Image based rendering of large historical image collections

Keywords

Image based rendering, Real-time rendering, 3D, Uncertainty.

Context and Research Goal

With the advent of large historical image collections (postcards, engravings, paintings, street level or aerial photographs...), the classical approach, consisting of browsing image galleries, is likely not providing sufficient context to give users an immersive feeling, for them to fully understand the context and spatial relationships between images. We propose to enable the discovery and continuous navigation within these image collections through space and time. However, this cannot be based on the rendering of 3D models as they may not be available and their 3D reconstruction may be impossible due to insufficient data. Whereas recent datasets may present massive amounts of precisely calibrated images and accurate 3D models and point clouds, with dense viewpoint sampling and homogeneous radiometry (e.g. using mobile mapping systems [Paparoditis12]), historical datasets are likely featuring sparsely sampled image viewpoints, and thus their calibration and pose estimation [Aubry14] may be imprecise. Moreover, pixel values may not be directly comparable (due to the digitization process or scene and illumination changes, for instance). By morphing and blending input images, Image based rendering techniques (IBR) may synthesize novel views from calibrated images [Hedman16] and may handle little or no geometrical information [Buehler01, Goesele10]. Contrary to textured models, a novel IBR view from the viewpoint of an input image may directly display that image. This is a valuable property of IBR techniques: their resulting image quality degrades gracefully as the synthesized viewpoint departs from the viewpoints of the input images. IBR techniques have been extended to take some aspects of uncertainty into account [Eisemann08, Brédif14] or heterogeneous datasets (such as point clouds and simplified meshes in [Devaux16]).

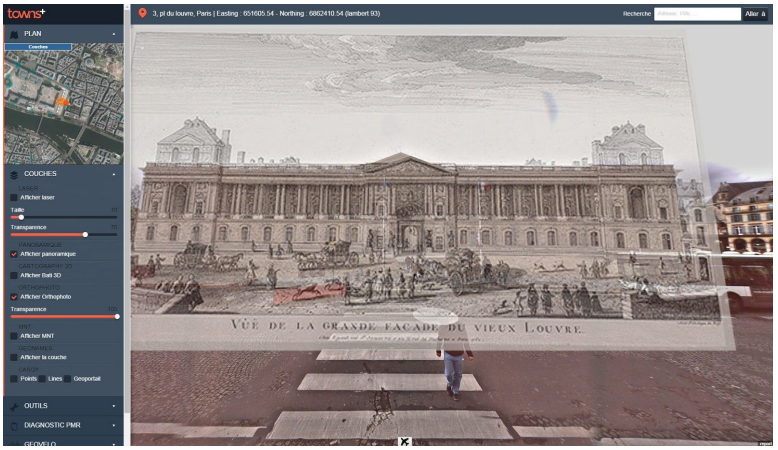

Figure 1: Co-visualization of an historical postcard within an immersive webGL application featuring image-based rendering of recent street level images (iTowns).

Approach

Research will be conducted to tackle the following scientific aspects:

- In order to reduce rendering artefacts, uncertainty will be taken into account at all levels : relative or absolute poses/extrinsics, intrinsics, distortions, 3D geometry, etc, extending prior work [Eisemann08, Goesele10, Brédif14] to the uncertainty of both the viewing camera and the texturing cameras, ensuring that IBR is only affected by uncertainties relative to the viewing camera, such that rendering an uncertain image from its own view yields the unmodified image.
- Historical images may suffer from non-perspective distortions, so that visualizing a non-perspective image in context requires to apply the inverse distortion to the rendering of

the surrounding scene, possibly as an extension of [Lorenz09]. Likewise IBR techniques require reprojecting the input image and will have to take into account the distortion parameters and their uncertainty.

- Heterogeneous datasets have heterogeneous radiometry (pixel values), which is a property that the user may either like to enhance (to drive the user focus to a given subset of the input images with a gray level or blurred rendering of other images for instance) or to limit (eg by colorizing and applying gradient-based IBR techniques).

Due to the massive amount of recent and historical images, the proposed approach will focus on its performance and scalability, as the goal is to propose a real-time, interactive and continuous navigation through these large image collections.

Funding

This PhD position is funded by the French research project ALEGORIA (ANR). This project targets the valorization of large national iconographic collections, composed of photographs and postcards from vertical and oblique aerial imagery as well as terrestrial/street-level acquisitions. These collections are very rich in terms of content and span an extended historical period from between-wars to today. The ALEGORIA project as a whole focuses on indexing, interlinking and visualizing these datasets.

Advisor

Mathieu Brédif, Researcher, mathieu.bredif@ign.fr doing research on processing and real-time rendering of point clouds and images. LaSTIG/GeoVIS team, Paris-Est University/IGN

Prerequisites

Computer Graphics with experience in js/WebGL programming (cf our research platform iTowns).

Location

The PhD will take place at IGN, Saint-Mandé, very close to Paris, and the research will be conducted in the LaSTIG/GeoVIS team focusing on issues in geovisualization and interaction with spatial data for visual spatio-temporal analytics.

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