8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

DIVE: A NEW APPROACH FOR MULTIDISCIPLINARY OPTIMIZATION

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Key Words: *Multidisciplinary optimization, DIVE*

ABSTRACT

The main objective of Disciplinary Interaction Variable Elimination (DIVE) approach is the unification of commonly used MDO algorithms. In DIVE framework, each discipline provides a meta model and a validity (trust) region around the current design point. This meta model could be, a first or second order approximation of the model, with in general a small trust region or a reduced order model or the full model, when the model is easy to solve. For given system and interaction variables, the response of each meta model is optimal with respect to its local disciplinary variable. DIVE thus, first eliminates local disciplinary variables. Then interaction variables are eliminated by accurately solving an equilibrium system. This system could be seen as the state equation and it is possible to define a corresponding adjoint problem. DIVE is in charge of the optimization at the system level. The trust region is considered as an optimization constraint. When the validity limit of a discipline is reached, DIVE asks for an update of the meta model around the current point. Meta model management is thus embedded in DIVE.

Application:

The Dive approach is demonstrated using Super Sonic Business Jet (SSBJ) test case. This aircraft design problem is divided into several sub-systems, namely, structures, aerodynamics, propulsion, and range modules. Fig. 1 shows data dependencies for this MDO problem as reproduced from NASA-TM-1998-208715. The objective is to have maximum range for given constraints on private and public design variables. Further details about the test case are referred to the same report. The test case problem is solved using MDF, IDF, CO, DIVE and BLISS methods. Randomly selected, 100 different starting points are used for each of this method. For each starting point, number subsystem calls, optimized value of the range is recorded.

Results:

Table 1 shows results obtained with different MDO methods. Compared to other methods, number of times the optimization process converged is higher for DIVE. The standard deviation of optimized range value is minimum for DIVE. Also, the average number of subsystem calls are minimum with respect to MDF, IDF and CO method. This is because, in DIVE approach priority is given to the accurate solution of state equations.

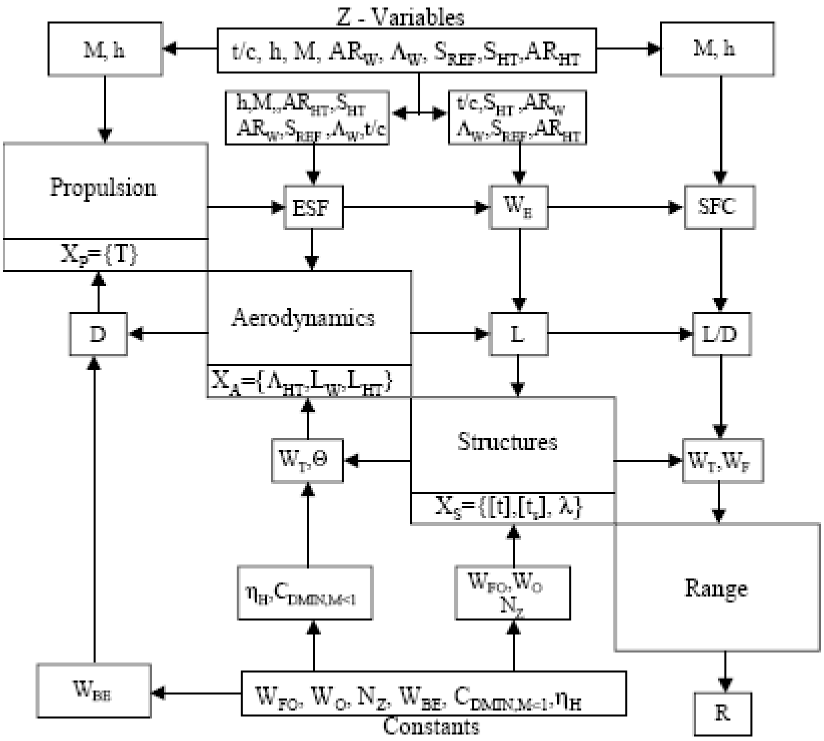

Fig.1: Data dependencies for business jet model

	MDF	IDF	CO	DIVE	BLISS
%optimization converged	59	43	57	98	37
R (min)	2367	2944	711	3482	3465
R (max)	3494	4099	4657	3499	3494
R (avg)	3445	4057	3964	3494	3492
Standard deviation, σ (R)	188	184	550	4	6
No of calls (min)	580	1792	890	342	215
No of calls (max)	87754	14144	46994	1478	461
No of calls (avg)	14612	3565	6850	279	60

Table 1: SSBJ test case: results with different MDO methods

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