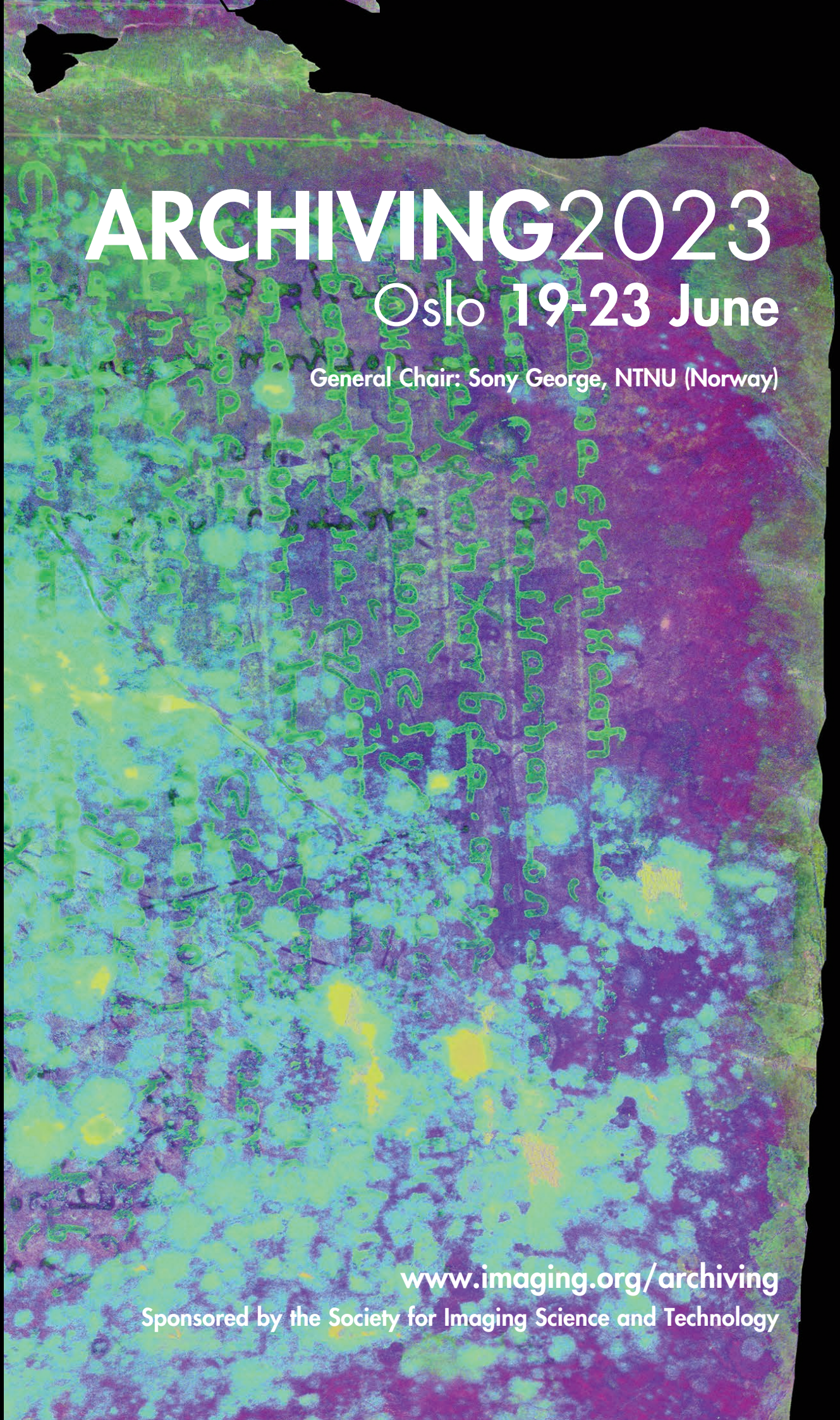
FINAL PROGRAM AND PROCEEDINGS



ARCHIVING2023

Oslo 19-23 June

General Chair: Sony George, NTNU (Norway)

www.imaging.org/archiving

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REVEALING HISTORIES

DIGITAL TRANSITIONS
HERITAGE | PHOTO | PIXEL ACUITY

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GMS

HIP

PHASE ONE
IMAGING BEYOND IMAGINATION

piql

ZEUTSCHEL
Cultural Heritage is our Passion

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 hertitage 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

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Historical Museum

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CHANGE
CULTURAL HERITAGE ANALYSIS FOR NEW GENERATIONS

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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 Metamorfoze 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 Plutino, Universita degli Studi di Milano, and Giorgio 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

RECEPTION SPONSOR

Historical Museum

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)* **1**
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.

10:20 **Multimodal Measurement of Parchment Using a Custom 3D Scanner,** *Athanasia Papanikolaou[1], Sony George[2], Suneel Aditya Sole[2], Giorgio Trumpy[2], and Malgorzata Kujawinska[1]; [1]Warsaw University of Technology (Poland) and [2]Norwegian University of Science and Technology (Norway)* **7***

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 subjected to changes in relative humidity.

10:40 **Can Surface Topography Give Us Best Light Positions for Reflectance Transformation Imaging?,** *Muhammad Arsalan Khawaja[1,2], Sony George[2], Franck Marzani[1], Jon Yngve Hardeberg[2], and Alamin Mansouri[1]; [1]Université de Bourgogne (France) and [2]Norwegian University of Science and Technology (Norway)* **12**

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.

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 Yngve 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 Theoharis, Norwegian University of Science and Technology (Norway)* **A-1***

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 multi-temporal 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.

EXHIBITOR PREVIEWS

12:30 – 12:50

Archiving 2023 exhibitors Arkhênum, Digital Transitions, fokus GmbH Leipzig, GMS Digitaliseert, HIP, PhaseOne, PIQL, Zeutschel share information about their products/services in short previews.

12:50 – 14:00

LUNCH BREAK ON OWN

EXTRACTING INFORMATION

Session Chair: Laura Margaret Ramsey, The Image Centre, Toronto (Canada)

14:00 – 15:00

14:00 **Data Extraction, Visualization, and Storytelling: A Case Study in Headline Analysis on "The Hongkong News" with Deep Learning,** *Michael Kin-Fu and Vincent Wai-Yip Lum, The Chinese University of Hong Kong (Hong Kong)* **29**

This paper presents the methodologies to extract the headline and illustrations from a historical newspaper for storytelling to support digital scholarship. It explored the ways in which new digital tools can facilitate the understanding of the newspaper content in the setting of time and space, "The Hongkong News" was selected from Hong Kong Early Tabloid Newspaper for the case study owing to its uniqueness in historical value towards the scholars. The proposed methodologies were evaluated in OCR (Optical Character Recognition) with scraping and Deep Learning Object Detection models. Two visualization products were developed to showcase the feasibility of our proposed methods to serve the storytelling purpose.

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.

14:20 **Improvements in Handwritten and Printed Text Separation in Historical Archival Documents,** Mahsa Vafaie, Jörg Waitelonis, and Harald Sack, FIZ Karlsruhe and Karlsruhe Institute of Technology (Germany) **36**

The presence of handwritten text and annotations combined with typewritten 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.

14:40 **Reflectance Transformation Imaging (RTI) Data Analysis for Change Detection: Application to Monitoring Protective Coating Failure on Low Carbon Steel,** *Amalia Siatou[1,2], Marvin Nurit[2,3], Sunita Saha[4], Gaëtan Le Goïc[2], Laura Brambilla[1], Christian Degrigny[1], Robert Sitnik[4], and Alamin Mansouri[2]; [1]HES-SO University of Applied Sciences and Arts Western Switzerland (Switzerland), [2]Université de Bourgogne Franche-Comté (France), [3]South Brittany University (France), and [4]Warsaw University of Technology (Poland)* **42***

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 – 15:30

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. Farnand, Rochester Institute of Technology (US)* **48**

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)* **53**

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)* **57**

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[1], Hilda Ayala Gonzalez[2], and Victor Ramirez[1]; [1]General Archives of Puerto Rico and [2]National Library of Puerto Rico (Puerto Rico)* **62**

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

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.

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.

17:20 **Third Edition of the FADGI Technical Guidelines for Digitizing Cultural Heritage Materials,** *Hana Beckerle, Library of Congress (US)* **66**
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 Auala 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-ITN 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

AI Powered Tools for Improving Usability in Digital Archiving,
Tuomo Räisänen, South-Eastern Finland University of Applied Sciences, and Mikko Lipsanen 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 Luxman[1], Hermine Chatoux[1], Gaëtan Le Goïc[1], Jon Yngve Hardeberg[2], Franck Marzani[1], and Alamin Mansouri[1]; [1]Université de Bourgogne (France) and [2]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 Norwegian Approach—Automated Quality Control of Digitization on National Level in the Digital Archives. A Practical Approach, *Ottar Anderson, Intermunicipal Archive of Møre og Romsdal (Norway)* . . . **82**
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 Digitzation 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.

eArchiving for Engineering, *Bendik Bryde, Piql AS (Norway), and Roberto Gonzales, Piql AS (Spain)* **A-5**
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

Session Chair: Amy McCrory, The Ohio State University (US)
11:05 – 12:45

11:05 **Against Digital Obsolescence: The Challenges of Preserving Cultural Heritage in the "Ningunismo" Archive,** *Luiza Gonçalves, Argentine Network of Audiovisual Preservationists, and Lucas Larriera, Universidad del Cine (Argentina)* **101**
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 disused 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)* **A-7**
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 Chiquet[1], Ulrike Felsing[2,3], and Peter Fornaro[1]; [1]University of Basel, [2]Bern Academy of the Arts at Bern University of Applied Sciences, and [3]The 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 cumbersome 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 (SSFS, 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?,** *Anssi Jääskeläinen[1], Karin Oolu[2,3], and Andres Uueni[3]; [1]South-Eastern Finland University of Applied Sciences (Finland), [2]Tallinn University (Estonia), and [3]Estonian Academy of Arts (Estonia)* . . **112**
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,** *Yosi Pozeilov, Los Angeles County Museum of Art (US)* **116**
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)* **121***
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 possibly 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 Trumpy, and Ali Raza Syed, Norwegian University of Science and Technology (Norway)* . . **126**
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 Haila[1,2], Felix Schneider[2], Reimar Tausch[1], Martin Ritz[1], Pedro Santos[1], and Dieter Fellner[1,2,3]; [1]Fraunhofer Institute for Computer Graphics Research IGD (Germany), [2]Darmstadt University of Technology (Germany), and [3]Graz University of Technology (Austria)* **131**
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.

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.

THURSDAY 22 JUNE 2023

CLOSING KEYNOTE

9:00 – 10:00

Session Chair: Robert Kastler, MOMA (US)

From Smells of Collections to Collections of Smells, *Matija Strlic, 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 olfactorily, 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.

TWO-MINUTE INTERACTIVE PAPER PREVIEWS II

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

10:00 – 10:15

Texture-based Clustering of Archaeological Textile Images, *Davit Gigilashvili[1], Ha Thu Nguyen[1], Casper Fabian Gulbrandsen[1], Margrethe Havgar[2], Marianne Vedeler[2], and Jon Yngve Hardeberg[1]; [1]Norwegian University of Science and Technology and [2]University 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 complicate 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 Sharma[1,2], Marvin Nurit [2,3,4], Ulrike Rothenhäusler[1], Katharina Schmidt-Ott[1], Edith Joseph[5,6], Sony George[7], and Tiziana Lombardo[1]; [1]Swiss National Museum (Switzerland), [2]Altimet (France), [3]Université de Bourgogne Franche-Comté (France), [4]South Brittany University (France), [5]HES-SO University of Applied Sciences and Arts Western Switzerland (Switzerland), [6]University of Neuchâtel (Switzerland), and [7]Norwegian 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 Arteaga[1,2], Clotilde Boust[1,3], and Jon Yngve Hardeberg[2]; [1]Centre of Research and Restoration of the Museums of France (France), [2]Norwegian University of Science and Technology (Norway), and [3]PSL-PCMTH 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 Wilanów (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 Tobing[1], Pavel Škrabánek[2], Sule Y. Yayilgan[1], Sony George[1], and Torleif Elgvin[3]; [1]Norwegian University of Science and Technology (Norway), [2]Brno University of Technology (Czech Republic), and [3]NLA University College (Norway)* **155**

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.

HIGHLIGHTING CHANGE

10:15 – 11:00

10:15 **Multiscale and multimodal strategies and systems for change capture and tracking of CH assets,** *Alamin Mansouri, Université de Bourgogne Franche-Comté (France)*

10:30 **Computational methods for change studying (characterization, visualisation, and monitoring) of CH assets,** *Robert Sitnik, Warsaw University of Technology (Poland)*

10:45 **Application: Change during the alteration and conservation of CH artefacts,** *Clotilde Boust, Centre for Research and Restoration of the Museums of France (France)*

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

Session Chair: Carolina Gustafsson, Stiftelsen Föremålsvård i Kiruna (Sweden)

12:15 – 12:55

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)

14:00 – 15:00

14:00 **Gimme Three Steps: A Mass Digitization Method at the Smithsonian,** *Nathan Anderson, Jeanine Nault, and Luis Villanueva, Smithsonian Institution (US)* **172**

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 re-invention of the wheel and even to library and archival personnel deciding to not use FADGI

at all. This puts inexperienced users at a decided disadvantage and creates a formidable barrier to entry for new practitioners who want to use the FADGI guidelines on their projects. As discussed in this paper, a DIO (or Digitization Information Object) is a data model encompassing all technical parameters of a still image digitization project. At its core, the DIO schema is intrinsically tied to FADGI, and enforces FADGI compliance through its use. It provides a common, machine-readable instruction set for digitization-facing software programs. This allows consuming applications to be quickly and precisely configured per-project to specify output image parameters, configure post-processing workflows, verify both working files and huge batches of completed content at scale, and even to provide plain-English text for a project's Statement of Work—all from the same DIO JSON file.

14:40 **Current and Anticipated Digitization Competencies,** *Sari Järn and Stina 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 archive materials. The competencies required in digitization pose challenges to individuals and organizations engaging in digitization activities. We take a competency mapping approach to support digitization skills anticipation. Current and anticipated digitization competencies in public and private organizations 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 practical organization and technical delivery of digitization. There is anticipated 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 development and planning of future digitization efforts.

MULTISPECTRAL APPROACHES

15:00 – 17:35

Session Chair: Yosi Pozeilov, Los Angeles County Museum of Art (US)

15:00 **Build, Select, Reshuffle: Uncovering Distinct Features of Cultural Heritage Objects with Multispectral Imaging,** *James Falotico, Kyra Schultz, Etta Arnold, Izzy Moyer, Morteza Maali 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 present 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 positioned multispectral imaging as a critical method 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 software to capture and visualize the spectral data offers a basis for demonstrating the possibilities for low-cost, low barrier-to-entry software on cultural heritage imaging, research, preservation, and dissemination.

15:20 **Full VNIR-SWIR Hyperspectral Imaging Workflow for the Monitoring of Archaeological Textiles,** *Federico Grillini[1], Jean-Baptiste Thomas[1,2], and Sony George[1]; [1]Norwegian University of Science and Technology (Norway) and [2]University 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 displays an example in which an inappropriate selection of the processing steps can lead to a misinterpretation of the hyperspectral data.

15:40 – 16:10

AFTERNOON BREAK

Join other attendees in the courtyard for a final beverage.

16:10 **Spectral- and Image-based Documentation Metrics for the Evaluation of Conservation Cleaning Treatments,** *Jan Dariusz Cutajar[1], Calin Constantin Steindal[2], Edith Joseph[3], Francesco Caruso[4], Jon Yngve Hardeberg[5], and Tine Frøysaker[1]; [1]University of Oslo (Norway), [2]Cultural History Museum (Norway), [3]Haute École Arc Conservation-Restoration (Switzerland), [4]University of the Basque Country (Spain), and [5]Norwegian University of Science and Technology (Norway)* **A-13**

The contribution discusses a range of evaluation methods, based on (spectral) imaging techniques, for providing more reliable and reproducible appraisals of cleaning studies when compared to the subjective user-dependant scores that are currently used in the conservation profession. Specifically, novel agar spray cleaning tests on exposed ground and unvarnished oil paint mock-ups are reported as a case study to demonstrate cleaning efficacy and homogeneity metrics in practice, showcasing novel options that could be adapted for use within the conservation community.

16:30 **Endmember Extraction for Pigment Identification Pre- and Post-intervention: A Case Study from a XVIth Century Copper Plate Painting,** *Ana B. López-Baldomero, Miguel A. Martínez-Domingo, Javier Hernández-Andrés, Rosario Blanc, J. L. Vilchez-Quero, Ana López-Montes, and Eva M. Valero, University of Granada (Spain)* **198**

Three endmember extraction methods (NFINDR, NMF and manual extraction) are compared in two stages (pre- and post- intervention) of the same painting, a Maternity on copper plate, under study for the formulation of a hypothesis on the authorship and the dating. The endmembers are extracted from spectral images in the 400-1000 nm range. The main aim is to determine if simple automatic endmember extraction is enough for pigment and re-painted areas identification in this case study.

16:50 **Spectral Imaging of Ink Behind Glass: A Preliminary Investigation of the Colorimetric Shift,** *Hilda Deborah, Norwegian University of Science and Technology, and Ariadne Kostomitsopoulou Marketou, MF Norwegian School of Theology, Religion, and Society (Norway)* **204**

Transparent glass frames are often used to exhibit, handle, and store ancient manuscripts (folia or fragments) across museums, libraries, and collections. Once the manuscripts are carefully sealed (glazed), the

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 Jee Mandal, Marius Pedersen, Sony George, and Hilda Deborah, Norwegian University of Science and Technology (Norway), and Clotilde Boust, 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

Held at The National Museum

9:00 – 9:20
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, Université de Bourgogne Franche-Comté (France)*

Appearance change assessment: Link between local geometry and global appearance descriptors, *David Lewis, Université 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. Berns, 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

13:00 – 14:00
GROUP LUNCH

* Talk associated with the EU Cultural Heritage Analysis for New Generations (CHANGE) project.

ARCHIVING 2023 APPENDIX A
EXTENDED **ABSTRACTS**

NOTES

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

Evdokia Saiti[1], Theoharis Theoharis[1]
[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

Cultural Heritage (CH) is an integral part of human history, inherited from the past and should be maintained for future generations. However, CH resources are constantly exposed to threats arising from natural or human actions, resulting in alterations to their physical properties or appearance. Recent advancements in imaging techniques and image processing have become a buoy for capturing and tracking changes in CH objects. [1].

An accurate, high-resolution digital model can reveal details and features of the object that might not be visible to the naked eye. Moreover, high-accuracy digital acquisitions, performed at regular intervals, could detect very small deformations and cracks before serious damage [2]. This can enable more efficient analysis and opportune interventions to prevent further deterioration and preserve the asset for the future [3].

The data obtained from various acquisitions can be geometrically and chronologically incoherent. To enable the analysis and comparison of these differential acquisitions, they need to be registered into a common reference frame. Most commonly, methods that monitor the geometric change of an object over time, try to compare the 3D model of the same object captured at different time intervals. Geometry acquired from 3D surface scanners is a core element of a digital model but is limited to measure only the surface of the object. However, the penetrative capabilities of CT scanning modalities allow the digitization of the interior of an object without having to perform physically invasive actions [8]. By combining the geometry and inner structure of the 3D models, changes in the surface and the internal can be tracked and recorded.

This work is motivated to facilitate the CH object monitoring of both the external and internal structure by proposing a multimodal cross-time registration pipeline. We are inspired by the research of two European projects, the PRESIOUS [4,5,6] and ITN-CHANGE [7], and we propose a digital monitoring pipeline, consisting of proven, robust methods for automatic 3D registration of differential and multimodal data. The research presented is carried out in the framework of ITN-CHANGE (Horizon 2020, GA 813789) project which aims to develop new methodologies to assess and monitor the changes the CH objects face. The proposed pipeline combines the methods of [9] and [10], extending their application to enable the non-invasive monitoring and analysis of CH objects.

2. Problem statement

Exposure to atmospheric factors can affect the materials and physical properties of an object, resulting to minor changes in its geometry and inner structure. Detecting such minute alterations in an object's surface by the human eye is not feasible. Additionally, conservators have limited access to an object's internal structure without resorting to invasive techniques. This work aims to facilitate the change detection over time in the surface and the core of CH objects by combining the advantages of cross-time and multimodal registration.

Both cross-time and multimodal registration are special cases of 3D registration. In general, 3D registration is a crucial tool in visual computing having widely applied in the text of CH. Registration aims to find the transformation that optimally aligns two or more datasets into a common reference frame. In cross-time registration, the data are instances of the same object acquired at different times, and in multimodal registration, the data to be aligned are of different modalities.

The registration of 3D models across time presents several challenges. Registering the surface of models that have undergone alterations can be difficult. Traditional registration methods, like ICP [11], try to bring the scans as close as possible, weighting more the areas with dense sampling. However, a change due to erosion or degradation is more likely to affect the surface of an object evenly, resulting in surface recession. Additionally, 3D Volume registration methods can be sensitive to pixel intensity variations, meaning that noise, differences in illumination, or use of different sensors can cause inaccuracies. When objects have undergone weathering

changes, their material, pore structure and volume might be affected, which can prevent an accurate alignment of the two volumes.

The pipeline tries to address these challenges by first aligning the 3D surface scans taken before and after the modification event, using a method specifically designed for cross-time alignment problems. Once the 3D surface scans are temporally aligned, the pipeline proceeds to fuse each one of the surfaces with their respective 3D volume. The result is a holistic representation of both the before and after timestamps of the object, making it easier for an expert or an automatic change detection method to highlight the changes that have occurred.

3. Approach

Figure 1 illustrates the presented pipeline, which consists of two parts, the cross-time and multimodal registration. The pipeline takes as an input two sets of the 3D model and 3D Volume of a CH object acquired at different time intervals. Between these time intervals, the surface and the interior may have altered due to environmental or human actions. The first part adapts the CrossTimeReg framework of [9] for aligning 3D point clouds across time. The resulting aligned 3D models along with their respective 3D Volumes, are subsequently forwarded to the next step. This step consists of two parallel multimodal registration frameworks presented in [10]. This stage is responsible to align and fuse each pair of the 3D model and 3D Volume.

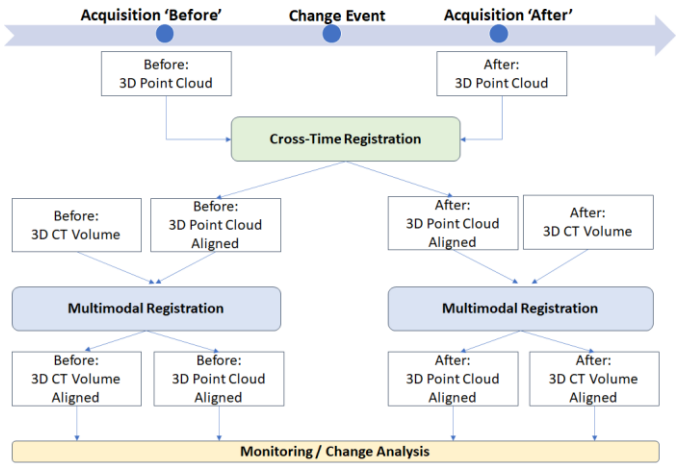

Figure 1: The presented pipeline for digital monitoring of external and internal structure of CH objects

Cross-Time Registration Stage

The first stage adopts the CrossTimeReg method [9], especially created for dealing data that have undergone to uniform degradation and changes over time. CrossTimeReg is a deep learning registration method which learns latent correspondences between point clouds and pose invariant GMM (Gaussian Mixture Models) components. The registration result is invariant to the magnitude of initial transformation or the density of the input geometries.

We used the CrossTimeReg variation that had been trained with the ECHO dataset [12]. The ECHO dataset consists of CH objects that experienced changes in their geometry, such as loss or gain of material. The training process has been supervised by the ground truth of proper transformation of the dataset and has shown high accurate results and robustness in geometry changes.

Multimodal Registration Stage

The latter stage contains two instances of PCD2VOL [10] working in parallel for registering the two pairs of modalities taken before and after the change event. PCD2VOL is a deep learning framework capable of aligning 3D surface scans and 3D Volumes. The network first identifies the features of each modality independently and passes them to a parallel architecture of cross-modal attention blocks to capture local features and their global correspondence across the modalities.

4. Results

Each of the methods [9,10] in our proposed pipeline has been evaluated against state-of-the-art techniques. The comparative results and ablation studies can be found in the corresponding papers.

We tested our pipeline with the multimodal and differential data from the PRESIOUS project [6]. The data consist of stone slabs of two different types of material: pentelic marble and grytdal soapstone. The two modalities considered as input in the pipeline are the 3D model from surface scanning and the 3D volume from micro Computed Tomography (micro-CT) scanning. Both modalities were measured before and after accelerated erosion experiments that simulate weathering effects from polluted environments, like acid rain.

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 totally immersed in an acid solution of H_2SO_4 in order to simulate the effect of acid rain and specifically the sulfuric acid weathering [13]. It is interesting to see that the simulation experiment caused several cracks to the stone's surface, but also affected the interior material causing also decay [14].

The importance of these findings is that they demonstrate the practicality and usefulness of the proposed pipeline on real data, where point clouds may undergo differential changes over time due to environmental factors. Measuring these changes enables experts to survey and identify the type of damage, and to classify the resulting changes.

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.

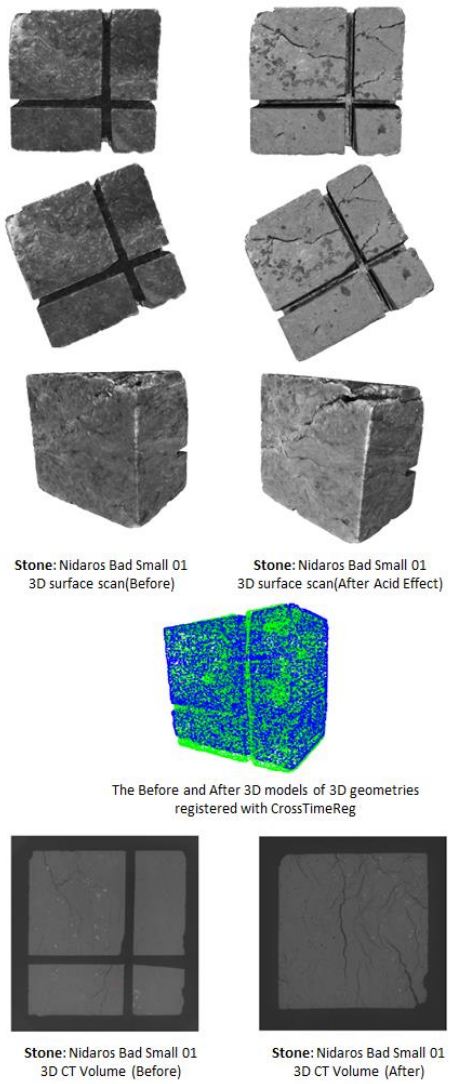

Figure 2: The results of cross-time and multimodal registration of the Nidaros_Bad_Small stone. The data was acquired in two rounds of measurements, before and after the simulation of acid rain.

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.

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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 follows 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 projected need 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.

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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

Binky Lush, Sharon Mizota; Penn State University Libraries; University Park, Pennsylvania, United States

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

Feminist artist Judy Chicago has been creating art since the mid 1960's, and continues to be a prominent voice in the field. As a pioneer in both the making and teaching of feminist art, Chicago's archives represent a valuable resource for scholars, curators, and art educators. The Judy Chicago Research Portal arose out of a desire to create a single point of access to all of Chicago's archives and artworks, which are housed at five different institutions: Penn State University Libraries, Harvard University's Schlesinger Library, the National Museum of Women in the Arts, the Nevada Museum of Art, and the Jordan Schnitzer Family Foundation. The collection at each institution focuses on a different aspect of Chicago's long career. The collection at Penn State focuses on Chicago's collaborative feminist art pedagogy; her papers at the Schlesinger Library contain manuscripts and other documentation from her many art and publishing projects; the image-based holdings at the National Museum of Women in the Arts reflect her creation of art objects, and her archives at the Nevada Museum of Art document her time-based, site-specific environmental installations and performances, which often take place outdoors in natural environments. The Jordan Schnitzer Family Foundation, which holds a complete collection of Chicago's work in printmaking, is the most recent partner to join this collaborative effort.

Scholars, curators, and art educators wishing to understand the depth and breadth of Chicago's career as an artist and teacher previously would have had to visit all five of these repositories, either in person or online, to get a full picture of her work. Furthermore, the collections were in varying states of processing and access. Some had full finding aids and were largely digitized and accessible online, while others had only an inventory list. The portal was conceived to address this challenge by uniting Chicago's archival collections in one place and giving researchers a single point of access to her archival legacy. It was also designed to use the technology and staffing resources of larger institutions like Penn State and Harvard to highlight holdings and programs at smaller institutions like National Museum of Women in the Arts, the Nevada Museum of Art, and the Jordan Schnitzer Family Foundation. In this way, Chicago's art historical prominence could be leveraged to drive traffic and attention to a wider variety of collections and institutions.

The portal was planned, designed, and developed at Penn State, which coordinated input and contributions from the four other institutions, as well as from the artist's studio and Through the Flower, a foundation established by Chicago. Partners meet quarterly via Zoom conference to review milestones, share announcements, and weigh in on decisions that impact the future of the portal and access to Chicago's collections. Although team members from Penn State lead these meetings and perform most of 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. Although there is a projected schedule and deadlines for each portal milestone, the project has ebbed and flowed to accommodate changing partner priorities and abilities. For example, a recent staffing change at a partner institution required a deadline for the delivery of images be moved from the spring to the fall.

Although it is hosted and maintained by Penn State (the project is funded through an endowment at Penn State established by Chicago and Through the Flower.), the portal, in keeping with Chicago's pedagogical style, is truly a collaborative effort. The project explored how to coordinate contributions of metadata and images from different types of institutions, each with different standards, time frames, and resources for processing, cataloging, digitizing and providing access to archival materials. Each institution had a slightly different metadata schema which had to be mapped to the portal schema, which is based on Dublin Core.

Digital imagery became a big challenge when it came to implementation. The original plan for displaying images on the portal was based on all partners utilizing IIIF-compliant Digital Asset Management Systems. This was, unfortunately, not the case in reality. Some of our partners' digital asset management systems (DAMS) had limited capacity and our IIIF link requests were throttled, which resulted in a failure to display thumbnails on the portal. Some of the partners are still in the installation phase of their DAMS and continue to work on getting them up and running to house their collection images. We had to be flexible and develop new processes and workflows including downloading, cropping, and resizing thousands of individual JPGs to create thumbnails for the portal.

Representing Penn State, the presenters will share lessons learned in this complex, multi-year project working with many disparate participants and moving parts. They will each discuss their role on the portal team, encompassing project management and planning, schema development, metadata normalization and creation, and technical implementation.

We employed an iterative development process in which change and adaptation became the rule. The portal was initially designed in a pilot phase with representative contributions of fifty items each from the three original partners: Penn State, the Schlesinger Library, and the National Museum of Women in the Arts. These contributions were initially intended to drive interest in the full collections housed at the partner institutions, not to represent the collections in their entirety on the portal. As excitement about the portal grew, and additional partners were added, the possibility of creating a single access point to all the collections led to a broader project scope. The team developed a content curation strategy that strove to balance each partner's presence on the portal regardless of whether they had hundreds or thousands of items in their collection. It was then decided that the portal would accommodate up to four hundred items from each partner. This phase of the project was completed last year, and we are now looking at ways for the portal to accommodate all items that have been digitized and described at the partner institutions.

As the portal grew, criteria and workflows for receiving metadata and images also needed to be changed in order to accommodate contributions from new partners. The portal's schema is a lightly modified version of Dublin Core, but each partner supplied metadata with a slightly different structure. Partners supplied their metadata as Excel or csv files. Mapping took place in Google Sheets, with the partner-supplied metadata imported on one tab and the portal metadata template on another. Each field was mapped manually but the data was transferred to the portal template using functions (=NameOfPartnerTab!Cel#) that referred to the corresponding cells on the partner tab. In this way, once a mapping between two fields (or columns) had been made, all the data could be transferred simply by repeating the function formula in each cell. This flexible system allowed us to accommodate each partner's schema without creating a "set in stone" crosswalk for each. This system also allowed us to be flexible. In at least two cases, we needed to combine data from two fields in the partner schema into one in the portal schema. For this, we used a simple concatenate function (=CONCATENATE("firstPartOfURL", Cell#ofID, "secondPartOfURL") or prepend (="Text you want to prepend"&[Cel ID]). This was especially important for archival records that required a series name to make sense. Because it links directly to item or folder level records, the portal schema does not have a field for series titles. For example, on the portal, the folder name "Correspondence" would be out of context unless we prepended the series name: "The Dinner Party. Correspondence".

In one case, normalizing the metadata required the writing of a custom script to properly resolve IIIF links provided by the Schlesinger Library. In order to properly resolve them, the links for over 900 folder-level records required manual click throughs to secure the proper link to the IIIF images. This would have taken a long time to do link by link, so a Penn State developer was able to write a script to automate this process and provide accurate links for all the items.

As metadata was received, it was not only mapped but enhanced with portal-specific metadata that tagged items as belonging to specific bodies of work, themes, and formats. This layer of metadata was developed to provide consistent pathways through the portal under standardized terms that are more or less uniformly 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 these terms are standardized forms of terminology already present in the partner-supplied metadata so they were not shared back with the partners. However, alternative text was also added for accessibility of image thumbnails and was eventually shared back with the partner institutions for use with their own images. In this way, support for the portal project was leveraged to provide a concrete, labor-saving benefit for the partner institutions.

Technical decisions made at the beginning of the project, such as a decision to rely on IIIF for images, had to be adjusted in order to include partners who didn't have this capability. Another lesson learned was the need to include a digital image specialist on the portal team who could batch process images to create hundreds of thumbnails and visually check them to ensure they met the design specifications for the portal. Because we didn't have a person in this role, some of the thumbnail images on the site are awkwardly cropped.

The portal's user interface was also modified along the way. Its design was initially based on collaborative user testing across the founding three partner institutions, with library staff, graduate and undergraduate students, researchers, and curators. Once the portal was up and running, an undergraduate student at Penn State was engaged to conduct a second round of user testing to evaluate its usability. Usability tests were run online with art educators and researchers interested in feminist art. Many of the difficulties identified in the user interface were due to the increased number of images presented - the portal was originally designed to showcase a small sampling of the collections held by three partners.The design remained the same, but as the number of partners increased and the number of images multiplied, our testing identified user pain points. One example of this is the left navigation menu. As the user scrolls through a page with hundreds of images - the navigation is lost. Recommendations from our user studies include changing the menu into a jump-to linked list that follows the user as they scroll through the page. An example of this behavior can be found by scrolling to the bottom of the following page: https://judychicagoportal.org/projects/dinner-party. Additional suggestions involve providing a more engaging and unified overview for each work and having the link to the providing institution's repository open in a new page. The findings from this testing will be used to guide a new round of user interface design

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.

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Measuring and modelling the appearance of gilded surfaces: applications in conservation and restoration

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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 $\theta_i = -57.5°$ to $\theta_i = 12.5°$, with a sampling of $3°, 2°, 1°$, and $0.5°$, and a total of 63 angles.

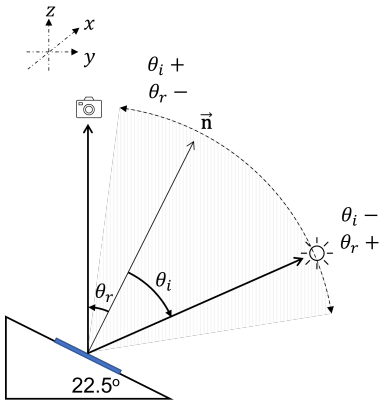

Figure 1: Side view schematic of the system. The camera is looking down on the surface which is on a tilted stage with an elevation of 22.5°. The light is attached to the robotic arm (not illustrated here) and it moves in a 70° arch on the y-z plane.

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].

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 HRD 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:

$$I_p = \begin{bmatrix} I_{Px} \\ I_{Py} \\ I_{Pz} \end{bmatrix} = I_a R_a + I_i \cos\theta_i \left(k_s R_s + (1-k_s) \begin{bmatrix} R_{dx} \\ R_{dy} \\ R_{dz} \end{bmatrix} \right), \quad (1)$$

where I_p is the CIE tristimulus value at point P with incident angle θ_i and at fixed reflection angle $\theta_r = -22.5°$. $I_a R_a$ 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:

$$R_s = \frac{1}{\pi} \frac{FDG}{(\mathbf{n}.\mathbf{l})(\mathbf{n}.\mathbf{v})}, \quad (2)$$

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.

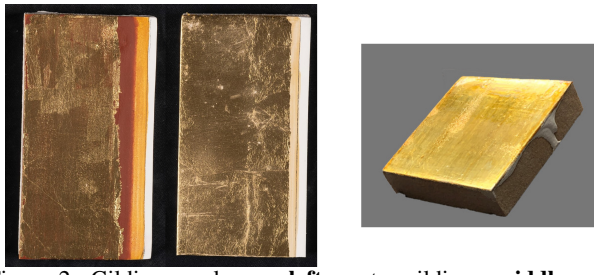

Figure 2: Gilding mock-ups. **left:** water gilding. **middle:** oil gilding. **right:** imitation gilding (taken from [23]).

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.

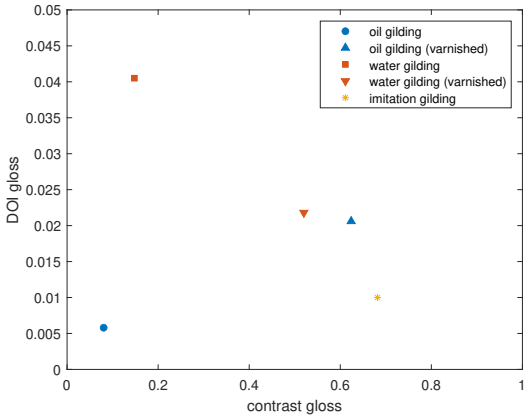

Figure 3: Contrast gloss and DOI gloss values obtained from BRDF coefficients for the CIE Y channel modelled for oil gilding and water gilding, varnished and unvarnished, and imitation gilding.

Appearance based evaluation of varnish removal methods

The second example is taken from [15]. Here, four varnish removal methods are evaluated based on their appearance. The BRDF of the samples is modelled and the perceptual metrics are calculated. Using the BRDF model coefficients and the perceptual metrics, the different surfaces can be clustered in a perceptual component space.

Unvarnished water and oil gilding samples are found at opposite ends of the scale in terms of dinstinctness-of-image gloss. The varnished samples become very similar in appearance. The four varnish removal methods change the appearance of the samples but do not restore the original appearance of the gilding before varnishing.

Based on this appearance evaluation, it is found that the most appropriate method is solubilisation by applying a compress. This method is used in the restoration of a 15th century painted panel.

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.

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Spectral- and image-based documentation metrics for the evaluation of conservation cleaning treatments

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Abstract

The contribution discusses a range of evaluation methods, based on (spectral) imaging techniques, for providing more reliable and reproducible appraisals of cleaning studies when compared to the subjective user-dependant scores that are currently used in the conservation profession. Specifically, novel agar spray cleaning tests on exposed ground and unvarnished oil paint mock-ups are reported as a case study to demonstrate cleaning efficacy and homogeneity metrics in practice, showcasing novel options that could be adapted for use within the conservation community.

Motivation

The subjectivity of current treatment evaluations within the conservation discipline is presented as the knowledge gap driving the investigation. Despite advances in treatment techniques, most novel cleaning treatments are evaluated in a somewhat subjective manner. Scores are usually assigned according to pre-defined criteria to results of cleaning tests, following an increasingly established practice within the profession[1,2,3]. This evaluation method is relatively easy to apply, and can also be easily visualised as star diagrams to better comprehend outcomes[4 5,6].

However, such subjective scorings, albeit assigned by trained and experienced eyes, are hard to reproduce, heavily user-dependant, and reliant upon a myriad of contextual factors that might skew the judgment of the assessor. Furthermore, the mock-ups often used in cleaning studies cannot be guaranteed to be entirely homogenous, and might contribute further bias when attempting to weigh cleaning test outcomes. The imaging technologies discussed in this contribution offer opportunities to incorporate a higher amount of empirical-based data as a complementary aid for conservators in making more reliable, repeatable, and accurate assessments when assigning scores for novel treatment evaluations. Research efforts have already begun addressing this issue[7,8], and serve as a foundation for the strategies presented here.

This material forms part of doctoral research carried out at the University of Oslo within the framework of the CHANGE-ITN project, which has aimed to incorporate the latest imaging technologies into conservation practice. The research is discussed in depth in the primary author's PhD thesis and in a forthcoming CHANGE-ITN book, which will be published in late 2023.

Context

The assessment of agar spray cleaning trials on unvarnished oil paint and exposed ground mock-ups is presented as a practical case study for the implementation of empirical documentation metrics. The mock-ups are based on Edvard Munch's (1865–1944) monumental unvarnished painting, *Kjemi* (1914–1916), situated at the University of Oslo Aula (1911). This painting forms part of a frieze of eleven monumental artworks (oil on canvas) under study within the CHANGE-ITN and Munch Aula Paintings (MAP) projects[9,10]. The mock-ups were designed to evaluate a new cleaning technique – agar gel spray[11,12] – for unvarnished, water-sensitive painted surfaces as a response to the heavy soiling history of the Aula paintings[13,14,15,16]. The study focused on evaluating the performance of four different cleaning solutions used to make the gel, namely deionised water, pH- and conductivity-adjusted waters, and citric acid in sodium hydroxide, and ammonium hydroxide solutions.

Approach

A multidisciplinary set of evaluation metrics for selecting the most effective cleaning option for treatment was developed for conservation research. Cleaning is taken to mean soiling removal from surfaces in this study. The metrics allow for the comparative assessment of cleaning efficacy, and cleaning homogeneity of treatment options. The presented metrics are based on **photography** and **optical microscopy**, appearance-based measurements (**colorimetry** and **glossimetry**), and imaging spectroscopy (reflectance imaging spectroscopy (RIS) i.e. **hyperspectral imaging** (HSI), **micro-Fourier-transform infrared** (μFTIR) **mapping**, and **scanning electron microscopy with energy dispersive X-ray spectroscopy** (SEM-EDS) **mapping**) [Fig. 1].

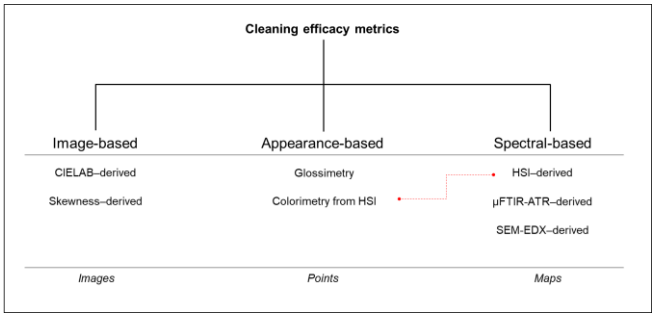

***Figure 1**: Breakdown of cleaning efficacy metrics developed based on the imaging and spectral imaging techniques employed in the study.*

Furthermore, the metrics are easily calculated within freeware such as **FIJI (ImageJ)**[17] and accessible spreadsheet packages. By juxtaposing these techniques together, this work aims to contribute towards offering a robust, rigorous, and comparable evaluation framework for documenting change as a result of surface cleaning trials across a large part of the electromagnetic spectrum. The methods for the proposed cleaning efficacy and homogeneity

metrics are presented according to accessibility to the general practising conservator, and are contextualised via their application to the agar spray cleaning results obtained on the mock-ups.

Methods and results

For the **cleaning efficacy metrics**, a normalised difference (equation (1), where *x* is a measured property before treatment (BT), or after treatment (AT)) was calculated to show the percentage return to an unsoiled control's surface property as a relative marker of cleaning success.

$$\text{cleaning efficacy} = \frac{x_{BT} - x_{AT}}{x_{BT}} \times 100 \quad (1)$$

The image- and appearance-based metrics used equipment that form part of the standard toolkit of conservators, providing information from the visible (VIS) part of the electromagnetic spectrum. The spectral-based metrics required access to imaging spectrophotometers, such as hyperspectral cameras, operating within the visible to near-infrared (VNIR), shortwave-infrared (SWIR) and mid-infrared (MIR) ranges. Most notably, they provided chemically ascertainable visualisations of soiling upon the mock-up surfaces (in the form of soiling maps) in the SWIR range. Normalised difference image (NDI) maps were found to generate the most chemically representative spectral visualisations. Examples of outputs are given in Fig. 2.

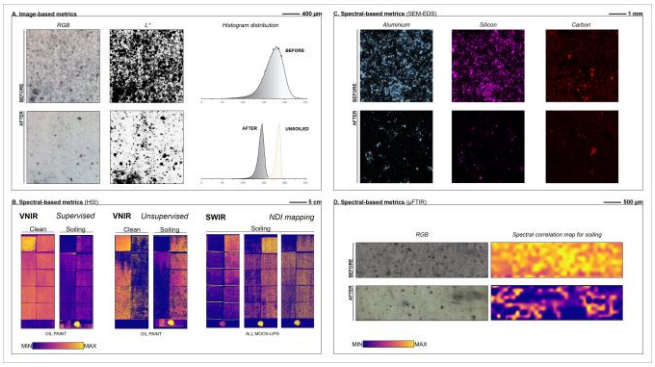

***Figure 2**: Examples of the visual outputs used to calculate cleaning efficacy as given by the image-based metrics (optical microscopy – top left, (A)) and spectral-based metrics (HSI (B), SEM-EDS (C), and µFTIR (D)). Colours and scale bars indicate intensity of soiling signal according to technique.*

Where access to specialised equipment for measuring spectral-based cleaning efficacy is limited (due to budget, time restraints, etc.), the image-based efficacy metrics offer an alternative low-cost, reliable and effective means of evaluation. These scores, calculated using image processing methods, tend to be lower than spectral-based scores, and thus mitigate against over-estimating cleaning.

The processed spectral data from the NDI maps was further used to calculate a **cleaning homogeneity metric**. This score was developed with the intention of empirically evaluating the degree of similar cleaning, i.e. the cleaning homogeneity, achieved across the mock-ups' surfaces. A parameter for measuring image homogeneity[18], for which a plug-in[19] exists in FIJI (ImageJ) was used for this purpose. This parameter was calculated from the *grey level co-occurrence matrix* (GLCM) of the NDI map. Since the pixels in the soiling maps can be understood to represent soiling spread, the homogeneity parameter from the GLCM was deemed an appropriate measure of calculation.

The empirically-derived image-, appearance-, and spectral-based metrics and homogeneity metric were used to compare the four different cleaning solutions loaded into the agar gel. Star diagrams were used to illustrate the ideal cleaning candidate based on weighted scoring criteria derived from the metrics [Fig. 3]. For the majority of the water-sensitive materials studied, spraying agar prepared with citric acid in ammonium hydroxide at a surface-tailored pH was evaluated as potentially the best candidate to date for efficacious and homogenous cleaning.

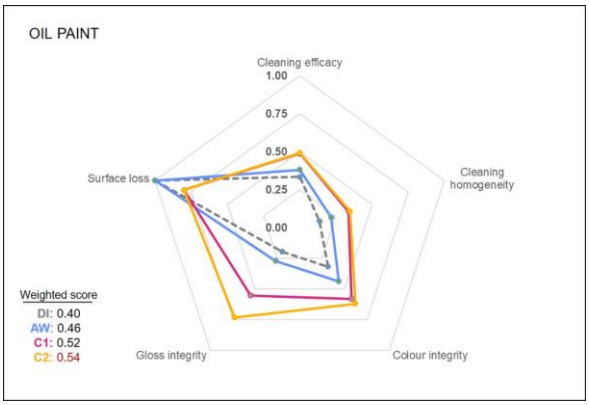

***Figure 3**: An exemplary star diagram with weighted score evaluations of the agar spray cleaning trials on oil paint mock-ups (DI: deionised water; AW: adjusted water; C1: citric acid in NaOH; C2: citric acid in NH_4OH).*

Conclusions

The metrics' relevance are appreciable for their potential in streamlining cleaning research studies, thus providing a solid platform for the comparison of cleaning treatment results on unvarnished, coloured surfaces. By measuring the change in visually observed and spectrally characteristic properties of the surfaces, the metrics minimise on user bias, and offer a toolkit of standardisable and reproducible methods, which are facile to execute, promoting the quality of documentation as well as the cross-dissemination of results in the literature.

These suggestions for more empirical-based evaluations aim towards improving decision-making for conservators when planning a treatment, especially if on a monumental scale, such as in the Aula. The presentation of results in this format makes it easier to document cleaning trials for treatment records, and also can aid in discussion with other heritage or museum colleagues, such as curators, private owners, art historians, archaeologists, and so forth, who might be stakeholders in the decision-making stages of treatments.

The evaluation metrics themselves would benefit from further testing in other case studies to ensure their usefulness and applicability in the conservation profession. Further developments in the spectral imaging technologies and post-processing methods reported are certain to ameliorate the representativity of the metrics, which could be also further tailored according to need in collaboration with conservators, conservation scientists and imaging scientists.

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AUTHOR INDEX

JIST 67(3)[1]:
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