GENERATION AND OPTIMIZATION OF TRUSSED TOWERS

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KEYWORDS
Space Truss, Form Finding, Genetic Algorithm, Evolutionary Computation

ABSTRACT
Masts and towers can be both iconic image producing symbols for cities and fairs, as well as very pragmatic civil engineering structures. With the proliferation of cellular telephones, self supporting trussed towers are a common solution to blanket transmission. For broadcast towers the greater height is a positive objective. However higher towers carry more load from wind or earthquake. For this reason, lightweight, open truss forms have an advantage in reducing the loading on the structure. This presentation explores the morphology of trussed towers under different loading conditions and uses Evolutionary Computation (EC) methods to find lightweight solutions.

Genetic Algorithms (GAs) can be used to explore efficient forms for both discrete and continuous structures. The GA based program used in this investigation explores a range of both different geometries and topologies of space truss structures, and allows comparisons to be made based on material efficiency and stiffness. Multiple load patterns (such as wind from different directions and gravity loads) are used to guide the form exploration process. The method allows not only quantitative assessment based on material weight, but also a qualitative comparison of the different solutions based on visual, aesthetic criteria.

Another comparison is made with tower forms produced by students engaged in an architectural competition. Using the same judging criteria that were given to the students, a fitness function was written for the GA program to explore a range of tower heights and weights. Student towers were actually load tested and preformed at a variety of heights under different load levels. The same dimensional range was used in the GA study. Both height and load capacity were maximized while weight of structure was minimized.

Finally, the presentation demonstrates through examples the level of structural complexity of discrete space truss structures that can be explored using GA search methods. A measure of the computational intensity (in time and CPU) is tabulated for each of these examples. Future directions for continuing efforts are projected.