A comparison of coordination methods for distributed optimal design in multidisciplinary optimization

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Introduction

Multidisciplinary design optimization of large engineering systems is a challenging task. Typically, the overall system is decomposed into smaller subsystems which are designed in an autonomous fashion (Fig. 1).

Since subsystems influence each other, a coordination method is required to find a design that is optimal for the system as a whole (Fig. 2). Several coordination methods have been proposed in the literature yet no extensive comparison has been undertaken making it difficult to determine which method is appropriate for a design problem at hand.

Numerical Comparison

The coordination methods CO, IPD and ALD are compared on their numerical performance for a set of test problems. The performance is expressed in terms of the global and local convergence. A typical outcome of the global convergence and local convergence is illustrated in Table 2 and Fig 3.

Objective

- Obtain an overview of existing decomposition methods and compare them with respect to their general characteristics.
- Compare a selection of these methods regarding their formulation, numerical behavior, and ease of implementation.

Coordination methods

The following six common coordination methods are evaluated on their characteristics (Table 1):
- Concurrent SubSpace Optimization (CSSO) [1].
- BiLevel Integrated System Synthesis (BLISS) [2].
- Collaborative Optimization (CO) [3].
- Analytical target cascading (ATC) [4].
- Inexact Penalty Decomposition (IPD) [5].
- Augmented Lagrangian Decomposition (ALD) [6].

Conclusions

Six main coordination methods have been compared on their general characteristics. Numerical experiments for CO, IPD, and ALD show that ALD outperforms both CO and IPD, and is able to find accurate solutions at low cost. CO suffers from convergence difficulties due to vanishing gradients. IPD experiences difficulties due to ill-conditioning.

References