ABSTRACT

Title of Thesis: A Graph Grammar Approach to the Generation of Non-isomorphic Graphs for the Structure Synthesis of Mechanisms

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The objective of this research is to investigate the applicability of graph grammars for the structure synthesis of mechanisms. Much of current mechanism design is based on a systematic method popularized by Freudenstein and Tsai (among others). Since it relies on algorithmic abstractions of graph theoretic principles, a graph grammar is a more natural expression for the method. For example, one assumption of the algebraic method is that the graph representation of mechanisms involves only planar closed loop graphs with no parallel edges; the start graph for our grammar is the (3, 3) graph which is the simplest graph satisfying these conditions. Subsequent application of our grammar rules preserve these requirements. The grammar rules add additional vertices and loops to obtain desired structural requirements. An important challenge to any graph-based synthesis method is to efficiently identify and eliminate isomorphic graphs. A grammar adaptation of an existing linear time algorithm for the detection of isomorphism is also presented in this thesis. The mechanism grammar coupled with the isomorphism detection grammar have the potential to produce mechanism atlases of high order; a task essential to but difficult for current design methods. A specialized grammar for the structure synthesis of Epicyclic Gear Trains is also presented in this thesis. A valid graph grammar for structure synthesis of mechanisms enables the eventual automation of general atlas construction and atlas construction for specialized mechanism classes.