Evolution of apparent contours

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The contour generator of a smooth surface, under parallel or perspective projection, locally separates backward and forward facing regions on the surface. It consists of those points on the surface where the normal is perpendicular to the direction of projection. The apparent contour is the projection of the contour generator onto the image plane. See Figure 1. The contour generator and the apparent con-

Figure 1: The contour generator and the apparent contour. The red segments correspond to tangent lines of the surface, parallel to the direction of projection. The locus of the points of tangency is the contour generator, its projection onto the view plane is the apparent contour.
tour play are important visibility features of a smooth surface, e.g., in connection with visualization. Koenderink [Koe90] describes in a very intuitive style the geometric features of curves and surfaces relevant for geometric computing. The silhouette of a surface is the curve in the view plane that separates the projected surface from the background. It is a subset of the apparent contour, that plays a prominent role in non-photorealistic rendering, cf. [BH98] and silhouette clipping [SGG+00]. In computer vision [CG00] techniques have been developed for partial reconstruction of the geometry of a surface from a sequence of apparent contours corresponding to a discrete set of projection directions.

Generically, the apparent contour is a smooth curve consisting of several components, and the contour generator consists of regular points and isolated cusp points, like the sharp beak-shaped points in the rightmost column of Figure 2. Moreover, the apparent contour may have self-intersections, which correspond to distinct points on the contour generator being projected to the same point on the apparent contour.

![Figure 2: A beak-to-beak bifurcation. Top row: a sequence of views of a smooth surface. Middle row: the corresponding apparent contours. Bottom row: blow up of the apparent contour near the bifurcation event.](image)
The connected components of the contour generator may merge or split when the projection direction changes, or when we rotate or deform the surface. Such visual events, or singularities, correspond to non-generic views of the surface, but are unavoidable if the position or shape of the surface changes continuously. Other types of visual events are related to the birth or death of components of the apparent contour.

Algorithms computing the apparent contour are reported to crash if the the evolution of the surface gives rise to the occurrence of these visual events. Therefore, a better understanding of these events is a first step towards a more robust computation of apparent contours. The classification of the various types of visual events, as well as the derivation of simple local models of the surface exhibiting these events, has been achieved using sophisticated methods from singularity theory and differential geometry. In particular, these mathematical methods do not transfer directly to robust numerical computation. An accessible description of the singularity theory behind this classification is contained in [Bru84].

In this talk we review an algorithm for the computation of the apparent contour of implicit surfaces, and describe its generic evolution as the direction of projection changes over time. In particular, we obtain approximate local models describing the generic visual events of evolving surfaces. Furthermore, we discuss how to detect the occurrence of these events for evolving implicit surfaces. Details are described in a forthcoming technical report [SV02].

References


