Measuring and modeling aging effects on the appearance of alabaster artifacts

Romain Pacanowski
romain.pacanowski@inria.fr
April 19, 2021

Keywords: Materials, Applied Optics, BRDF, diffusion, Rendering

Scientific priorities:

1 Scientific Research Context

The human and social sciences (SHS) are facing new societal challenges with the preservation of heritage, but also new opportunities thanks to the progress of opto-numeric technologies and 3D in general. Digitizing ancient cultural heritage objects helps their preservation. 3D digital tools allow us to better understand how our ancestors perceived the objects or to determine the different stages of degradation that led them to their current appearance.

This post-doctoral fellowship offer is part of this interdisciplinary context where experimental optics and computer graphics must bring tools to answer these problems related to heritage.

More precisely, the objects of study are authentic and reconstructed alabasters (cf. Figure 1a and b) as well as work samples. These alabaster have the particularity of having been covered with different layers of paint (cf. Figure 1c). In its raw state, alabaster has the optical property of diffusing light inside the whole volume of the object.

Although the field of application is that of alabaster, the methods, techniques and devices developed should remain as general as possible in order to use them in a broader context.

![Figure 1: (a) Original Alabaster from Medieval Times. (b) Completely reconstructed Alabaster made by a sculptor and an archeo-artisan. (c) Paint samples, deposited on raw alabaster material, made by the archeo-artisan to work on several hypothesis. (d) Ptolomees vase (front face): The light striking the vase is reflected and diffused in the whole volume.](image-url)
2 Work Description

The first objective of the proposed work is to measure these diffusion properties (e.g., absorption, scattering and phase functions) on the alabaster (cf. Fig. 1b) to infer whether the diffusion is strong enough to have an influence on the final appearance of the alabaster covered with paints. This will be possible thanks to the measurements already made in reflection on alabaster with the help of the Coupole: an appearance measurement system (cf.[MSM+20]) that has been developed inside the Manaoo team under R. Pacanowski’s supervision.

Traditionally, the radiometric quantity to describe this light diffusion in a volume is called the BSSxDF (cf. [NRH+77]). There can be both lateral transport in reflection (BSSRDF) but also in transmission (BSSTDF). However, these quantities are only valid for quasi-planar samples (i.e., where the shape of the object is not taken into account). Therefore, measuring physical parameters (absorption, scattering, phase functions) of diffusive materials, on a complex object is very challenging.

The second objective is to establish an (or several) analytical model(s) that predicts how paintings (and alabaster) age depending on different physical parameters such as humidity, heat, etc.

To achieve the above stated objectives the following work items are planned:

(i) To establish a state of the art regarding the measurement of spectral and polarized BSSxDF using imaging system.

(ii) To design a simplified experience, but metrologically adequate, to acquire the appearance, of the alabaster under controled illumination (very colimated light source) for a few observing directions.

(iii) To develop an imaging system for BSSxDF that will be used on material samples (cf. Figure 1c.) to infer absorption and scattering coefficients and phase function (in the spirit of e.g., [GZB+13]).

(iv) To compare the appearance simulated with the previous parameters with the one obtained in (ii).

(vi) To establish an up-to-date state of the art for aging appearance models (cf. [DR09, MG08]) specifically for medieval paints (SV-BRDF) and alabaster (BSSxDF).

(vii) To assess the quality of the found models by comparing them to measurements made on a renovated piece vs. the original artifact (cf. Figure 1a and Figure 1b).

(viii) If necessary, to develop new models that predicts more precisely the aging appearance for alabaster materials.

3 Required Knowledge and background

We are looking for a candidate with strong knowledge in Computer Graphics but also in Optics applied to measurement science. Computer Vision skills and the knowledge of the OpenCV library would also be beneficial.

Expected Programming Skills:

- C++
- Matlab or Python with NumPy for prototyping aspects especially regarding the modeling part of the project.
References


