Synopsis

Creating aesthetically pleasing, *fair* curves and surfaces is a principal issue of Computer Aided Geometric Design (CAGD). It is especially so in Digital Shape Reconstruction (DSR), which deals with the creation of geometric models based on measured data. It is a very complex procedure, where even slight measurement errors can cause significantly decreased quality.

Fairing constitutes the final phase in the DSR pipeline, having a direct effect on the output. A **new smoothness measuring method** was introduced for identifying low-quality areas, and **efficient curve and surface fairing algorithms** were proposed that minimize this measure in order to improve the model.

Most real-life objects, where appearance counts, contain smooth edges, usually defined by fillet surfaces and corner patches. These need to be continuously joined to the primary surfaces, so besides individual fairing, care should be taken to enhance the connections between surfaces as well. **A novel fairing mechanism was established that goes through the patches in a hierarchical order**, always retaining and enhancing continuity to the surfaces higher in the hierarchy. Special **master–slave algorithms were developed for numerical continuity enhancement**, which are glued together by a framework **capable of handling patches with an arbitrary number of sides**.

Another fundamental application of fairing is in surface design. One modeling approach is to first create a curve network representing the edges and feature lines of the actual object. The curves may come from several sources, like traditional blueprints, 2D sketches, or directly by some GUI interface. In this context, we have no information on the interior of the surfaces, so transfinite interpolation, which defines patches solely by their boundary curves, seems to be an ideal choice for generating surfaces.

The Coons patch is a well-known example for four-sided configurations, widely used due to its natural curvature distribution. Popular n-sided variants of the Coons patch, however, do not exhibit the same nice properties. In order to resolve the issues of conventional methods, **a line sweep parameterization** and **curved side interpolants** were proposed, along with **three new algorithms for creating non-regular domain polygons**.

Two novel surface representations were also introduced: the first one can be regarded as the **direct generalization of the Coons patch**, using linear ribbons, and the second is a **natural application of curved side interpolants**. In addition, **several new parameterization methods were developed** that satisfy the more strict requirements of these surfaces.

We believe that these patches offer numerous advantages over traditional control point-based approaches, especially in 3D curvenet-based design.