

Superpixel Generation by Agglomerative Clustering With Quadratic Error Minimization

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Abstract: Superpixel segmentation is a popular image pre-processing technique in many computer vision applications. In this paper, we present a novel superpixel generation algorithm by agglomerative clustering with quadratic error minimization. We use a quadratic error metric (QEM) to measure the difference of spatial compactness and colour homogeneity between superpixels. Based on the quadratic function, we propose a bottom-up greedy clustering algorithm to obtain higher quality superpixel segmentation. There are two steps in our algorithm: merging and swapping. First, we calculate the merging cost of two superpixels and iteratively merge the pair with the minimum cost until the termination condition is satisfied. Then, we optimize the boundary of superpixels by swapping pixels according to their swapping cost to improve the compactness. Due to the quadratic nature of the energy function, each of these atomic operations has only $O(1)$ time complexity. We compare the new method with other state-of-the-art superpixel generation algorithms on two datasets, and our algorithm demonstrates superior performance.

Interactive Iconized Grammar-Based Pailou Modelling

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Abstract. Pailous are representative Chinese architectural works used for commemoration. However, their geometric structure and semantic construction rules are too complex for quick and intuitive modelling using traditional modelling tools. We propose an intuitive modelling system for the stylized creation of pailous for novices. Our system encapsulates structural components as icons and semantic layouts as topological graphs, using which users create and manipulate icons with topological recommendations. The interpreter automatically and immediately transforms a graph to its corresponding model using built-in components with the proposed parametric L-system grammars derived from architectural rules. Using this system to re-create existing representative pailous and design imaginary ones yields results with the desired visual complexities. In comparison to Maya, a 3D modelling tool, when modelling a pailou and toukung, our system is effective and simple, and eliminates the need to remember and understand complex rules.

Physically Based Real-Time Rendering of Teeth and Partial Restorations

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Abstract. Visually accurate real-time rendering of teeth has many applications ranging from computer games to dental computer aided design (CAD). Similar to skin, the realistic and physically correct appearance of teeth cannot be achieved by simply using opaque diffuse textures, mainly because of the subsurface scattering behaviours of both. While both have a layered structure in common, the scattering characteristics of the teeth layers are drastically different from those of the skin, making rendering much more complicated. We present an approach which uses the Henyey-Greenstein scattering to achieve a near realistic real-time rendering of human teeth. To simulate the multi-layered geometry of teeth, we use standardized teeth models with dentin cores and fit them to real scanned teeth or dental restorations. By using a proxy geometry to compute the scattering, we can also render partial restorations as they would look like when attached to the remaining teeth. Finally, we compare our results to the VITA shade systems and human teeth to evaluate the visual fidelity of our approach.

Automatic Design of Cable-Tensioned Glass Shells

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Abstract. We propose an optimization algorithm for the design of post-tensioned architectural shell structures, composed of triangular glass panels, in which glass has a load-bearing function. Due to its brittle nature, glass can fail when it is subject to tensile forces. Hence, we enrich the structure with a cable net, which is specifically designed to post-tension the shell, relieving the underlying glass structure from tension. We automatically derive an optimized cable layout, together with the appropriate pre-load of each cable. The method is driven by a physically based static analysis of the shell subject to its service load. We assess our approach by applying non-linear finite element analysis to several real-scale application scenarios. Such a method of cable tensioning produces glass shells that are optimized from the material usage viewpoint since they exploit the high compression strength of glass. As a result, they are lightweight and robust. Both aesthetic and static qualities are improved with respect to grid shell competitors.