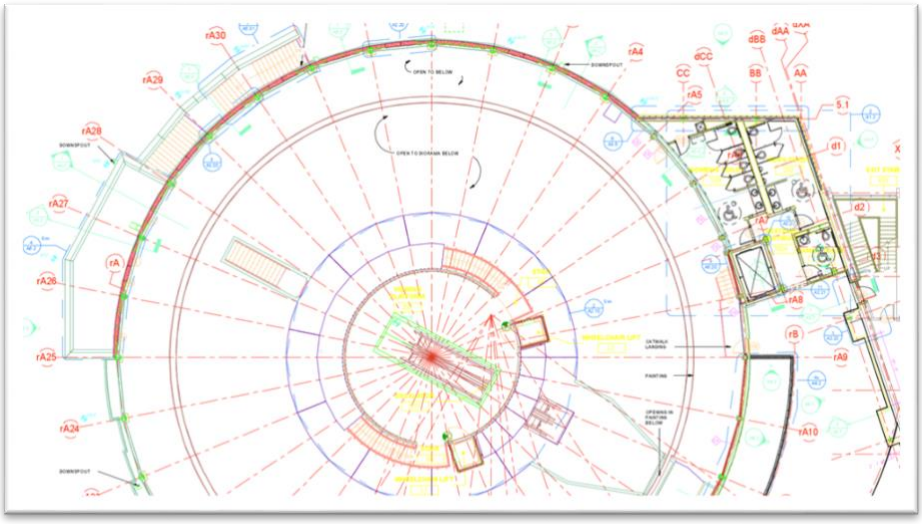
Augmented History: Battle of Atlanta Cyclorama

Introduction

A behemoth painting measuring 49 feet high and 358 feet in length, the Battle of Atlanta Cyclorama[1] exhibits opened to the public at the Atlanta History Center on February 22, 2019[2], fully restored to its original form as painted by the artists of the American Panorama Company in the 1880s. The Cyclorama is an immersive experience depicting the battlefield at approximately 4:45 p.m., July 22, 1864. In 1840, Atlanta was a nexus of the railroads. As a result, it had grown into a bustling small city as a Southern industrial base. As Sherman prepared to fight his way across Georgia, the city became a valuable asset for both the North and the South. In the summer of 1864, William Sherman maneuvered his army to the outskirts of Atlanta, fighting several Confederate generals, and after four months and roughly 50,000 casualties, conquered the "Gate City of the South."



[1] Cyclorama: The Big Picture

[2] A Giant and Long-Contested Civil War Painting Returns to Its Former Glory

In 2017 the Emory Center for Digital Scholarship and the Atlanta History Center began a collaboration to develop an educational application to accompany the opening of the Cyclorama that would enable easy identification and illustration of significant points-of-interests (POIs) embedded in the painting.

Augmented Reality (AR) is a technology that superimposes a computer-generated image and or 3d model on the user's view of world, providing a composite picture. Chosen as a tool to enhance the scholarship of the Cyclorama painting, AR enables a smart device, such as a smartphone or tablet, to scan for an image target in the painting. Once the device locates an image target, it calls on the application to augment more information about a particular POI, (as depicted below).

Implementing a working AR experience

There are many ways to achieve an AR experience, but a marker-based AR approach was chosen for the Cyclorama project. Marker-based AR is a variant of standard AR practices that allows you to scan physical images, "markers," and render a 3D model, another image, video, or scene and interact with it using the smart device. Marker-based AR application relies on a predefined feature, a close approximation of the physical target image, which helps it to recognize and trigger augmented content on top of the physical target image. An image target is how the AR software development kit (SDK), Vuforia, defines its augmentable anchors. The SDK can recognize and track these anchors by analyzing the contrast-based features of the image target that are visible to the smart device's camera in real-time.

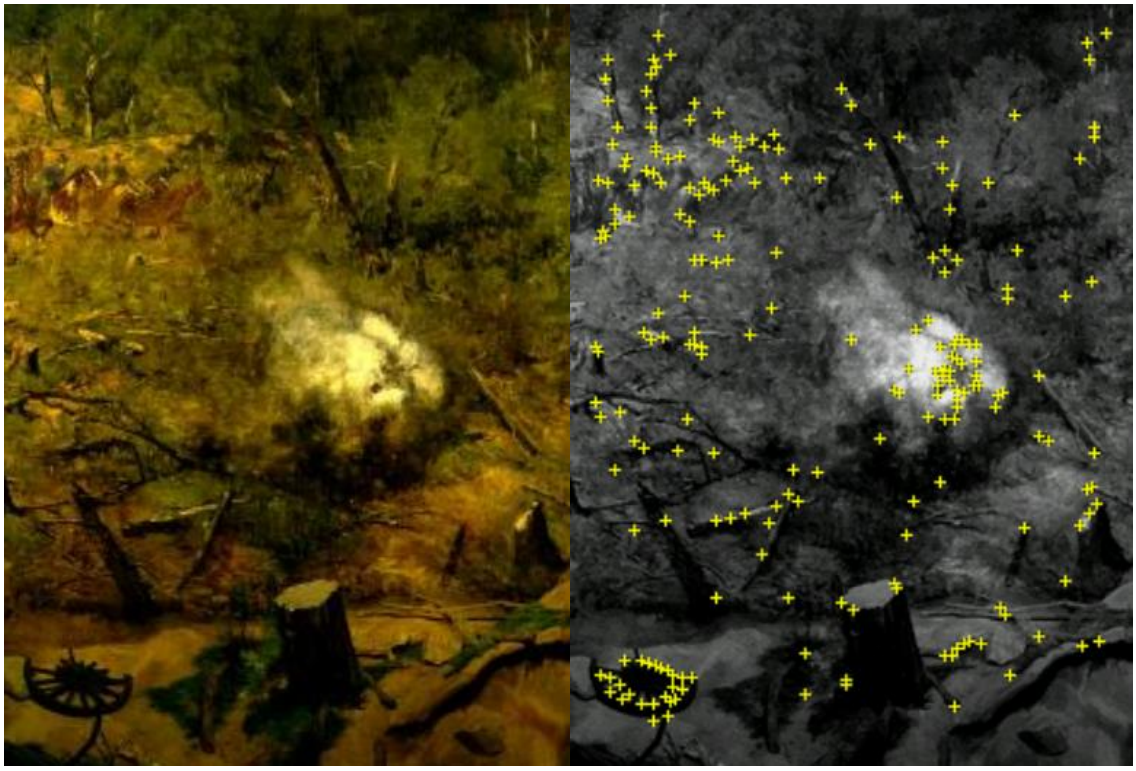
A seamless AR experience encapsulates a consistent and smooth triggering of the POIs. But there are practical limitations.

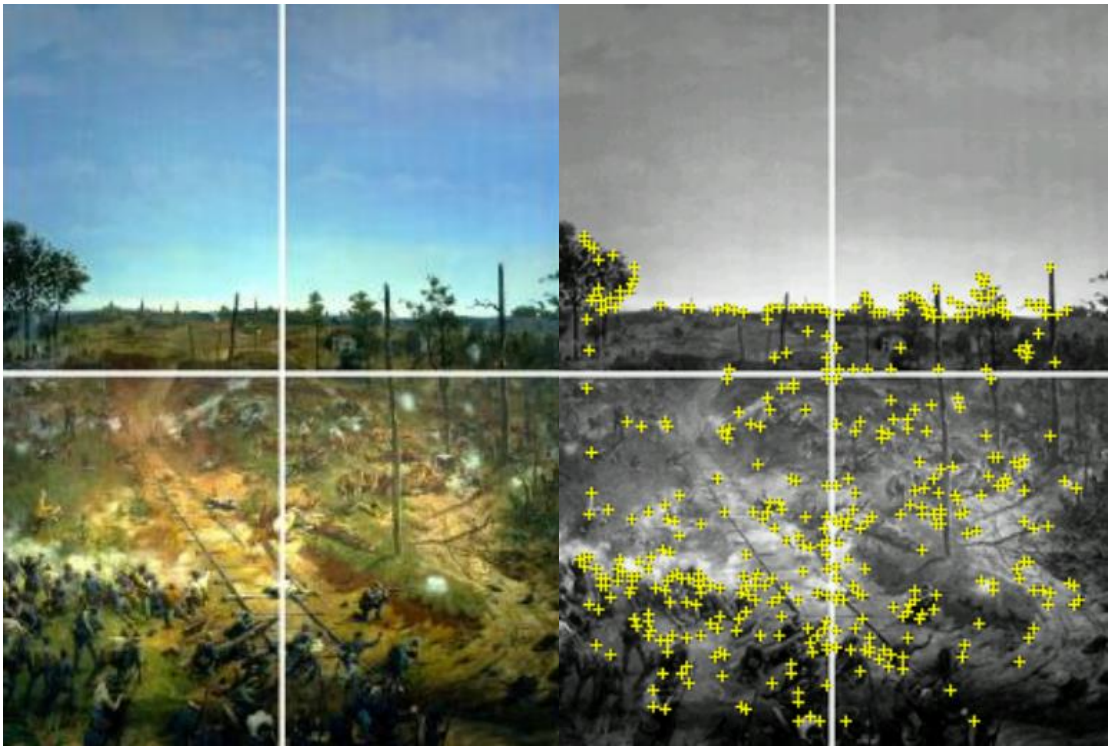
1. Zero training AR
   The marker-based approach tethers the triggering of POIs to a physical location in the Cyclorama painting. These markers are flat images representing the target POI in a neutral setting. But user behavior and handling are seldom neutral or consistent. Ideally, if a user can hold the smart device orthogonally to the POI in question, the app would pop up

relevant information about that POI. Without prior training and exposure to AR applications, an unassuming user won't be able to hold the smart device in sync with the POI to trigger the marker.

2. Focused triggering
   There is an inherent dependency of the target POI to be in focus so that the smart device's camera can recognize it. If the target is not focused well in the camera view, the camera image result can be blurry, and the target details can be hard to detect. As a consequence, detection and tracking performance can be negatively affected. On the other hand, a constant auto-focusing will ultimately drain more power from the smart device, thereby rendering a long AR experience non-existent.

3. Target star rating
   Image targets in Vuforia SDK are detected based on natural features that are extracted from the target image and then compared at run time with features in the live camera image. The star rating of a target ranges between one and five stars. Below is an example of two image targets (low and high star ratings) with the local image features marked in yellow pluses alongside it.



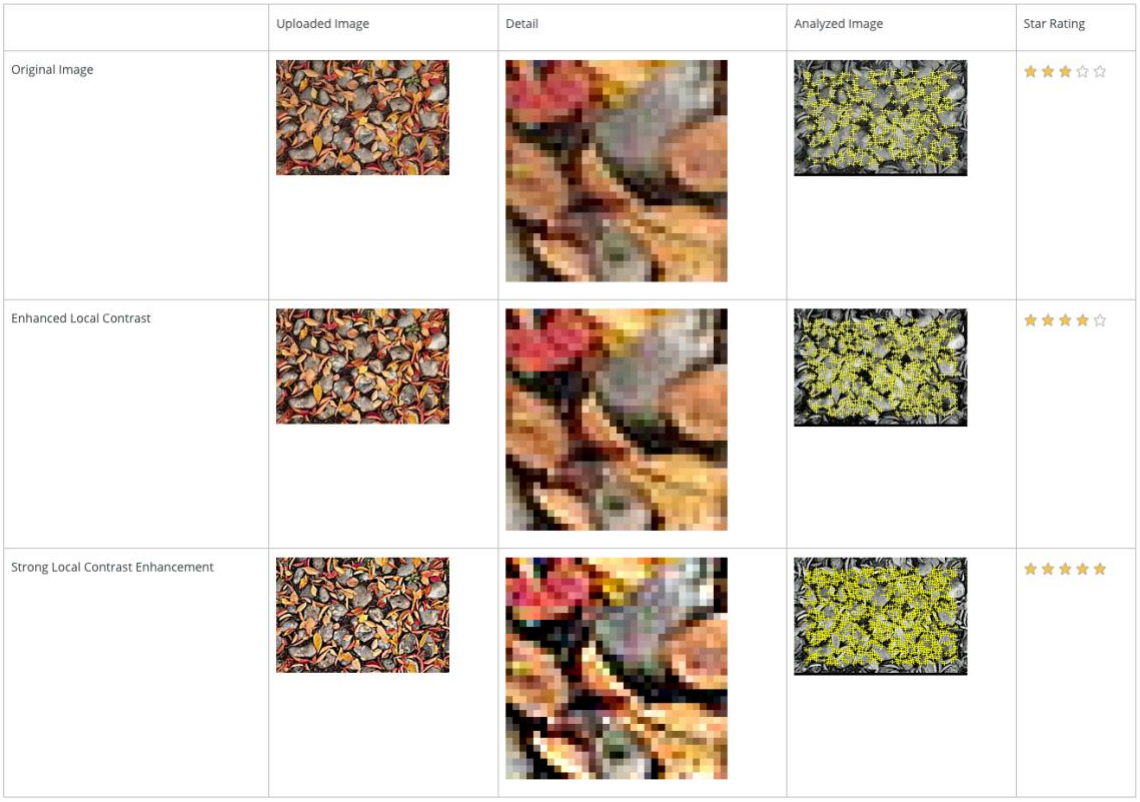


As seen from above, the painting is a continuum of battlefield events frozen in a single scene. Consequently, there are areas of the picture that are sparse in action, and there are denser areas of the painting rich in movement. It makes the POIs around the scattered regions of the image less augmentable.

4. Lighting conditions
   The lighting conditions (physical) in the test AR environment can significantly affect target detection and subsequent tracking. The camera view on the smart device needs enough light in the operating environment to approximately match the trigger image target. Vuforia SDK works best in indoor settings where the lighting conditions are stable and controlled. It is a significant hurdle for AR to cross. There is much scholarly engagement that remains untapped in the real world.

5. Target size
   Typically, the general use case of a standard AR experience would constitute augmenting a business card or reading more to a wine label using the marker-based AR philosophy. The Cyclorama is an entirely different story. The distance from the Cyclorama viewing platform to the painting is roughly 12 meters. To engage the POIs at this distance, we had to forego the independent target image triggering. Instead, we opted for a multi-target trigger approach. A multi-target consists of multiple image targets in a defined geometric arrangement. The position and orientation of each image target within a multi-target is defined relative to the origin of the multi-target, which is at its volumetric center. We modified the dataset configuration XML file of the multi-target to account for the geometric shape and curvature of the painting. The modified approach is more stable than the independent triggering of POIs.

6. Image target attributes: flatness and glossiness
   An ideal image target should not have glossy appearance and should be flat. The Cyclorama being a fixed circular exhibit space, the POI image target attributes are less than ideal. We worked around this problem by focusing on the local contrast feature of each target POI instead of its shape as shown below as an example.



7. Viewing Angle
   The Cyclorama is a large painting housed inside a rotunda with a circular viewing platform. By virtue of walking on the viewing platform, the image targets can be harder to detect, and tracking can also be less stable if the user is looking at the image targets from a very steep angle. Once again, the multi-target trigger mechanism helped us get around the problem of less than ideal viewing angles.

Closing remarks

The entire developmental journey of the Cyclorama AR app experience was riddled with hard to solve problems ranging from multi-faceted usability issues to inconsistent image target triggering. During this phase, multiple localized user studies were deployed to gauge unassuming AR user behavior. But none of that distracted the dedicated team at the Emory Center for Digital Scholarship and the Atlanta History Center from achieving a smooth and consistent AR experience of the Battle of Atlanta Cyclorama.

Tools of the trade

- Unity game engine
- Vuforia SDK