CHANGE

CULTURAL HERITAGE ANALYSIS FOR NEW GENERATIONS

Newsletter - April 2021

Welcome!

Recently, the PhD students in CHANGE have published several new papers. In this newsletter edition, you can read more about two of them published at the Electronic Imaging Conference (EI 2021) this year. We hope you will enjoy reading about Athanasia Papanikolaou's work on 3D Digital Image Correlation technique for monitoring changes in cultural heritage objects and David Lewis' work on how to create the best digital copies of the same objects.

Monitoring changes of Cultural Heritage objects

Photo: ESR 15 Athanasia Papanikolaou

Cultural Heritage (CH) objects represent the history and identity inherited from our ancestors, and it is our responsibility to safeguard and protect them for future generations. One way of protecting them is to understand the changes they undergo over time and record them. But one might wonder, what do we mean by changes?

Changes might refer to different features such as: shape, deformation, damage or colour of an object and they are linked with the properties (for example chemical, structural, mechanical, optical etc.) of the material. When the recording of an object changes is distributed in time according to a certain protocol, we call it monitoring. The analysis of the collected information help us to track the response of the object caused by a variety of external factors including humidity, temperature, mechanical loading, exposure to air pollution and many others. The most practical way to collect this information is to apply vision based methods which can deliver data in the full field-of-view (FOV) and in contactless manner.

Therefore, Athanasia Papanikolaou, Early Stage Researcher (ESR) 15, is working on the design and building of a portable and low-cost device to record, monitor and measure changes that happen in CH objects over time. To achieve this, three different quantitative imaging techniques will be combined (namely Structured Light, 3D Digital Image Correlation and simplified Multispectral Imaging) into a single scanner that will be able to record the 3D shape, displacements/strains and spectral content of the studied objects in situ. Using this information, we can develop methodologies and protocols to determine safe storage or displaying conditions, conservation strategies or assess environmental changes, while at the same time we create a digital record of the object

for future generations.

For this reason, Warsaw University of Technology has established a good collaboration with the Warsaw Academy of Fine Arts. There, we get the chance to work side by side with conservators and face open conservation challenges, combining the field of optical metrology and conservation. At first, we had jointly selected the groups of Cultural Heritage objects (painting, ceramics, parchment and marble), which require the full-field monitoring by means of all modalities. Next, she focused on the modifications and implementation of 3D Digital Image Correlation technique for monitoring and analysing displacements and strains in CH objects exposed to environmental changes. For example, you can find the recently published study (EI 2021paper), which focuses on monitoring the response of a parchment to fluctuations of relative humidity using 3D Digital Image Correlation (3D DIC). In this work they positioned the 3D DIC system consisting of two cameras on a rigid bar within a humidity chamber in which they mimic part of the relative humidity fluctuations happening in storage rooms, without controlled environment, due to the change of the seasons. With their system they tracked the shape (h(x,y,z), in-plane displacements (u(x,y) and v(x,y)) and out-of-plane deformations (w(x,y)) that the parchment sample can undergo if appropriate fixation of a parchment is not used. An example of such a measurement can be found in Fig.1, where the sample, the system and representative results of shape and displacements are shown. The historical parchment sample was exposed to relative humidity difference equal to 20% resulting into the creation of displacement and change in its shape. In general the aim of this collaborative project is to create an affordable tool with significant potential in the hands of conservation scientists for the monitoring of cultural heritage objects as well as the development of protocols that will ensure their safety and digitization.

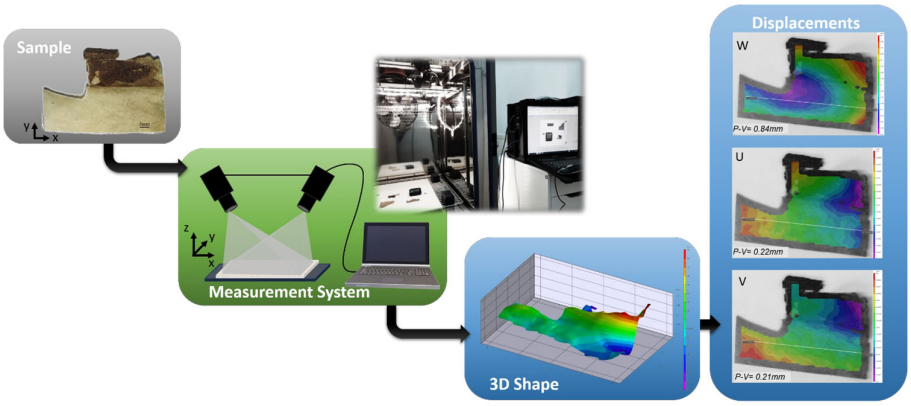
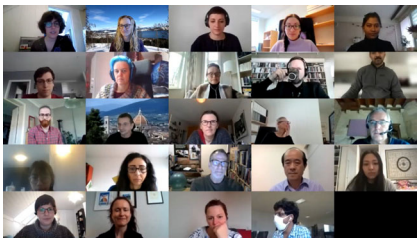


Photo: Example of a historical sample, measuring system and output quantities from a 3D DIC measurement. The sample is subjected to humidity fluctuations which result in the formation of displacements and change of its shape.

Read Athanasias' EI paper here



PhD fellows' midway presentations

The ESRs have just presented their current status of their research to the consortium and the External Expert Advisory Board members. Read more on our website by clicking the button below.

Midway presentations

Scans of Munch paintings

The ESRs Agnese and Jan have been to the Aula of the University of Oslo, taking hyper-spectral scans of the Munch Aula painting "Chemistry". Read more on Facebook by clicking the button below.

Scans in the Aula

Digitizing the past

With cultural heritage objects, the ability to create 3D digital copies of these objects has become more prevalent as the technology needed has become more accessible. This process of digitizing cultural heritage objects is incredibly important for multiple reasons connected to conserving, studying, and sharing them with as many people as possible. From a conservation standpoint, digitization can provide methods of analyzing how the object changes over time, whether due to the wear of time or due to handling of the object during study, transport, etc.

Photo: A coin with small-scale detail such as nicks and dents as well as the manufactured designs

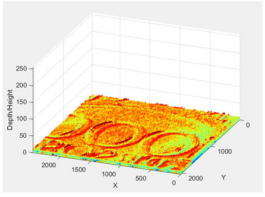


Photo: Basic 3D depth map of coin, used for further digitization methods

It can also be important for study as having a digital representation of an object can enable scholars to spend more time with it without having to expose it to elementsthat could hasten its degradation. Beyond this, different types of data, such as infrared and ultraviolet imagery, can be used to be augment the 3D models and to reveal information and patterns that aren't visible to the naked eye. Lastly, digitizing objects can make them available to a significantly wider audience, with people halfway across the world who might have never had a chance to see the object in person now able to get a better sense of the object while being able to explore it a bit more freely and with more interactivity than can be provided by pictures. Since a desire of this expansion of access is a realistic representation of the object, there's also the added benefit of long-term preservation in that it can be referenced in the future as a snapshot in time. In both academia and general curiosity, this ability to more freely and widely share objects that can communicate our cultural heritage is one of the most important developments.

Early Stage Researcher (ESR) 9 David Lewis' work so far has been concerned with the goal of improving how images of different cultural heritage objects can be captured so that more information can be extracted from them and the accuracy of the digitization process can be improved. His work tries to understand both the overall shape and structure of objects as well as the smaller-scale texture so that their contributions to the overall object appearance can be better understood. The status of this work was presented at Electronic Imaging 2021, where David was able to show how he proposes to analyze stacks of images that are varyingly focused to pick out groups of important details that lie on similar focal planes.

Photo: ESR 9 David Lewis

The results of this can better communicate to the camera what images might be important for understanding the 3D shape of the object.

While the aim of this proposed work is to increase the quality of these points and subsequently increase the quality of the 3D digital model, this work came out of a broader attempt to understand how texture can be examined on these objects. This deep dive into texture (and overall shape and structure) now continues with the hope of finding the relationship between shape, texture, and the digitization process.

Read David's EI paper here

All CHANGE publications are available here

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