Inpainting Using Intrinsic Images

Advisers
George Drettakis, Adrien Bousseau, Inria Sophia Antiopolis
drettakis@inria.fr, adrien.bousseau@inria.fr
http://www-sop.inria.fr/members/George.Drettakis/
http://www-sop.inria.fr/members/Adrien.Bousseau/
Patrick Perez, Technicolor Research and Innovation, Rennes
http://www.erikreinhard.com/index.html

Context and Research Challenge
The goal of inpainting methods is to fill holes in photographs, for instance to restore old pictures or to remove unwanted objects, as shown in Figure 1. One of the main difficulties of these methods is to identify which pixels of the image could be copied into the region to be filled. Many methods exist to perform this search quickly [Barnes et al. 2009] and apply different similarity criteria such as rotation and scale [Darabi et al. 2012] or favor pixels lying on similar planes [Huang et al. 2014]. Nevertheless, a single image does not always contain enough information to properly fill the hole. In particular, while some parts of the image may share the same material and texture, their lighting often differs. Similarly, areas that receive the same lighting may differ in materials. In general, appropriate metrics for finding matching patches is a hard problem without a satisfactory solution to date.

![Inpainting Example](image)

*Figure 1: Inpainting algorithms can fill holes by copying pixels from other parts of the image*

Approach
The goal of this project is to improve inpainting algorithms by using intrinsic decompositions and by investigating learning-based patch matching approaches.

We will first enrich inpainting algorithms with knowledge of lighting and materials in the scene, so that regions with different lighting could still contribute to the inpainting of materials, and vice-versa. We will use the method of [Bell et al. 2014] to provide an initial decomposition into materials and lighting of the photograph (Figure 2). This decomposition is the basic ingredient to inpaint material and lighting independently. We will then modify the method of [Wexler et al. 2004] to incorporate reflectance similarity and shading similarity in the matching metric of the algorithm. We will also investigate how to combine a separate synthesis approach for reflectance then shading, which can then be used to guide the inpainting, in the spirit of Image Analogies [Hertzmann et al. 2001].
We will also investigate ways to improve matching of patches, using learning-based descriptors. We will investigate the use of texture similarity filters based on Convolutional Neural Networks (e.g., [Cimpoi et al. 2014]) and compare them with the traditional difference measures. Possible additional directions of research include:

- Incorporating interaction in the inpainting task, for example a stroke-like interface to inform the system that “this is the same lighting (or material)”. This information can help both the intrinsic decomposition [Bousseau et al. 2009] and the inpainting itself.
- Using semantic segmentation (for example based on learning from recent databases of materials\(^1\)) to determine the class of objects to be inpainted, which in turn can help guidance for inpainting.

**Implementation.** The intern will use existing code for the intrinsic image decomposition, and will build an inpainting system similar to [Wexler et al. 2004] based on existing libraries available in the group. The implementation will be in C++.

**Requirements/Location**
The successful candidate should have taken courses in Computer Graphics and/or Computer Vision (preferably both). The internship will take place at the GRAPHDECO ([http://team.inria.fr/graphdeco](http://team.inria.fr/graphdeco)) group at Inria Sophia-Antipolis, in the beautiful French Riviera.

**References**

---

\(^1\) [http://opensurfaces.cs.cornell.edu/publications/minc/](http://opensurfaces.cs.cornell.edu/publications/minc/)