of complexity led to the need of not being able to cover all types of data in the project, but rather to go deeper and really understand a few types. It was also then easier to create an amended version of a specification for the 3D data that follows on the established specifications in the E-ARK project.

By having a close ongoing discussion throughout the project with the data owner, Piql would eventually be able to help Airbus align their information management process to the standards and specifications of the E-ARK project and help them manage some of their information in a preservation system that would be coherent to these specifications.

By utilizing this approach as a pilot process, the project would also contribute with a process of developing specifications, a list of criteria and a workflow method that could be applied to other types of data in the dedicated department, but also to other parts of the organization.

The results

As a premise in project call to be compliant with the E-ARK specifications, the project amended existing work and develop a new specification, specifically aimed at managing complex industrial packages in the form of 3D information. This result, a new proposed specification for one type of material of Airbus was created. This
gives new insight and foundation to further develop the know-how and insight in how the digital archiving community needs to deal with more complex information formats from other industries. Especially with more and more born digital data being created this becomes more at the fore front of attention for engineering information.

Further, by exchanging experiences and references from the E-ARK community, the project was able to create a plan for the desired structure of data, which again led to the work of creating a set of modules that could convert the information from the source systems of Airbus according to the new specification and thus be compliant with the standards of E-ARK.

Conclusions

The conclusion of the project shows that the development of new standards is possible when there is a strong foundation to build on. The existing framework of E-ARK made it possible for the project to apply existing specifications to new complex datasets of engineering information and pave the way for new opportunities on how to more easily archive digital information from industries and fields within engineering data.

The paper aims at presenting the experiences and learnings from the EC HaDEA eArchiving project between Piql and Airbus and to share how this can be used by other, similar organizations with more complex datasets of information from around the world.

Author Biography

Bendik Bryde holds the position as Director of strategic client projects in Piql, leading a team with unique development competence and consultancy when it comes to digital archiving and long-term storage. More than 7 years of experience working in the field of digital archiving, he has been involved in major archival projects such as eArchiving and the Norwegian Health Archive. His educational background stems from a MSc in Organization and Leadership with focus on strategy.

Roberto Gonzalez is a Product Manager in Piql responsible for software solutions. He has also for 7 years been managing Piql in Spain. He is an engineer with more than 30 years of experience in Information Technology, from technical to managerial positions, especially linked to Document Services, Archives, Digital Preservation and artificial intelligence, in international organizations. He holds a Master in Artificial Intelligence and a Degree in Aeronautical Engineering.
Amplifying Access to Feminist Art: Cross-institutional Collaboration to Create the Judy Chicago Research Portal

**Abstract**

This paper presents a case study in developing an online portal aggregating the archives of Judy Chicago, a contemporary feminist artist, held in multiple institutions. The project represents a model for collaboration, iterative development, and improving access and discoverability for both feminist art archives and for collections at smaller institutions. The project partners are two academic libraries, two museums, two foundations, and the artist’s studio.

**Judy Chicago Research Portal**

Since the mid 1960s, and in a different aspect of Chicago’s long career. The collection at Penn State focuses on Chicago’s archives and artworks, which are housed at the Jordan Schnitzer Family Foundation. In this way, Chicago’s art historical prominence could be leveraged to drive amplifying access to other institutions, as well as from the artist’s studio and Through the Flower, a foundation.

The project explored how to coordinate contributions of metadata and for collections at smaller institutions. The project is funded through an endowment at Penn State established to highlight holding institutional priorities and abilities. For example, a recent staffing change at a partner institution required a deadline for the portal and access to Chicago’s collections. Although team members from Penn State lead the metadata and development work on the portal, they have attempted to foster an egalitarian structure in which partners can contribute according to their own schedules and capacities.

The Judy Chicago Research Portal was planned, designed, and developed at Penn State Libraries, Harvard University’s Schlesinger Library, the Binky Lush, Sharon Mizota; Penn State University Libraries; University Park, Pennsylvania, United States. The original plan for display included downloading, cropping, and resizing thousands of individual JPGs to create thumbnails for the portal. Some of the partners are still in the installation phase of their digital asset management systems. This was, unfortunately, not the case in reality. Some of our partners’ Institutional Archives Management Systems throttled, which resulted in a failure to display thumbnails on the portal. DAMS and continue to work on getting them up and running to deliver of Chicago’s work in printmaking, is the most recent documentation from her many art and publishing projects. The Judy Chicago Research Portal project represents a model for understanding the depth and breadth of Chicago’s career as a contemporary feminist artist, held in multiple institutions.
system allowed us to accommodate each partner’s schema without creating a “set in stone” crosswalk for partner’s presence on the portal regardless of whether

As metadata was received, it was not only mapped but
normalizing the metadata layer of metadata was develope uniform applied. They included bodies of work such as “The Dinner Party,” and “Early Feminist,” salient themes such as “Collaboration,” “The Body/Sexuality,” and “Site Specific Works,” as well as standardized terms for various formats: “Artwork,” “Documentary Photos,” “Documents,” etc. Most of

"Artwork," "Documentary Photos," "Documents," etc. Most of

system allowed us to accommodate each partner’s schema without creating a “set in stone” crosswalk for

The portal’s schema is a lightly modified "standard Dublin Core," and in order to accommodate the partner institution’s needs, we had to expand upon it. For example, when supplying metadata so they were not

The portal’s user interface was also modified along the way.

As the portal grew, criteria and workflows for

to include partners who didn’t have this case.

The portal was up and running, an undergraduate student at Penn State

usability tests were run online with art educators and

An example of this beh

behavior can be found

usability tests were run online with art educators and

An example of this beh

behavior can be found

usability tests were run online with art educators and

An example of this beh
revisions planned for the coming year. As the portal has grown, we have learned that these cycles of testing and revision will need to be built into the project; the portal originally designed for a relatively small number of items no longer works as well for a significantly larger number.

The portal team has also engaged a Penn State graduate student in graphic design to create a social media campaign for the portal, and we are in the beginning stages of promoting the portal via Instagram. These posts will be timed to coincide with specific historic dates and holidays and will promote the partner institutions as well as the portal itself. In this way, the portal project creates an ecosystem of awareness, not only of Chicago’s work and legacy, but of the history of women and feminist art, as well as the ways in which various institutions support research and dissemination.

The presentation will also discuss how the portal enhances discoverability of records related to feminist art by tagging them with overarching themes, finding commonalities among diverse records across multiple institutions that would otherwise be difficult to bring together. By adding this layer of metadata in addition to that supplied by the partner institutions, the portal provides a broader lens and context for these records. The project has also improved image accessibility by creating alt text for hundreds of images that had none at their home institutions.

Our presenters will discuss next steps for the Judy Chicago Research Portal which include incorporating all works into the portal that have been digitized to date. There are also a large number of items that have yet to be digitized at two of the partner institutions, and as they are available, the metadata will be updated, images will be processed and scanned, and alternative text will be created in preparation for ingest into the portal. We have a planned redesign in the near future, which once implemented, will again be followed by more user testing and iterative improvements. There is the potential of additional partners joining the project, and we will continue in our ongoing efforts to promote the use of the portal by researchers, students and faculty at all levels.

Finally, the project demonstrates how Penn State University Libraries, a large institution with relatively robust IT and metadata resources, can deploy them to highlight records at smaller institutions that might not otherwise be able to showcase their holdings as prominently, or in some cases be able to put them online at all. This inclusivity is especially important in the case of feminist art archives, which are often not widely known or may not be fully processed or digitized. The presentation will relate how a consistent and dedicated commitment to collaboration, combined with an iterative, flexible development process, created a portal that increases the visibility and accessibility of feminist art archives for research and education.

References


Author Biography

Sharon Mizota is the Metadata Specialist for the Judy Chicago Research Portal. She is also a DEI metadata consultant who helps archives, museums, libraries, and media organizations transform and share their metadata to improve diversity, equity, and inclusion in the historical record.

Binky Lush is the Manager of Discovery Access and Web Services for Penn State University Libraries in University Park, PA. She leads a number of teams in the Libraries focusing on enhancing the Libraries’ web site and discovery platforms to ensure an engaging, accessible, and user-centered search and discovery experience.
Measuring and modelling the appearance of gilded surfaces: applications in conservation and restoration

Yoko Arteaga1 2, Clotilde Boust1 3, Jon Yngve Hardeberg2
1 Centre of Research and Restoration of the Museums of France; Paris, France
2 Norwegian University of Science and Technology; Gjøvik, Norway
3 PSL-PCMTU UMR8247 CNRS; Paris, France

Abstract
In this paper, the appearance of gilded surfaces is measured and modelled, to guide conservation and restoration. Three types of gilding are studied, water gilding, oil gilding, and “imitation” gilding. The three materials present an appearance related to their manufacturing method. An imaging based acquisition system is used to measure the bidirectional reflectance of the materials and its BRDF is modelled. Using perceptual metrics, the appearance of the three different materials is analysed and used to guide conservation and restoration treatments.

Introduction
Gilding is a form of polychromy used to decorate artworks by applying a gold leaf to surfaces and thus, imitating the appearance of real gold. It was widely used in the Middle Ages to decorate altarpieces and religious imagery as gold represented light and God. However, the appearance of many gilded objects has now greatly changed due to the deterioration of the gilding caused by many factors.

Gilding is a material with special appearance which changes at different angles of viewing and illumination. In order to characterise the appearance of these materials, traditional colour measurements are insufficient [1].

This paper aims to introduce bidirectional reflectance measurements using an imaging based method, and provides examples of how appearance models have been used in the field of conservation and restoration. More specifically, two examples will be presented. The first deals with the characterisation of appearance differences of gilded surfaces and the second, with the evaluation of varnish removal methods for gilded samples.

The imaging setup and processing pipeline used to acquire the appearance of the samples has been presented and evaluated in [16]. The appearance characterisation of different types of gilding has been published in [17], and the evaluation of varnish removal for gilded samples has been published in [15]. The readers are invited to refer to the relevant papers for more details.

The structure of this paper is as follows: the next section describes the set-up of the imaging system used, the processing pipeline, and the samples studied. The third section present the two different case studies where appearance measurements were used. Finally, the conclusion and perspectives are presented in the fourth section.

Materials and methods
Flexible HDR multispectral-imaging BRDF system
The system presented in this paper and the processing pipeline to obtain the bidirectional reflectance of the surface is fully described in [16]. It is composed of three main elements: a five-joint Dexter robotic arm from Haddington Dynamics [5], a Spectral Filter Array (SFA) multispectral snapshot camera Silios CMS-C [6], and a tilted stage made in-house.

The robotic arm is used to move the illumination at a range of angles from the normal of the surface. The angles of illumination range from $\theta_i = -57.5^\circ$ to $\theta_i = 12.5^\circ$, with a sampling of $3^\circ$, $2^\circ$, $1^\circ$, and $0.5^\circ$, and a total of 63 angles.

![Figure 1: Side view schematic of the system. The camera is looking down on the surface which is on a tilted stage with an elevation of 22.5°. The light is attached to the robotic arm (not illustrated here) and it moves in a 70° arch on the y-z plane.](image)

HDR acquisition pipeline
Due to the specularity of the samples, an HDR acquisition pipeline is developed. For each angle of illumination, ten images are taken at exposure times 16 ms, 32 ms, 64 ms, 125 ms, 250 ms, and 499 ms.

For each acquisition, a dark-current set of images is obtained at the same exposure times. The non-uniformity of the light source is also corrected for by performing a flat-field correction. This is done by acquiring a set of images of a uniform white reference target [9].

A-10

©2023 Society for Imaging Science and Technology
**Data processing pipeline**

The data captured by the system is processed to obtain an HDR BRDF of the sample at the chosen viewing angle. The HDR multispectral image is created following the method proposed by Brauers et al [10].

For each HDR image, an area of pixels is averaged and spectral reconstruction is performed using the pseudo-inverse method.

**BRDF modelling and evaluation**

In this paper a simplified isotropic Cook-Torrance BRDF model is used:

\[
I_p = \begin{bmatrix} I_{p_x} \\ I_{p_y} \\ I_{p_z} \end{bmatrix} = I_0 R_d + I_i \cos \theta_i \begin{bmatrix} R_{dx} \\ R_{dy} \\ R_{dz} \end{bmatrix},
\]

where \( I_p \) is the CIE tristimulus value at point P with incident angle \( \theta_i \) and at fixed reflection angle \( \theta_r = -22.5^\circ \). \( I_0 R_d \) is the ambient light term which is assumed to be zero as the experiment is performed in a dark environment. \( I_i \) is the incident light intensity, \( R_d \) are the spectral diffuse reflectance components. The specular components, \( R_s \), are given by the Cook-Torrance GGX specular term:

\[
R_s = \frac{1}{\pi} \text{FDG} \frac{(n.l)(n.v)}{(n.l)(n.v)},
\]

The BRDF models are evaluated by calculating the contrast and distinctness-of-image gloss. In 1937, Hunter [18] suggested six dimensions of gloss, where two of them are perceptual dimensions, distinctness-of-image (DOI) gloss and contrast gloss [19, 20]. These perceptual metrics have been calculated following the formulas defined by Ferwerda et al. [21].

**Fabrication of gilding samples**

The gilding samples studied in this paper are: water and oil gilding, and “imitation” gilding.

Oil gilding and water gilding are two of the most common types of gilding since the Middle Ages and its fabrication method has not changed much to this day [22]. The third form of gilding is not actually made with gold, but consists of a burnished silver leaf covered with a yellow pine resin which gives the surface a particular appearance which imitates that of gold.

In the case of the water and oil gilded samples, they have been varnished using a mixture of colophony and dammar in equal proportions. The varnish has been removed using four different chemical methods: solubilisation using a cotton swab, by applying a compress, using an aqueous gel, and a silicon-based gel.

For more details on the fabrication of the samples please refer to [15, 17].

**Results and discussion**

**Appearance characterisation of gilded surfaces**

The first example is taken from [17]. Here, the three types of gilding (varnished and non-varnished) are compared and their appearance is characterised in terms of perceptual gloss metrics.

The five samples have different values of contrast gloss and DOI gloss (Fig. 3). As previously explained, contrast and DOI gloss are two perceptual dimensions of gloss. The three types of gilding can be grouped independently. Oil gilding has low contrast and DOI gloss, whereas water gilding has low contrast gloss and high DOI gloss. The “imitation” gilding sample has low DOI and high contrast gloss. The varnished, oil and water gilding samples have a similar value of DOI gloss, and contrast gloss higher than the non-varnished samples.

The varying gloss metrics serve to explain the light-matter interactions at the surface interface. The water and oil gilded samples have a metallic nature, which has an appearance completely different to those of the “imitation” gilding, and the varnished samples, which present a glossy appearance.
Finally, the BRDF models can be used to render the appearance of the samples. At a fixed angle of viewing, and changing the angle of illumination, the BRDF is converted to CIE 1931 XYZ colour coordinates and rendered in the Adobe RGB space. This gives conservators a visual guide on what to expect from each varnish removal method.

Conclusion

In this paper, an imaging-based method to obtain the bidirectional reflectance of gilded samples has been prevented. By modelling the BRDF of the samples perceptual gloss metrics were calculated. By using these gloss metrics, the appearance of the materials can be characterised and used to guide conservation methods. This paper has shown that appearance evaluations can be very useful in the field of conservation.

Some future perspectives are to use this appearance models to render real digital models of gilded objects. In order to achieve this, it is necessary to perform psychophysical experiments to validate that the models are perceptually accurate.

Acknowledgements

This research was funded with the support of CHANGE Cultural Heritage Analysis for New Generations European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 813789.

References

[22] , S. Courtier and M. Dubost, "L’or et la mani`ere : les techniques de la dorure sur bois `a travers le temps", Core, 1, (2021).

Author Biography

Yoko Arteaga is a Marie Skłodowska-Curie early stage research fellow at the Centre of Research and Restoration of the Museums of France and part of the Colourlab at the Norwegian University of Science and Technology. For her PhD she is working in the development of techniques to acquire and model material appearance for cultural heritage objects.

Clotilde Boust is the head of the Imaging Group at the Centre for Research and Restoration of the Museums of France (C2RMF). She is developing spectral, 3D, and XR imaging in order to measure and understand artworks before restoration.

Jon Y. Hardeberg is Professor of Colour Imaging at NTNU. Department of Computer Science, The Norwegian Colour and Visual Computing Laboratory, Gjøvik, Norway. His current research interests include spectral imaging, image quality, colour management, material appearance, cultural heritage imaging, and medical imaging, and he has co-authored more than 300 publications within the field. He has led several research projects funded by the Research Council of Norway, been NTNU’s representative in two Erasmus Mundus Joint Master Degrees (CIMET and COSI), and the coordinator of three Marie Skłodowska Curie ITN projects (CP7.0, ApPEARS, CHANGE).
Spectral- and image-based documentation metrics for the evaluation of conservation cleaning treatments

Abstract

Despite advances in treatment techniques, most conservation cleaning trials on unvarnished oil paint surfaces are based on Edvard Munch’s (1863–1944) monumental paintings Edvard Munch (1914–1916, situated at the University of Oslo Aula (1911). This painting for research purposes is chosen for its heavy soiling history. The research is discussed in a forthcoming book of the CHFITN and Munch Aula Paintings (MAP) projects. The painting is based on Edvard Munch’s (1863–1944) monumental painting Edvard Munch (1914–1916, situated at the University of Oslo Aula (1911). This painting for research purposes is chosen for its heavy soiling history.

Motivation

A main motivation for the research presented in this paper is to incorporate a high degree of homogeneity metrics in practice, showcasing that, for example, novel agar spray cleaning options can be adapted for use within the conservation discipline. A-13

Approach

The A-13 research efforts have already been addressed in a forthcoming book of the CHFITN and Munch Aula Paintings (MAP) projects. Specifically, novel agar spray cleaning trials on unvarnished oil paint mock ups are based on Edvard Munch’s (1863–1944) monumental paintings Edvard Munch (1914–1916, situated at the University of Oslo Aula (1911). This painting for research purposes is chosen for its heavy soiling history.

Image-based

Image-based effi

Figure 1: Breakdown of cleaning efficacy metrics developed based on the knowledge gap driving more reliable and reproducible appraisals of cleaning studies when compared to previous works.

Context

The presented image-based metrics are easily calculated within freeware such as FIJI (ImageJ) and accessible spreadsheet packages. By exposing ground mock ups, the metrics are designed to offer a robust, rigorous, and comparable evaluation framework for documenting change as a result of surface cleaning treatment.

Cleaning efficacy metrics

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Image-based</th>
<th>Appearance-based</th>
<th>Spectral-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIELAB-derived</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>keV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>µFTIR-FTIR-derived</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorimetry from FIJI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>µFTIR-FTIR-derived</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM/EDX-derived</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Images</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maps</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

©2023 Society for Imaging Science and Technology
Methods and results

cleaning efficacy metrics

Cleaning efficacy was calculated using the following equation:

\[
\text{Cleaning efficacy } = \frac{X_{AT} - X_{NT}}{X_{AT}} \times 100
\]

where

- \(X_{AT}\) is the visual measurement of the painted surface before treatment
- \(X_{NT}\) is the visual measurement of the painted surface after treatment

For the purpose of empirically evaluating the degree of cleaning success, return to an unsoiled control’s surface property as a relative marker.

Conclusions

The metrics’ relevance are appreciable for their potential in the evaluation of efficacy of cleaning methods and offer a toolkit of standardisable, reproducible methods, which are facile to execute, promoting the empirically adjusted weighting of various criteria.

Figure 2

Figure 3
References


Munch’s Aula paintings

Munch’s monumental Aula paintings. Pages 117–125.


Author Biographies

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings

Munch’s Aula paintings
<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abu Haifa, Tarek</td>
<td>131</td>
</tr>
<tr>
<td>Amiri, Morteza Maali</td>
<td>188</td>
</tr>
<tr>
<td>Anderson, Nathan Ian</td>
<td>172</td>
</tr>
<tr>
<td>Anderson, Ottar A.B.</td>
<td>82</td>
</tr>
<tr>
<td>Andrews, Judith</td>
<td>89</td>
</tr>
<tr>
<td>Arnold, Etta</td>
<td>188</td>
</tr>
<tr>
<td>Artega, Yoko</td>
<td>A-10</td>
</tr>
<tr>
<td>Ayala González, Hilda Teresa</td>
<td>62</td>
</tr>
<tr>
<td>Bein, Florian</td>
<td>53</td>
</tr>
<tr>
<td>Beckerle, Hana</td>
<td>66</td>
</tr>
<tr>
<td>Bennett, Michael J.</td>
<td>165</td>
</tr>
<tr>
<td>Bern, Roy S.</td>
<td>57</td>
</tr>
<tr>
<td>Blanc, Rosario</td>
<td>198</td>
</tr>
<tr>
<td>Boust, Clotilde</td>
<td>A-10</td>
</tr>
<tr>
<td>Brambilla, Laura</td>
<td>42</td>
</tr>
<tr>
<td>Brogle, Gabrielle</td>
<td>94</td>
</tr>
<tr>
<td>Bryde, Bendik</td>
<td>A-5</td>
</tr>
<tr>
<td>Busch, Eryk</td>
<td>149</td>
</tr>
<tr>
<td>Caruso, Francesco</td>
<td>A-13</td>
</tr>
<tr>
<td>Chatoux, Hermine</td>
<td>75</td>
</tr>
<tr>
<td>Chiquet, Vera</td>
<td>105, 109</td>
</tr>
<tr>
<td>Constum, Thomas</td>
<td>53</td>
</tr>
<tr>
<td>Cutajar, Jan Dariusz</td>
<td>A-13</td>
</tr>
<tr>
<td>Czech, Maximilian</td>
<td>126</td>
</tr>
<tr>
<td>Davis, Andrew</td>
<td>159</td>
</tr>
<tr>
<td>De luca, Iuliu</td>
<td>133</td>
</tr>
<tr>
<td>Deborah, Hilda</td>
<td>204, see JIST 67(3)</td>
</tr>
<tr>
<td>Decker, Juelle</td>
<td>188</td>
</tr>
<tr>
<td>Degniny, Christian</td>
<td>42</td>
</tr>
<tr>
<td>Easton, Roger</td>
<td>188</td>
</tr>
<tr>
<td>Elgvin, Torilf</td>
<td>155</td>
</tr>
<tr>
<td>Erdmann, Robert G.</td>
<td>121</td>
</tr>
<tr>
<td>Falatico, James</td>
<td>188</td>
</tr>
<tr>
<td>Farnand, Susan P.</td>
<td>48, 94</td>
</tr>
<tr>
<td>Fellner, Dieter</td>
<td>131</td>
</tr>
<tr>
<td>Felang, Ulrike</td>
<td>109</td>
</tr>
<tr>
<td>Färh, Atke</td>
<td>71</td>
</tr>
<tr>
<td>Formaro, Peter</td>
<td>23, 109</td>
</tr>
<tr>
<td>France, Fenella G.</td>
<td>159</td>
</tr>
<tr>
<td>Frøysaker, Tine</td>
<td>vi, A-13</td>
</tr>
<tr>
<td>George, Sony</td>
<td>7, 12, 18, 143, 155, 192, see JIST 67(3)</td>
</tr>
<tr>
<td>Gigalashvili, Davit</td>
<td>139</td>
</tr>
<tr>
<td>Gonçalves, Luiza</td>
<td>101</td>
</tr>
<tr>
<td>Gonzalez, Roberto</td>
<td>A-5</td>
</tr>
<tr>
<td>Grillini, Federico</td>
<td>192</td>
</tr>
<tr>
<td>Gulbrandsen, Casper Fabian</td>
<td>139</td>
</tr>
<tr>
<td>Gustafsson, Carolina</td>
<td>86</td>
</tr>
<tr>
<td>Hardeberg, Jon Yngve</td>
<td>12, 18, 75, 139, A-10, A-13</td>
</tr>
<tr>
<td>Havgar, Margrethe</td>
<td>139</td>
</tr>
<tr>
<td>Hernández Mejías, Natalia</td>
<td>62</td>
</tr>
<tr>
<td>Hernández-Andrés, Javier</td>
<td>198</td>
</tr>
<tr>
<td>Humenuck, Leah</td>
<td>48</td>
</tr>
<tr>
<td>Jääskeläinen, Anssi</td>
<td>112</td>
</tr>
<tr>
<td>Jam, Sari</td>
<td>182</td>
</tr>
<tr>
<td>Johnson, Heather Lynn</td>
<td>1</td>
</tr>
<tr>
<td>Joseph, Edith</td>
<td>143, A-13</td>
</tr>
<tr>
<td>Khawaja, Muhammed Arsalan</td>
<td>12</td>
</tr>
<tr>
<td>Kostomitsopoulou Marketou, Ariadne</td>
<td>204</td>
</tr>
<tr>
<td>Kujawinska, Malgorzata</td>
<td>7</td>
</tr>
<tr>
<td>Larriera, Lucas</td>
<td>101</td>
</tr>
<tr>
<td>Le Goic, Gaétan</td>
<td>42, 75</td>
</tr>
<tr>
<td>Lipsanen, Mikko</td>
<td>71</td>
</tr>
<tr>
<td>Lombardo, Tiziana</td>
<td>143</td>
</tr>
<tr>
<td>López-Baldomero, Ana B.</td>
<td>198</td>
</tr>
<tr>
<td>López-Montes, Ana</td>
<td>198</td>
</tr>
<tr>
<td>Lum, Vincent Wai-Yip</td>
<td>29</td>
</tr>
<tr>
<td>Lush, Binky</td>
<td>A-7</td>
</tr>
<tr>
<td>Luxman, Ramamoorthy</td>
<td>75</td>
</tr>
<tr>
<td>Mandal, Dipendra Jee</td>
<td>67(3)</td>
</tr>
<tr>
<td>Mansour, Alamin</td>
<td>12, 42, 75</td>
</tr>
<tr>
<td>Manz, Marian Clemens</td>
<td>23</td>
</tr>
<tr>
<td>Marrocches, Alessandra</td>
<td>121</td>
</tr>
<tr>
<td>Martínez-Domingo, Miguel A.</td>
<td>198</td>
</tr>
<tr>
<td>Marzani, Franck</td>
<td>12, 75</td>
</tr>
<tr>
<td>Messinger, David</td>
<td>188</td>
</tr>
<tr>
<td>Muzota, Sharon</td>
<td>A-7</td>
</tr>
<tr>
<td>Mayer, Izzy</td>
<td>188</td>
</tr>
<tr>
<td>Nault, Jeanine</td>
<td>172</td>
</tr>
<tr>
<td>Nguyen, Ha Thu</td>
<td>139</td>
</tr>
<tr>
<td>Nunn, Marvin</td>
<td>42, 143</td>
</tr>
<tr>
<td>Olsen, Karin</td>
<td>112</td>
</tr>
<tr>
<td>Papakolakou, Athanasia</td>
<td>7</td>
</tr>
<tr>
<td>Paquet, Thierry</td>
<td>53</td>
</tr>
<tr>
<td>Paulus, Deepa</td>
<td>1</td>
</tr>
<tr>
<td>Pedersen, Marius</td>
<td>see JIST 67(3)</td>
</tr>
<tr>
<td>Pozeilov, Yosi</td>
<td>116</td>
</tr>
<tr>
<td>Raemy, Julien Antoine</td>
<td>23</td>
</tr>
<tr>
<td>Raisanen, Tuomo</td>
<td>71</td>
</tr>
<tr>
<td>Ramirez, Victor</td>
<td>62</td>
</tr>
<tr>
<td>Ritz, Martin</td>
<td>131</td>
</tr>
<tr>
<td>Rothenhauser, Ulrike</td>
<td>143</td>
</tr>
<tr>
<td>Sack, Harald</td>
<td>36</td>
</tr>
<tr>
<td>Saha, Sunita</td>
<td>42</td>
</tr>
<tr>
<td>Satt, Evdokia</td>
<td>A-1</td>
</tr>
<tr>
<td>Santos, Pedro</td>
<td>131</td>
</tr>
<tr>
<td>Schmidt-Ott, Katharina</td>
<td>143</td>
</tr>
<tr>
<td>Schneider, Felix</td>
<td>131</td>
</tr>
<tr>
<td>Schultz, Kyra</td>
<td>188</td>
</tr>
<tr>
<td>Sharma, Deepshikha</td>
<td>143</td>
</tr>
<tr>
<td>Siatou, Amalia</td>
<td>42</td>
</tr>
<tr>
<td>Sitnik, Robert</td>
<td>42</td>
</tr>
<tr>
<td>Škrabáneček, Pavel</td>
<td>155</td>
</tr>
<tr>
<td>Sole, Aditya Suneel</td>
<td>7, 18</td>
</tr>
<tr>
<td>Steindal, Calin Constantin</td>
<td>A-13</td>
</tr>
<tr>
<td>Storeide, Markus Sebastian Bakken</td>
<td>18</td>
</tr>
<tr>
<td>Studnicki, Jim</td>
<td>177</td>
</tr>
<tr>
<td>Stilitz, Matija</td>
<td>ix</td>
</tr>
<tr>
<td>Syed, Ali Raza</td>
<td>126</td>
</tr>
<tr>
<td>Tauss, Reimar</td>
<td>131</td>
</tr>
<tr>
<td>Theoharis, Theoharis</td>
<td>A-1</td>
</tr>
<tr>
<td>Thomas, Jean-Baptist</td>
<td>192</td>
</tr>
<tr>
<td>Tobing, Tabita Lumban</td>
<td>155</td>
</tr>
<tr>
<td>Tranueze, Pierick</td>
<td>53</td>
</tr>
<tr>
<td>Trumpy, Giorgio</td>
<td>7, 126</td>
</tr>
<tr>
<td>Uueni, Andres</td>
<td>112</td>
</tr>
<tr>
<td>Vafaie, Mahsa</td>
<td>36</td>
</tr>
<tr>
<td>Valero, Eva M.</td>
<td>198</td>
</tr>
<tr>
<td>Vedeler, Marianne</td>
<td>139</td>
</tr>
<tr>
<td>Vilchez-Quero, J. L.</td>
<td>198</td>
</tr>
<tr>
<td>Villanueva, Luis J.</td>
<td>172</td>
</tr>
<tr>
<td>Walkenhorst, Jörg</td>
<td>36</td>
</tr>
<tr>
<td>Westman, Stina</td>
<td>182</td>
</tr>
<tr>
<td>Wyble, David R.</td>
<td>57</td>
</tr>
<tr>
<td>Yang, Yuchen</td>
<td>97</td>
</tr>
<tr>
<td>Yayilgan, Sule Yildirim</td>
<td>155</td>
</tr>
<tr>
<td>Yip, Michael Kin-Fu</td>
<td>29</td>
</tr>
</tbody>
</table>