EULAC MUSEUMS

A MANUAL FOR 3D DIGITISATION AND SPHERICAL TECHNOLOGIES

A GUIDE TO MAKE IT EASY

PRODUCED IN CONJUNCTION WITH EULAC VIRTUAL WORKSHOPS BY THE

University of St Andrews | FOUNDED 1413

www.eu-lac.org/virtualmuseum

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PHOTOGRAMMETRY

DIGITISING ARTEFACTS WORKFLOW

Following this workflow we can photograph objects and use structure from motion to create accurate 3D models. Having created the models, we can archive them and curate them in digital exhibits.

Selection of Objects

Successful digitisation depends in part on selecting objects with suitable characteristics, appropriate size, matt surface, appropriate features on surfaces and lack of occlusion.

Selection of Equipment

A high fidelity digitisation studio can be created on a budget. Tripod, lights, softbox and turntable can be used with phones, tablets and cameras to create a studio capable of producing professional results.

Doing the Shoot

Manual settings should be used for the camera, fixed for all the photos for eaxh object. Overlapping photos of all object surfaces should be taken, preferably in a RAW format. The camera should be mounted on a tripod. The subject should be lit softly and evenly.

Creating the Model

To create a model from photographs we go through the following steps. Select the photographs to use and import them, sift to find features and match to connect them, create a sparse point cloud and then a dense point cloud, clean up the point cloud. Transform the point cloud into meshes and apply textures to the mesh.

Archiving

Archiving digital artefacts will enable them to be future profed and made easily accesible. The digital object should be archived together with source photographs and meta data including a description of the object.

Curation

Platforms like sketchfab enable digital artefacts to be made accesible over the Internet and provide opportunities for sharing. In addition outputs can be embedded in web pages, which in turn may be developed using opensource platforms.

Following this workflow will enable the digitisation of objects to create 3D artefacts that may be used in digital exhibitions and virtual museums.

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SELECTION OF OBJECTS

Requirements

To create 3D digital renders of museum objects with minimal distortion, the object itself needs to be evaluated. Staff must decide whether angles, surface type, shadows and object detail all warrant the selection of an object. 3D software uses reference points, so a detailed object is best.

Size

An object must fit within the designated photogrammetry space, either in a softbox or chosen backdrop, with plenty of space around the object.

Integrity

If the object cannot be handled without compromising its soundness, or is fragile enough where excessive handling might damage it, it should not be chosen for 3D photogrammetry.

Material

Objects should hold their shape and position throughout the photogrammetry process. Items that easily change from their original shape of position if moved should not be chosen. Objects that are transparent or have transparent parts are difficult to get good results from.

Surface

Reflective surfaces will cause distortion in an image. Cyclododecene spray can be used to mute shine on an object and be removed by water. Fuzzy textiles of objects with small patterns may create noise in the image that will make it difficult to photograph.

Shape

The shape of an object affects how well it is photographed. Sharp angles create shadows and occlusion will cause parts of the object to not be photographed.

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SELECTION OF EQUIPMENT

Equipment described here makes up a tabletop studio which can be used for photographing and digitising small to medium sized objects. The object is placed in a softbox, against a plain background and rotated, whilst the camera is kept in a fixed position.

Camera

The camera should support manual settings, be at least 6 mega pixels resolution, should enable the object to fill the frame with the subject in focus for each shot. Good results can be obtained with a SLR, mirrorless, compact or a mobile camera.

Tripod

A tripod will enable a steady shot and improve the clarity of photos. It also enables longer shots which may be necessary depending on lighting conditions.

Lights

Artificial lighting ensures the subject is evenly lit and reduces shadows.

Turntable

Placing the object on the centre of a turntable and rotating it in 36 degree increments will allow accurate images to be taken without changing the camera position.

Backdrop

A backdrop without features will enable structure for motion to work with a turntable rotating the subject rather than the camera circling the subject.

Softbox Tent

Placing the object and the turntable in a softbox light tent will enable soft lighting for the shoot.

Remote Control

A remote control will enable photographs to be triggered without touching the camera, thereby reducing shake and improving image accuracy.

Processing the data on a computer, the amount of memory will determine the number of images that can be processed. A good CPU and discrete graphics card will enable processing to be done in a timely manner. Processing in the cloud is an option if appropriate hardware is not available locally.

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PROCESS OF CAPTURE

Through a more detailed process, photogrammetry using a DSLR camera and appropriate software yields higher resolution 3D objects and allows for more detail.

Equipment

DSLR camera
Tripod
Collapsible Lightbox
LED lights
Manual Turntable
Meshlab and Visual FSM

Setup

The collapsible lightbox or backdrop should be placed on a sturdy surface. The backdrop, top of the surface and manual turntable should all be the same colour. To maintain consistency, the manual turntable should be marked using a silver ink pen with degree marks.

The object should be securely placed on top of the manual turn table. If the object needs to be propped in order to stay immobile, use a material the same colour as the backdrop.

Camera and tripod should be set up facing the object and backdrop. When using the settings on the camera, have the object fill up the frame. Images should be shot in manual settings. Set the ISO to a low setting and f number set to a high to mid-range setting for optimum image accuracy. Image size should be set high for better resolution.

Image Capture

Before taking images at different angles take a few test shots in order to adjust the exposure of the image. Then once adjustments have been made, begin taking photos of the object at every degree of the manual turntable. Repeat this step placing the camera higher than object's midline by adjusting the tripod. Repeat this process by adjusting the camera higher than objects midline. Finally, flip the object over to expose the previously hidden side and shoot images at the higher angle.

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PROCESS OF CAPTURE (MOBILE)

Easier than using a DSLR camera, photogrammetry can be done using a mobile device and downloadable applications. Mobile photogrammetry needs little training and set up and online sharing is available by in app upload.

Equipment

Tablet of mobile device
Scann3D application (Android)
Trnio application IOS

Image Capture

Place the object within a well-lit clean space, or in the same setup as with a DSLR camera 9refer to card 2). Mobile applications allow for canning of large objects as well as objects that may be outdoors. If shooting without a tripod, the application will prompt the user to begin to move around the object, taking overlapping pictures.

Once the application has taken the required amount of photographs needed, the application will begin to stitch the images together into a 3D image. This process might take a few minutes. Both applications listed above process reconstruction within the app, so there is no need for computer software.

Both applications allow for user adjustments, but the majority of the model processing is done by the application itself. Trnio prompts the user to trim the low resolution model and apply changes to the high resolution final model. Scann3d asks the user to select the best photographs, allowing te deletion of blurred or unnecessary images.

Online Sharing

Once a model is built, upload to online sharing sites can be done within the application. Both apps have the ability to upload directly to SketchFab on online 3D model social platform. Scann3D models can be exported in STL file formats, which can be sent to a 3D printer for printing. Trnio models are exported in PLY formats which can be read by software such as MeshLab to further manipulate models.

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MODEL CREATION

Once the shoot has been done the photographs need to be processed to create the 3D model. The precise process will depend on the software used. There are commercial software (photoscan), open source software (VisualSFM) and cloud solutions (123D catch). Each has their own tutorials, here we provide an overview of the process that underpins each.

Software

VisualSFM lets us load up a folder of images, find unique features in each image, solve a set of these images into a 3D model, and then refine that model into a dense point cloud.

The two outputs of this step are:

- a .out file (bundler format) which stores the calculated (solved) cameras' positions and a sparse point cloud representing the points in the scene that the software used to deter mine the camera positions.

- a .ply file which stores a denser cloud of points, each with position, color and normal (a vector perpendicular to the surface the point is on) data.

Meshlab allows us to turn the cloud of points into a model. Using the two outputs from the above steps a textured, clean, high-res mesh can be produced. Meshlab also automatically calculates UV maps (the basis for 3D texturing) and builds a texture for us by estimating which projector is most accurate on each spot of the model.

The outputs of this step are:

- a .obj file of a mesh (with UVs) that can be easily interchanged with various 3D softwares

- a .png file of arbitrary size representing the texture of the mesh

These can be imported into a 3D environment, for viewing, annotation and manipulation. It may be necessary to "decimate" a copy of the model. This will make it quicker to load and easier to work with in 3D programs such as Sketchfab.

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ARCHIVING

Through archiving we will make digital artefacts accessible and available for re-use by researchers, the wider museums and galleries communities and researchers as well as the public at large.

There are three types of data that we wish to associate with each other and include in the archive:

1)Metadata will describe the model, this provides context to help people to understand its meaning and significance, and information that will make the model accessible.

2)Files that describe the shape of the model and the textures that cover its surface. These can be downloaded and then used in a variety of 3D programs so that the model can be viewed, manipulated and included in collections.

3)The source photographs that were used to create the model. Preferably high resolution and raw format. This will enable the model to be rebuilt in ways that enable future reuse. For example, it may be rebuilt at a higher or lower resolution or using different colour interpretation. This will also enable the model to be rebuilt utilising new techniques and will help future proof the model.

The metadata we are using is based on the Dublin Core schema. This has 15 elements including: creator, title, description and coverage. A form is available with a description of each field.

An archive tool is available at **eu-lac.org**. To use this feature, put all files into a zip archive, fill in the form and upload. We will then check that everything works, archive the data and share it within the EU LAC Museums project.

Virtual Museum

Meta Data for Digital Objects

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Title:	Click or tap here to enter text.		
Language:	Click or tap here to enter text.		
Location:			
Date:	Click or tap to enter a date.		
Creator:			
Contact:		**Image**	
Subject:			
Description:			
Size:			
Type:	Choose an item.	**Format**	Choose an item.
License:	Choose an item.	**Cleared for release:**	☐

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Virtual Museum

Meta Data for Digital Objects

Country:		Museum:	

Title: A descriptive title for the physical object.

Language: Original language of or associated with the physical object.

Location: Place or region of origin of the physical object.

Date: Time or period physical object was created.

Creator: The person, organisation or society that created the physical object.

Contact: Point of contact email for the physical object.

Image: Image of the physical object.

Subject: Subject category for the object.

Description: description of the object and interpretation for the object.

Size: Height, width and length in cm

Type: The type of the digital representation: image, 3D model, photosphere, audio or video.

Format: The file format used, select a Mime type

Country: Country object is currently located in.

Museum: Museum responsible or near the original object.

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CURATION

Digitization of an object makes it easy to edit, copy and share. It may be lit in different ways and be associated with interpretation. The digital artefact may add a new dimension to a physical exhibition, be presented in an online gallery, be embedded on a blog or shared through social media.

Sketchfab is a free site for hosting and sharing digital models. At the time of writing Museums that set up a Sketchfab account can apply for a free upgrade to a professional or business account. This increases the detail allowed in models and gives more control over how embedding works.

After uploading the model and textures there are controls for professional presentation of the models. Most of the defaults are good however we recommend choosing a black background for the model. If the model is too large it will may take a long time to load. Sketchfab recommend using less than a million faces, for big models this can be achieved by decimating the model in Meshlab.

https://help.sketchfab.com/hc/en-us/articles/205852789-MeshLab-Decimate-a-model

Once a model is uploaded it can be placed in one or more collections. There may already be models uploaded you would like to add to a collection as well.

Models on Sketchfab can be easily shared on social media. Also the embed button gives code that can be used to embed a model or a collection in a web page. Digital artefacts can also be embedded in a wiki where they can become the focus for community interpretation and stories.

PHOTOSPHERES
FOR VIRTUAL TOURS (MOBILE)

Equipment for THETA Camera
RICOH THETA camera
Tablet or mobile device
Monopod or tripod
Theta mobile application

Setup
Before photographing, download the Theta application onto a mobile device. Turn the camera on followed by pressing the wireless button. Follow the instructions within the application to connect the camera to the mobile device. Place THETA camera onto monopod/tripod within the application to connect the camera to the mobile device. Place the Theta camera onto nonopod/tripod within the area you would like to photograph, placing the camera within the center of the space free of obstructions.

Step out of the frame of the photosphere and take a picture using the mobile application using the image icon. Be mindful not to step too far away as the mobile device will loose wireless connection to the THETA.

All photos can be viewed within the application or in an auto created folder within the mobile devices gallery. Images can be shared from any folder. A list of social networking sites will appear that the photosphere can be uploaded to.

Equipment for Google Street View
Tablet or mobile device
Google street view application

Setup
Open the Google Street View application on a mobile device. Click on the camera button in the bottom right corner. Hold the phone vertically and close to your body. Slowly rotate around the area you are photographing, keeping the dot in the centre of the frame. Once all frames have been filmed within your space, touch the stop button, which saves the image.

Photospheres can be uploaded directly to Google Maps, as long as they are a full 360 degree photo. Photospheres are saved to the mobile device's gallery and then can be uploaded to other social networking and archival web pages.

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SOCIAL ARCHIVING

Digital materials generated from the workshops and those created afterwards can be uploaded to Social Archiving sites such as SketchFab and Round.Me. During the workshops, digital objects and spherical scenes will be uploaded to the EULAC professional accounts of each platform. Any digital content created after the workshops can be uploaded by sending the digital files to the virtual museum contact.

Each museum will be given an account for each of the social archiving sites during the time of the workshop.

SketchFab is a social archiving site for 3D digital objects. The process of photogrammetry or 3D scanning of objects are used to create models that can be uploaded to the site. An account can great Collections of individual models, either of their own uploads or from other accounts.

Objects hosted on the SketchFab can be embedded on websites and shared on social media sites such as Facebook.

Round.Me is a social archiving site for 360° spherical images that can assembled together to create digital virtual tours. Photospheres are made for mobile devices, 360° cameras and images stitched together from a digital SLR camera. Hotspots are added into spherical scenes and can include images, videos and text. Scenes are stitched together to create a digital walking tour of the museum.

Scenes loaded on Round.Me can be embedded into websites and into other social media sites.

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AN ONLINE RESOURCE

An online version of this manual is available as part of the EU LAC Virtual Museum, which provides further support for the digitisation, archive and curation of digital artefacts and scenes.

To use the Virtual Museum, go to **www.eu-lac.org** and fill in the short form to register as a user.

The site is in six sections:

- Virtual Tours
- Virtual Artefacts
- 3D Printing
- Wiki
- Archive
- Toolkit

Models and supporting files may be uploaded using the Archive section. Place the files associated with a model into a zip file and then use the file browser to select and upload. Please fill in the form to create meta data for the resource you are uploading.

The Toolkit, contains an online version of this manual, together with links to more detailed guides and to relevant software.

The Wiki provides a space for community engagement and interpretation of the virtual museum content.

The Virtual Tour and Virtual Artefacts provide galleries where digital outputs from the 3D workshops may be viewed, and shared through social media and web sites.

Feedback on the Virtual Museum is welcome as it will continue to be developed during the project.