SCISSORS-ACTION DEPLOYABLES BASED ON SPACE-FILLING OF POLYGONAL HYPERBOLOIDS

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Architecture needs lightweight and kinetic structures that are easy to move and which occupy small volume. Among these, deployable structures, especially those based on scissors action, are of great interest. This paper explores the application of the angulated scissors originated by C. Hoberman (Ref. 1) to periodic deployable structures composed of doubly-faceted curved surfaces. More specifically, we show the applications of the angulated scissors to a special class of facetted structures, which are here termed polygonal hyperboloids. The concept readily extends to other surfaces of translation.

Angulated scissors are obtained when straight scissors are bent to contain an angle as shown in Figure 1.

Figure. 1(a, b)

S. Pellegrino and S. D. Guest (eds.),
A polygonal hyperboloid is a surface of revolution generated by rotating a portion of any segmented curve around an axis of rotation a fixed number of times (Figure 2). This means that all sections perpendicular to the axis are regular polygons. Alternatively, the regular polygon is the directrix and the segmented curve is the generator of the surface. The surface is faceted and each facet is a trapezoid. This trapezoid face determines the plane of the angulated scissors.

Figure 2 (a, b, c) shows perspective views of three stages of deployment of a faceted hexagonal hyperboloid where the angulated scissors lie on the plane of the symmetric trapezoids that define the underlying geometry of the entire surface. Figure 3 shows the elevation and the plan view of the structure in Figure 2 (a).

During the deployment, each angulated scissors moves within the same trapezoidal facet such that the angle between adjacent facets remains fixed. The hinge of each angulated scissors moves along the mirror line of each trapezoid. The smoothness of the surface of these deployables can be controlled by changing the number of segments of the generator as well as the directrix. It is thus possible to vary the curvature (Figure 4), but we find that the greater the curvature the lesser the deployment, and the lesser the curvature the greater the deployment.