EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1023

VEHICLE CONFIGURATION DESIGN USING CELLULAR-DIVISION AND LEVEL-SET BASED TOPOLOGY OPTIMIZATION

RAMANA GRANDHI[(1)], Hao Li[(1)], Marcelo Kobayashi[(2)], RAYMOND M. KOLONAY[(3)]

[(1)]Wright State University, United States
Ramana.Grandhi@wright.edu, li.138@wright.edu

[(2)]University of Hawaii, United States
marcelok@hawaii.edu

[(3)]Wright Patterson Air Force, Base, United States

Keywords: Topology Optimization,Global Optimization,Level-set method

Abstract: While developing new aircraft configurations, the designers have to consider the mission performance based on the requirements on payloads, thermal boundaries, dynamic stability, control effectiveness, and propulsion cycles limitations. Creation of conceptual geometries from simple straight surfaces requires extensive design space exploration for achieving an optimal performance while satisfying multidisciplinary requirements. Always innovative tools are needed for realizing potential configurations with limited computer and manpower resources. In this research a combination of modern optimization methods are integrated for shape and topology evolution of structural components. A combination of global-local optimization with the possibility of multi-objective trade-off solutions is considered. Cellular-division concept is inspired by the division of biological cells in living organisms. The approach starts by taking the Genetic Algorithm (GA) generated binary string (chromosome) for creating the base-line structural topologies using edge production rules and geometric properties. Based on the edge production rules that are developed in cellular-division with dynamic equilibrium, initial edges break points and regions are created. The approach facilitates creation of several conceptual topologies that need to be optimized further, for meeting the multi-physics design requirements. Based on the GA generated populations, many innovative configurations have the potential to be candidate vehicles. Recently level-set based topology optimization has gained popularity due to its advantages in providing smoother boundaries for complex shapes, and also precisely satisfying the local constraints. The implicit boundary definition allows complicated shape changes with a smooth description of structural boundaries, which avoids the ambiguities of intermediate elements within the material domain as appeared in density based method. Cellular-division created geometries need to be optimized for local constraints using an optimization scheme. The proposed design framework integrates level-set method into the cellular-division framework as a local optimizer to form a global-local design scheme with GA. At the global-level, many potential configurations are created using the cellular-division as the initial designs and at the local-level level-set method optimizes these initial designs for strict constraint satisfaction. A combination of these two approaches with their individual strengths are synergistically integrated for evolving a configuration from an open-ended design space. The presentation demonstrates the framework using several benchmark problems of topology optimization and air vehicle structural problems.