Computational method for surface continuity of segmented shell structures

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Abstract

An evolution of generative design processes which taking similar principles of biological processes to translate them to fabrication processes is using the logic of stripes as construction system, in analogy to biological morphogenesis. An already established design methodology is generating bifurcating thin shell structures, linking mesh relaxation process, segmentation process and fabrication process, as one unified system in equilibrium, testing structurality in several different prototypes. However, a discussion has been raised upon the stripes topology and direction in relation with the branching topology of the shell structure, its performance and connectivity, especially in the saddle points. Also, a relation has been observed between stress lines and the deflected areas.

The objective of this article is to develop a creative methodology based partly on the intuition, designer skills and experience and to explore the potentials of state-of-the-art machine learning approach for the selection process between multiple segmentation typologies for the one with the best structural performance and normalized folding angles, which consequently make the stripe deviation more effective for the fabrication process. Considering the above attributes/inputs, a series of databases consisting of geometrical outputs are extracted to help the designer to have a visual judgement of the numerical values based on multifunctional criteria. Finally, the vital benefit of creating such datasets is to be utilized specifically in machine learning, to train an Artificial Neural Network (ANN) to be able to predict a new building information based on a new combination of desired parameters.

The fact that the approach preserves the intuitiveness of a generic design process is the most important landmark to note. This can be further expanded by saying that the implementation of machine learning and artificial neural network in a design workflow can enhance a designer's inventory by providing control over the scalability of a design process or a design outcome.

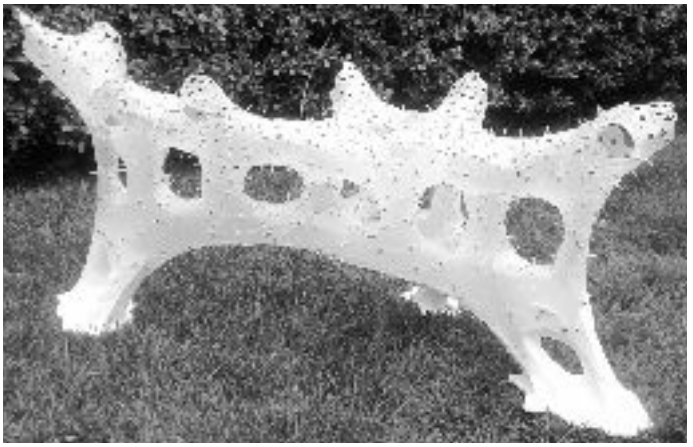

Figure 1. Prototype made of Polypropylene. Segmented minimal surfaces with mechanical joints.