Design and Analysis of Deployable Bar Structures for Mobile Architectural Applications

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Abstract

Deployable structures have the ability to transform themselves from a small, closed or stowed configuration to a much larger, open or deployed configuration. Mobile deployable structures have the great advantage of speed and ease of erection and dismantling compared to conventional building forms. Deployable structures can be classified according to their structural system. In doing so, four main groups can be distinguished: spatial bar structures consisting of hinged bars, foldable plate structures consisting of hinged plates, tensegrity structures and membrane structures.

Because of their wide applicability in the field of mobile architecture, their high degree of deployability and a reliable deployment, two sub-categories are studied in greater detail: scissor structures and foldable plate structures. Scissor structures are lattice expandable structures consisting of bars linked by hinges allowing them to be folded into a compact bundle. Foldable plate structures consist of plate elements which are connected by line joints allowing one rotational degree of freedom. Singly curved as well as doubly curved surfaces are possible.

Although many impressive architectural applications for these mechanisms have been proposed, due to the mechanical complexity of their systems during the folding and deployment process few have been constructed at full-scale.

The aim of the work presented in this dissertation is to develop novel concepts for deployable bar structures and propose variations of existing concepts which will lead to viable solutions for mobile architectural applications. It is the intention to aid in the design of deployable bar structures by first explaining the essential principles behind them and subsequently applying these in several cases studies. Starting with the choice of a suitable geometry based on architecturally relevant parameters, followed by an assessment of the kinematics of the system, to end with a structural feasibility study, the complete design process has been demonstrated, exposing the strengths and weaknesses of the chosen configuration.