



REKREI

reconstructing lost heritage

PROGRESS REPORT

11 April 2016

Introduction

On the 26th of February, 2015, Daesh (the self-proclaimed Islamic State), released a video depicting the systematic destruction of the Mosul Cultural Museum. This was not the first time that Daesh attacked heritage, and the museum was yet another casualty in the wake of destruction of the extremist group. Rekrei (formerly Project Mosul) was founded as a response to this destruction. Launched just under two weeks from the release of the video, the project aimed to crowdsource the virtual reconstruction of the destroyed museum and eventually release a virtual museum where people around the world could virtually visit the museum and offer a way to digitally preserve its memory. Thanks to an overwhelming response of international support, this early concept will become a reality very shortly thanks to our collaboration with the Economist Media Lab.

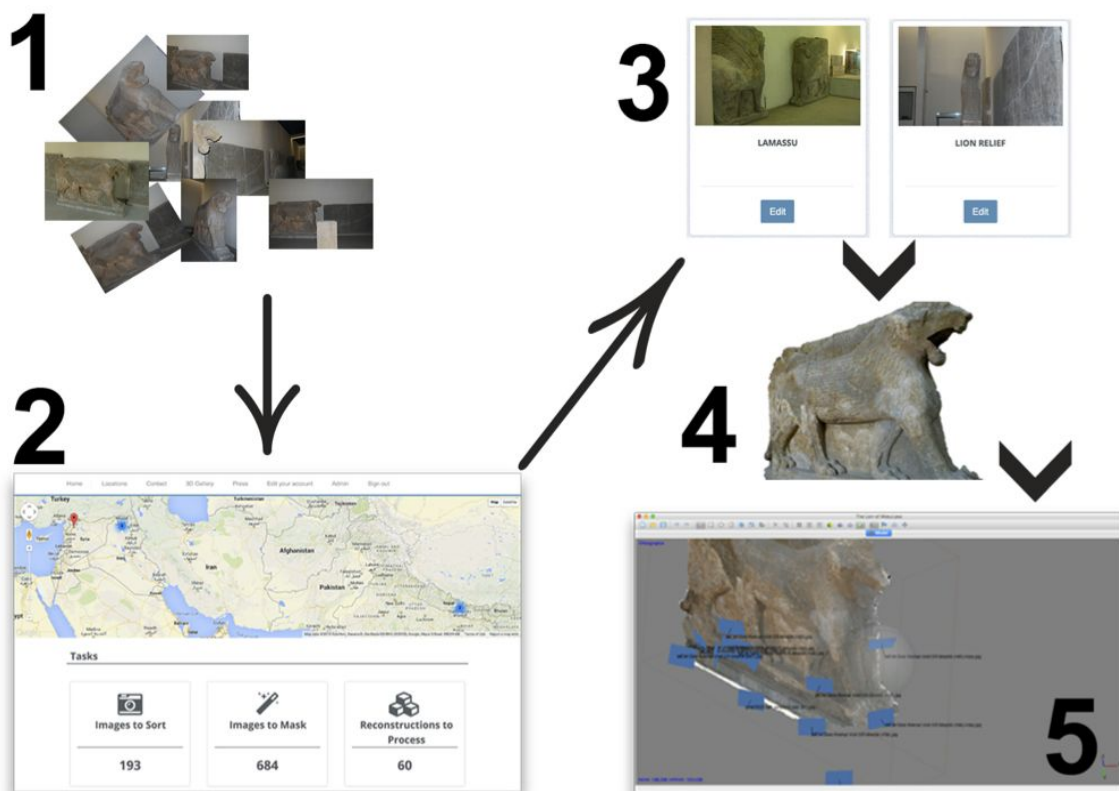
An early version utilizing photogrammetry and crowdsourced images for reconstructing cultural heritage was successfully accomplished with the Bamiyan Buddhas in Afghanistan after they were destroyed in 2001. Fabio Remondino, a member of that research team, is now one of the advisors for Rekrei. Thanks to the advances in computer vision, web development, and digital cameras, Rekrei was able to successfully reconstruct some of the objects in the Mosul Cultural Museum. We recognised quite quickly the further potential for this as the news of the nearby sites of Hatra, Nimrud, and Nineveh suffered similar fates. Since then, the project has expanded to a global scale and increased its presence and actions thanks to the growing participation of public and private organizations, even without any funding resources.

The Problem

Heritage is at risk around the world, whether through human intervention or natural disasters. While we see the barrage of high-profile destruction in areas like Iraq or Syria, much of the world's heritage is lost or at risk on a regular basis. Stemming the loss of heritage is an insurmountable problem, and unless the world community rallies behind the preservation of heritage, this will be a problem we are faced with for decades and even centuries to come. The destruction of heritage is, of course, nothing new. Invading armies have erased the names of previous kings, destroying heritage in order to destroy the memory of a particular past. While we cannot prevent the loss of heritage across the globe, we can at least take steps to preserve the memory of the heritage that is lost. In a digital world, we have the technology and capacity to recreate digital representations of heritage and place them in repositories and virtual museums for both the public and professionals alike. In doing so, we preserve the narratives of peoples and cultures from around the globe in open-access, democratised repositories and can serve as the basis for research, education, digital curation, and new art.

The Solution

Thanks to an innumerable amount of images flooding onto the web everyday, the potential for using photos of cultural heritage is ever-increasing. So too, the developments in photogrammetric reconstruction now make it possible to use these images to digitally recreate lost heritage. The key ingredient to this equation is the online platform. In its first version, the platform provided a simple user interface for identifying locations of destroyed heritage, uploading and sorting images, and a 3D gallery of completed reconstructions. Building on early concepts, our platform continues to evolve and integrate new features.



The Process

The main work of Rekrei happens both online and offline. The online platform provides the primary area for organising and managing the digital images that are used for photogrammetric reconstructions. Online, there are three primary tasks that volunteers participate in. First, users identify locations around the globe where heritage has been lost, either through natural or human intervention. These locations serve as the major divisions in organizing the work. The second task is uploading images to these locations, which any one can do, as long as they have created an account on the site. Finally, the third task is organising the images at each location into relevant groups for reconstructing. Images can belong to more than one group, as an image may contain one or more parts that should be

included for photogrammetric processing. Likewise, some monuments are too large or simply do not have the coverage in the digital imagery for processing in photogrammetric software. As such, breaking these monuments down into smaller groups allows for parts to be reconstructed and eventually merged together if more imagery becomes available at a later date. In some cases, these monuments may be reconstructed manually by digital artists who base their work on the photographs. As all of the above reconstructions are not valid for scientific analysis, but rather serve primarily for visual representations of the lost heritage, any process is valid for recovering lost heritage.

As the platform continues to grow, we will incorporate new features to facilitate greater coverage and track the process by which models are created through the platform. One example is the integration of Flickr through their geolocation API. As each location on the Rekrei platform has a latitude and longitude, users will be presented with a section of the page that displays all the available, non-restrictive licenses, from Flickr that have also been assigned to the same location. Users can adjust the radius of search through a slider, extending it up to a kilometre away from the centre of the location that they are browsing. This allows for many more photos to be included by simply presenting the user with other possibilities on other platforms. Future development will attempt to do the same from similar online image repositories.

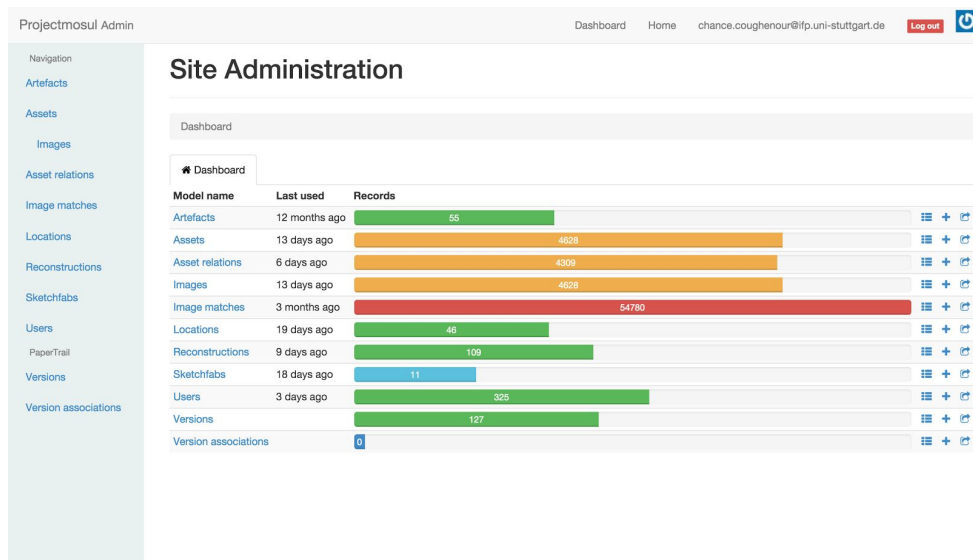
Along the same lines, it is important to track how models are produced using this platform. For example, if a user wants to upload a photo but requires attribution, it is then necessary that the metadata of that 3D model maintains a complete list of the photographic sources that were used to produce that model. Therefore, we are working on implementing a metadata system on the platform that tracks the work of users, who uploaded what image, what license that image has, who organized it into which group, and finally who did the processing to generate a 3D model. Through this workflow, it is possible to track the contribution of all the volunteers who contributed to the creation of the recovery of lost heritage through the Rekrei platform.

The Results

Web-based, open-source platform

The web application for Rekrei is a Ruby on Rails application with a SQL backend. There are sections that use Angular to improve the front-end interaction, and eventually the API will be ported from the Ruby app to a Go app. All of this is dockerised for easy deployment on any service. The database is also portable, thanks to the Ruby on Rails attitude towards database agnosticism, and can be switched to any flavour of SQL easily. The movement in development is increasingly towards shifting to each component being its own service with its own datastore for lightweight portability and faster growth.

Task	Progress (%)	Count
Images to Sort	100%	1336
Images to Mask	~75%	4628
Reconstructions to Process	0%	0



Since the inception of the project, the effort of volunteers from around the world has been instrumental in the successes of the project. The people offering their help and support has been overwhelming at times for only two people to manage in their free time, but thanks to social media, our Slack channel, email conversations, and video discussions we've been able to direct their effort. Moreover, many more 3D reconstructions have been created by the volunteers than through our own work. The volunteers have also been included in media interviews and we promote they demonstrate their work at cultural heritage conferences and events.

3D/4D gallery



The most interactive section of the Rekrei platform is the gallery which integrates embedded Sketchfab viewers for each reconstruction. Once a volunteer finishes with photogrammetric processing, they simply upload and tag the model on Sketchfab, and then the model immediately appears in the our gallery. Thanks to recent improvements in the Sketchfab viewer, visitors to the gallery can interact with the 3D models on any device as well as Google Cardboard. Specific visualization developments were also exclusively organized with Sketchfab for the 4D reconstruction of Durbar Square in Kathmandu.

Network of private and public partners

Currently, the partners come from academic research institutions such as digitalMED at the University of Murcia in Spain, the Institute for Photogrammetry at the University of Stuttgart in Germany, the Fondazione Bruno Kessler in Trento, Italy, and the Center for Visualization and Applied Spatial Technologies at the University of South Florida, USA. As mentioned previously, Sketchfab provides the embedded viewers for the reconstructions. Private companies which develop photogrammetry software and offer licenses to our project's participants are Agisoft Photoscan, nFrames, and 3Dflow. The Economist Media Lab has

been a very active partner through their collaboration on the development of a VR museum application and exhibitions. Finally, CyArk and AD&D 4D offer their support as digital cultural heritage organizations.

VR museum application prepared for public distribution

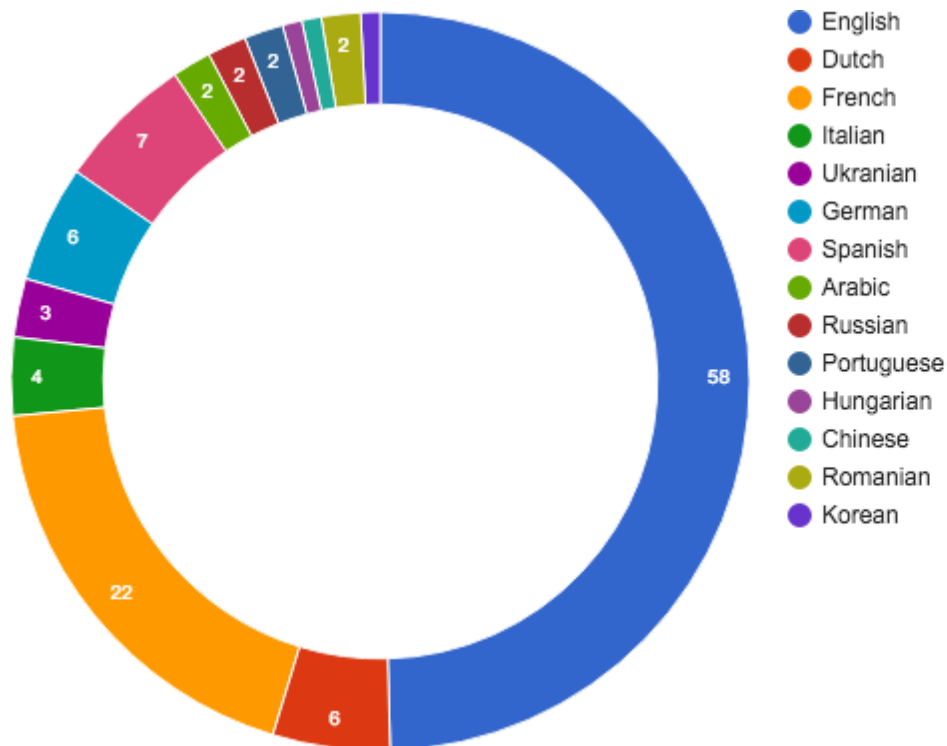


Last November, the dream since the project's beginning was realised during a short exhibition in Amsterdam thanks to the Economist Media Lab (<http://labs.economist.com/>). A virtual recreation of the museum was modelled and then the 3D artefacts were virtually returned to the museum, along with references to the volunteers who recreated them. The model was enriched further with an audio track with interviews from cultural heritage specialists. In addition to providing a VR experience to the public, three 3D printed artefacts were also on display, providing a dramatic representation of preserving the memory of lost cultural heritage.

Enthusiastic support from academia, government and private sectors

Since the beginning, our project has sought to communicate with experts in the archaeological community as well as government and private organizations. Their official and unofficial endorsement of our initiative was essential because a similar project had yet to exist and the nature of digital reconstruction of cultural heritage is still quite new to the public on an international scope. The Gilgamesh Center for Antiquities and Heritage Protection in Iraq, the Iraqi ambassador to Germany, the former curator of the Mosul Cultural Museum, UNESCO and the European External Actions Service are some of the many people and organizations that have encouraged the project's development.

Media Coverage



Interest in reporting on the project started only a short time after the launch of the website. As reporting of the project increased, so too did the number of volunteers and image uploads. The primary languages of media coverage have been in English and French, yet other articles and interviews have been published widely in other languages. Rekrei is also actively participating in upcoming documentaries in French and German which investigate the topics of cultural heritage destruction and digital reconstruction. More recently, a review of the project was produced by a group of graduate students in the UK and published on Medium.

Selected links:

BBC News	BBC World Radio (@ 09:12)
Medium	The Economist podcast part 1
PBS	The Economist podcast part 2
Techcrunch	Le Monde