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## Multi-scale Vectorial Representation of Rich Appearances

**Keywords:** Multi-scale representations, Appearance representations, Shape analysis, Real-time rendering

### Scientific context

In the last decade, the domain of Computer Graphics has exhibited tremendous improvements in image quality. This is mainly due to the availability of rich appearances obtained as the combination of an ever increasing amount of shape and material details which are either created by artists in modern digital sculpting, or painting applications, or densely scanned from real-world objects. Unfortunately, such a visual richness implies huge masses of data such as the finely tessellated meshes combined with high-resolution textures found in 3D applications. Such dense representations exhibit severe limitations regarding the generation of level of details (LOD), as well as editing, abstraction, and animation abilities since, 1) input data contain no semantic information, and 2) appearance is decoupled as a micro geometry and a material components. Indeed, there is always a scale for which the frontier between geometric details and material properties is fuzzy.

### Goals

In this context, the main goal of this thesis will be to study a novel representation of appearance tailored to the creation and manipulation of highly detailed objects. In order to address the issues found in current approaches, the starting idea is to unify the micro geometry and material properties in a multi-scale and vectorial manner. Here vectorial means the representation will be composed of a sparse set of continuous high-level primitives allowing for infinite zoom, and smart automatic simplification or abstraction.

The main challenge of this thesis is thus to identify the most appropriate family of vectorial primitives for a given application. It raises additional issues though: 1) providing a minimal set of tools for defining, manipulating, and assembling the primitives; 2) offering real-time rendering and manipulation routines that work directly at the primitive level; and 3) converting geometry provided in raw data format to our vectorial format via feature extraction mechanisms.

Beyond the scientific goals, this project is further motivated by high needs from the 3D content creation industries. For instance, during the PhD thesis, it is expected to have close collaborations with Luxology (Modo), or Autodesk (MudBox), with which we already have privileged contacts. While the thesis will be mainly focused on 3D graphics, contributions to the world of vector 2D graphics might also happen as it is both a source of inspiration and share similar issues. In this regard, we could pursue our existing collaboration with Adobe Research.

### Profile

The candidate should exhibit a strong background in computer graphics: realtime rendering (OpenGL and GLSL), and geometry processing in particular. Some mathematics and programming skills will be required. Finally, a knowledge of existing 3D modeling and painting tools (e.g., Z-brush, MudBox, Mari, Modo, Maya, 3DS, Blender) would be a valuable plus for the project.