From 2D images to 3D Virtual Reality: A Digital Application in Cultural Heritage

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Introduction

The digital documentation and preservation of historical and cultural monuments has become more prevalent in recent years, because of concerns regarding the destruction and damage of the monuments. With new technologies like augmented reality (AR), virtual reality (VR) and mixed reality (MxR) supporting 3D and virtual experiences it is becoming easier to do this. This work will also outline a procedure that allows us to capture, digitally preserve, and then view these monuments/artefacts in the virtual environment. 2D Photographs are taken and then generated into a 3D point cloud and mesh (using Agisoft). The 3D model is then uploaded online for public sharing and visualizing in AR/VR (with Sketchfab). This work was done based on images of the Telayfac Bridge located in Guam.
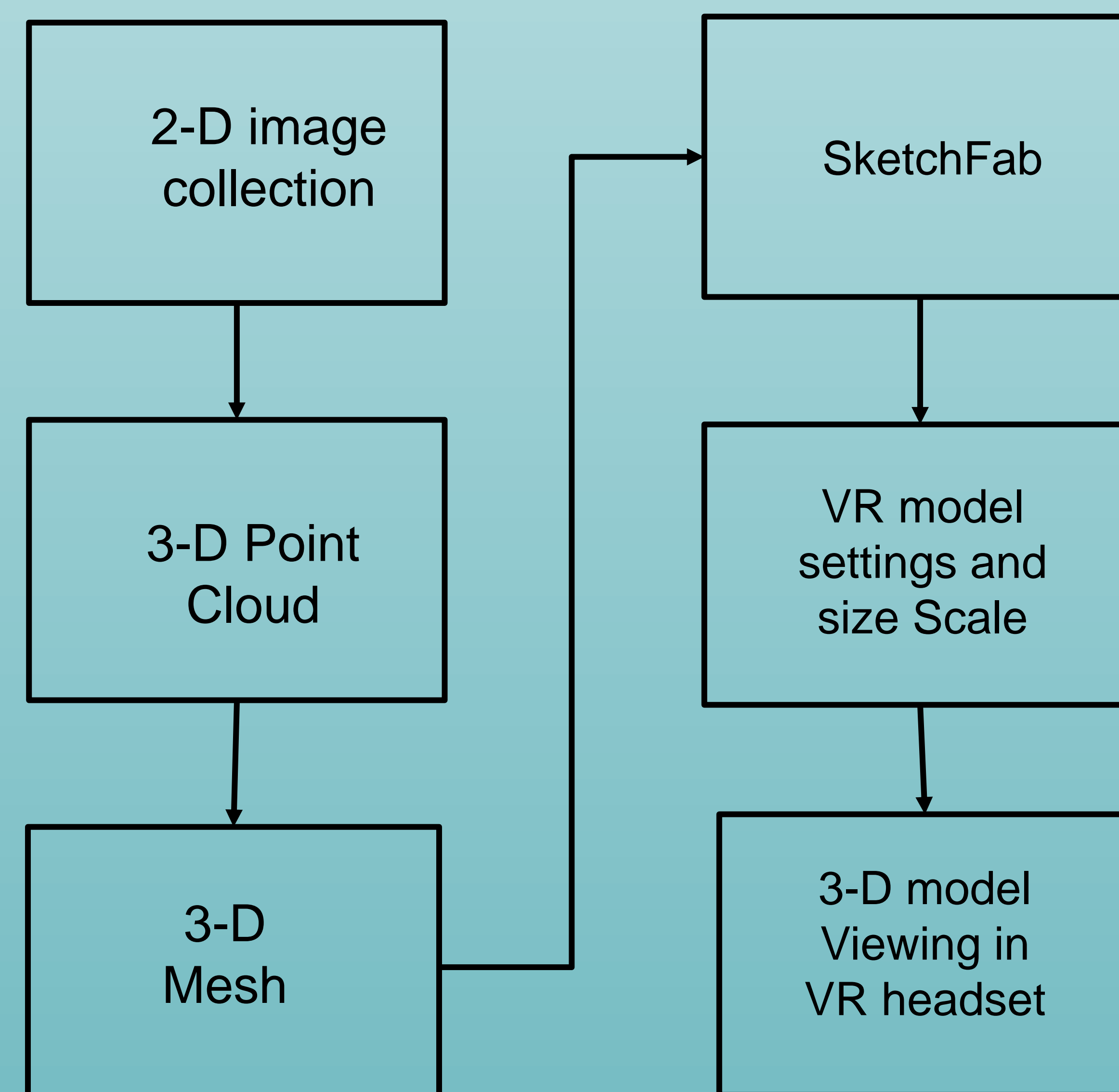
Historical Courthouse located in Conway, SC

Historical Fort Sumter located in Charleston, SC

Research Objective

The objective of this study is to investigate cost effective digital tools for creating a virtual, immersive, and 360-degree experience of a historic arch stone bridge from a large volume of 2D digital images.

Methodology

- 2-D image collection
- 3-D Point Cloud
- 3-D Mesh
- SketchFab
- VR model settings and size Scale
- 3-D model Viewing in VR headset

Results

Small Scale Verification on point cloud reconstruction

A small-scale verification was done on a household item to ensure that the workflow and large-scale validation would be successful. Images were taken with an iPhone camera. Pictured below is the item's 3D point cloud and mesh.

Vase 2D image
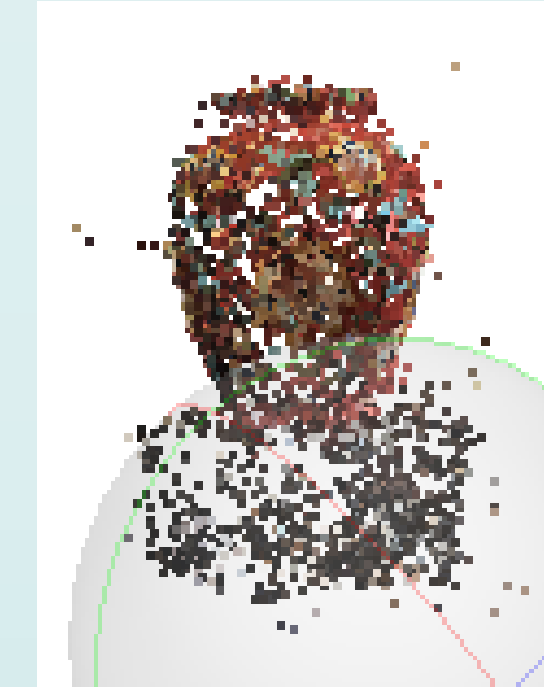
Vase 3D Point Cloud

Vase 3D mesh

Large Scale Validation

The Taleyfac Bridge is one of the most photographed and visited historic sites in the US Territory Guam. It is one of two double-arched bridges in the Mariana Islands. This bridge was originally constructed out of wood, but later replaced with stone during Governor Calderan's tenure (1855-1866). The stone bridge designed for bull-carts. Recently there has been proposed repair and maintenance strategies that includes investigations of structural integrity, stabilization of riverbanks, and a conservation plan for maintenance.
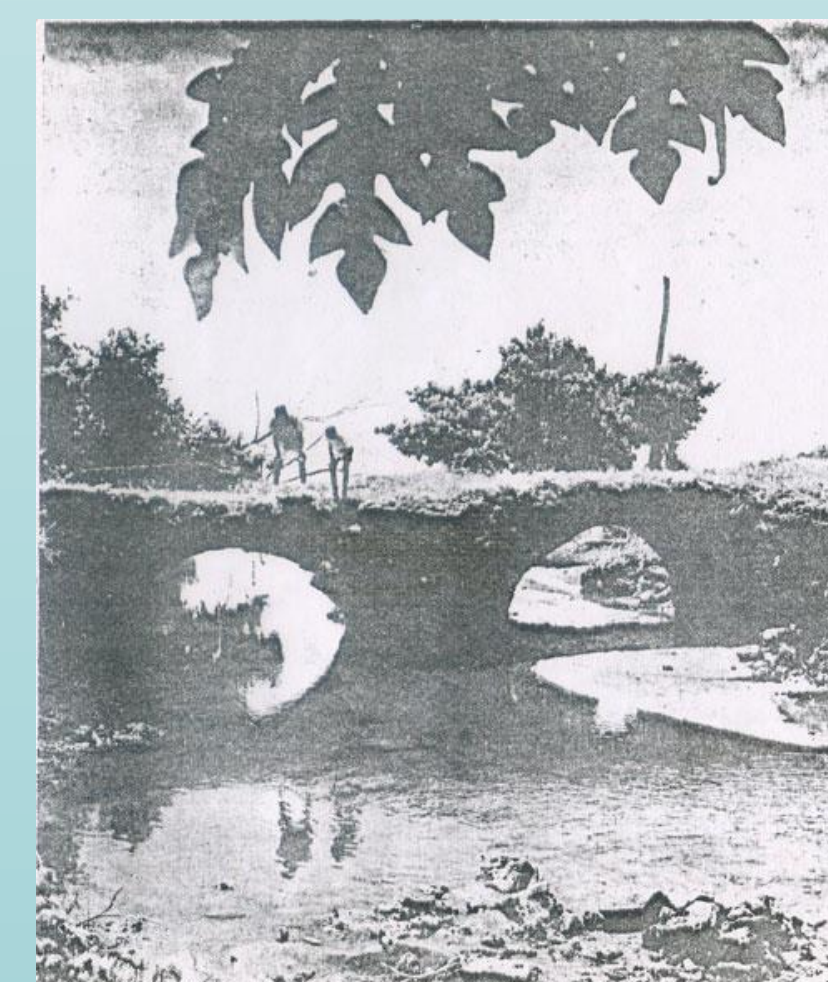
Old Bridge in 1968

Current Bridge

Using the Agisoft we can create 3D point clouds of the bridge using 2D images. There were about 80 2D images of the bridge captured from a drone. These images were uploaded into Agisoft and aligned to create a sparse point cloud. Once the images are aligned, we can create a dense point cloud, which is a more accurate point cloud. Once the dense point cloud is created, we can build a 3D mesh. This will fill in the blank spaces and add texture to the bridge, making it look like a real 3D model.

Taleyfac Bridge 2D drone image

*Taleyfac Bridge 3D Point Cloud*

Taleyfac Bridge 3D Mesh

Sketchfab is the program that was used for Viewing the 3D model in a virtual environment. Sketchfab supports 50 extensions and has a user dashboard is simple and easy to use. Sketchfab is also the only platform that was considered that supports the Virtual Reality (VR) option. Sketchfab also works on most operating systems such as Windows, Mac, Linux, etc. Sketchfab can help us easily change the settings of the 3D model such as material textures and setting the size of the viewer.

Sketchfab Compared to other Platforms

Name	Supported file format	Accessibility	3D model display
Sketchfab	50 popular file formats	Varies between paid and free model	2D, 3D, AR, VR
Blendswap	37 popular file formats	Varying Creative Commons	2D
3d Warehouse	.skp	General Model License Agreement	2D,3D

Sketchfab was very easy to use, and it allowed us to easily view the bridge 3D model in the VR headset. The Oculus Quest 2 was used to view the 3D model in the in the Virtual Reality (VR) environment. By changing some settings, we were able to make the experience more life like. We change the scale to roughly 1.28 in the Sketchfab scale settings.
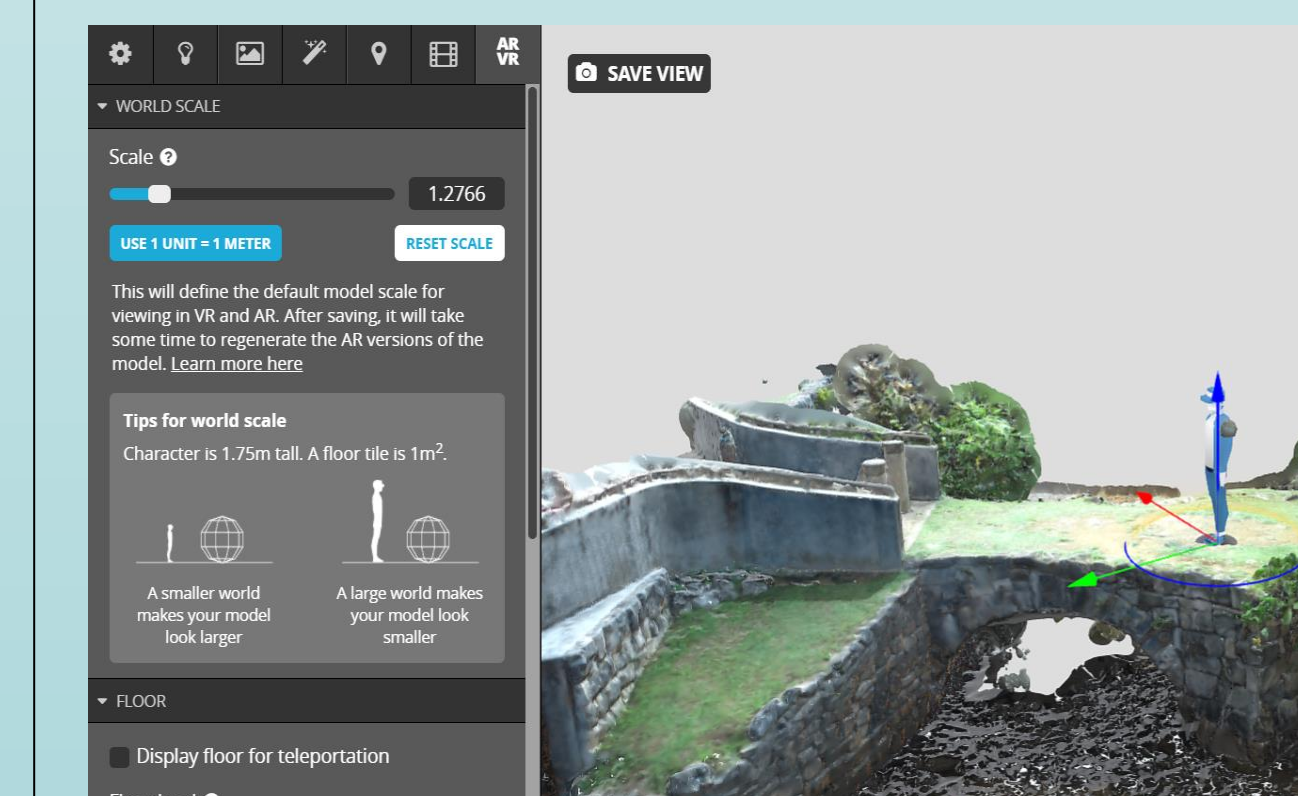
Sketchfab scale settings
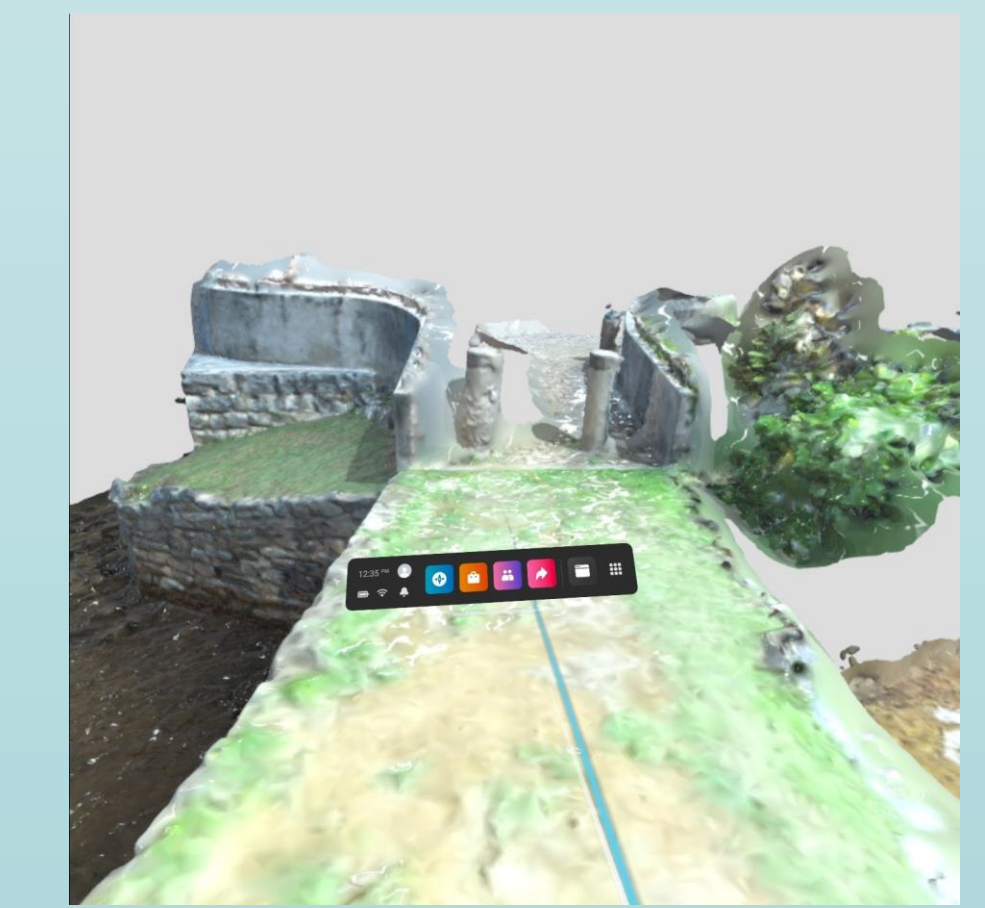
Taleyfac Bridge 3D model Viewed in VR

Oculus Quest 2

Conclusions

The Workflow presented in this poster is an effective way to create a 3D virtual experience of historic structures that we wish to preserve. This workflow allows us to preserve entire structures through 2D images. The workflow is easy to follow and use by anyone that is interested in this work and easily accessible. Some potential improvements could be things involving Image collection and Sketchfab settings. Images need to be very clear and have high resolution for the 3D model to have the best accuracy. Changing the Sketchfab 3D model settings could also provide a more life like experience in the Oculus Quest 2 headset.

Acknowledgements