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STRATEGIES TO ENHANCE CONFIGURATIONS FOR HIGH-PRECISION MULTI-DISCIPLINARY OPTIMIZATION

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Abstract

For aim to establish a high-precision sensor system configuration, this paper presents a new approach to the software architecture to enhance the multidisciplinary design frame that facilitates the reuse of existing components, the addition new ones, and the scripting of multidisciplinary optimization procedures. Firstly, some strategies applied to implement the necessary components of a high-precision optoelectronic structural design environment for complete sensor system configurations, and demonstrate the advantages with different parts studied, that is optical system module, electronic module, control module, and the relationship among these correlative components. At the core of the configuration is a core photonics to define the system function and role to give solutions to external users, and three so that more than three subjects will be applied cooperative.

Keywords: System Engineering, Information Sensor, Multi-Disciplinary Optimization

1. Introduction

Evolutionary methods for multidisciplinary design problems and their applications have been required for a long time. This field covers a wide domain, including but not limited to that some robust optimizers, parallel computing, asynchronous evaluation strategy, game theory and hierarchical topology of fidelity solution, which reduces the computational cost of multi-objective and multidisciplinary design optimization process.

Researchers aim to solve the practical problems in engineering, which include three types of complexity.

Firstly, it is different from a single optimal solution. Due to the constraints of manufacturing, technology and human resources, there will be trade-offs between conflicting objectives, and without preference information, none of these trade-off solutions can be said to be superior to others.

Secondly, the search spaces of the optimal solutions are usually complex enough, which may involve nonlinear, multimodal and traditional sweep methods. These methods may often encounter problems or eventually fail.

Thirdly, the real world problems usually involve multiple disciplines.

2. Methods

2.1 Solutions

The selection of optimal architecture is a great significance what to provide effective solutions for MDO problems, because an MDO architecture can find feasible solutions and other invalid solutions without consuming huge computational costs. Researchers have developed two algorithms that is the adaptive algorithm A and the adaptive algorithm A+.

2.2 The adaptive algorithm A

The concept is widely used in the field of optimization, and can be understood as a standard method. It can be expressed as:

Hypothesis, $f_A(z, y(x, y, z))$

Achieve, $g_A(z, y(x, y, z)) \le 0$

Here, $f_A(z, y(x, y, z))$ is the objective function; and $g_A(z, y(x, y, z))$ represents the constraints of all systems or disciplines.

This method can be described as,

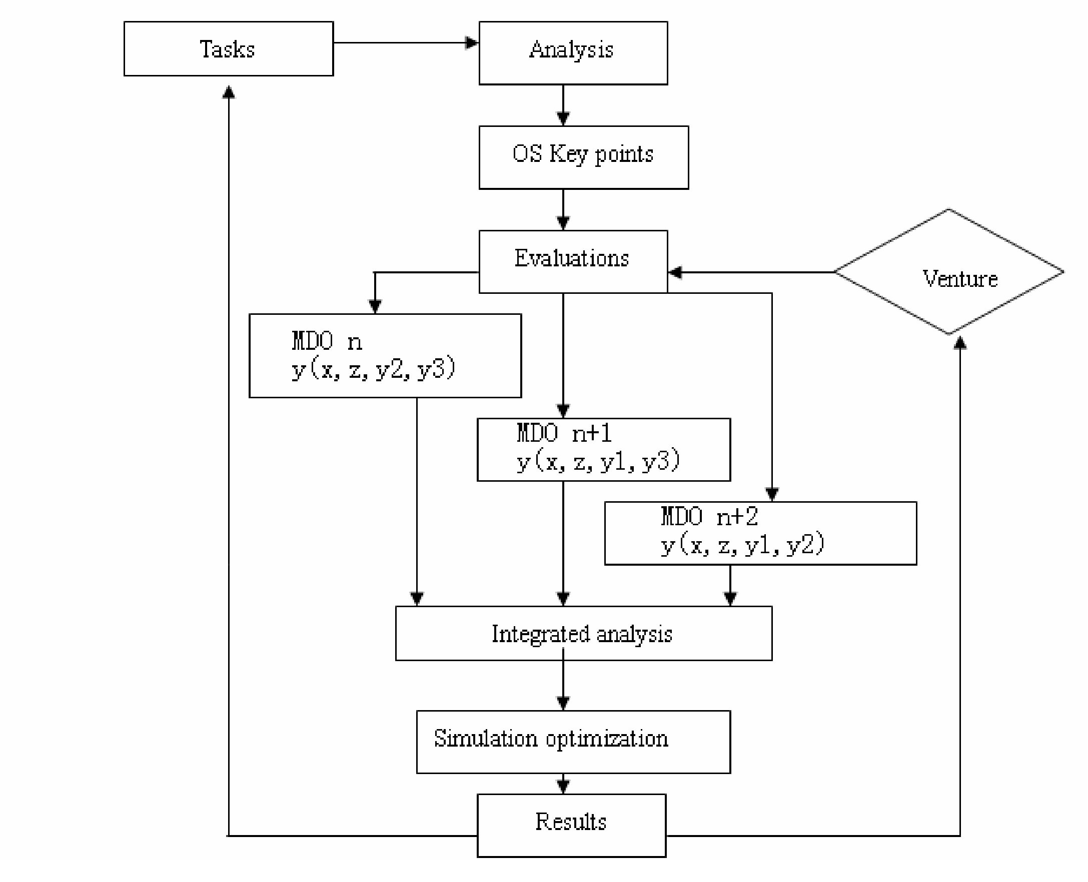

Figure1 – The adaptive algorithm A

2.3 The adaptive algorithm A+

The system ensures the feasibility of multidisciplinary design by determining the corresponding objectives of subsystems, optimizing the coordination level, and sharing the design variables that meet the compatibility constraints.

Through self space optimization, each module controls its own design variable space and makes its own region constraints. Each module does not need to have a deep understanding of the design variables of other groups. The goal of each self spatial analysis is to make the values of interdisciplinary variables consistent with other groups. Then, a system level optimization is carried out to ensure the compatibility of the global solution, meet the interdisciplinary constraints, and minimize the objective function.

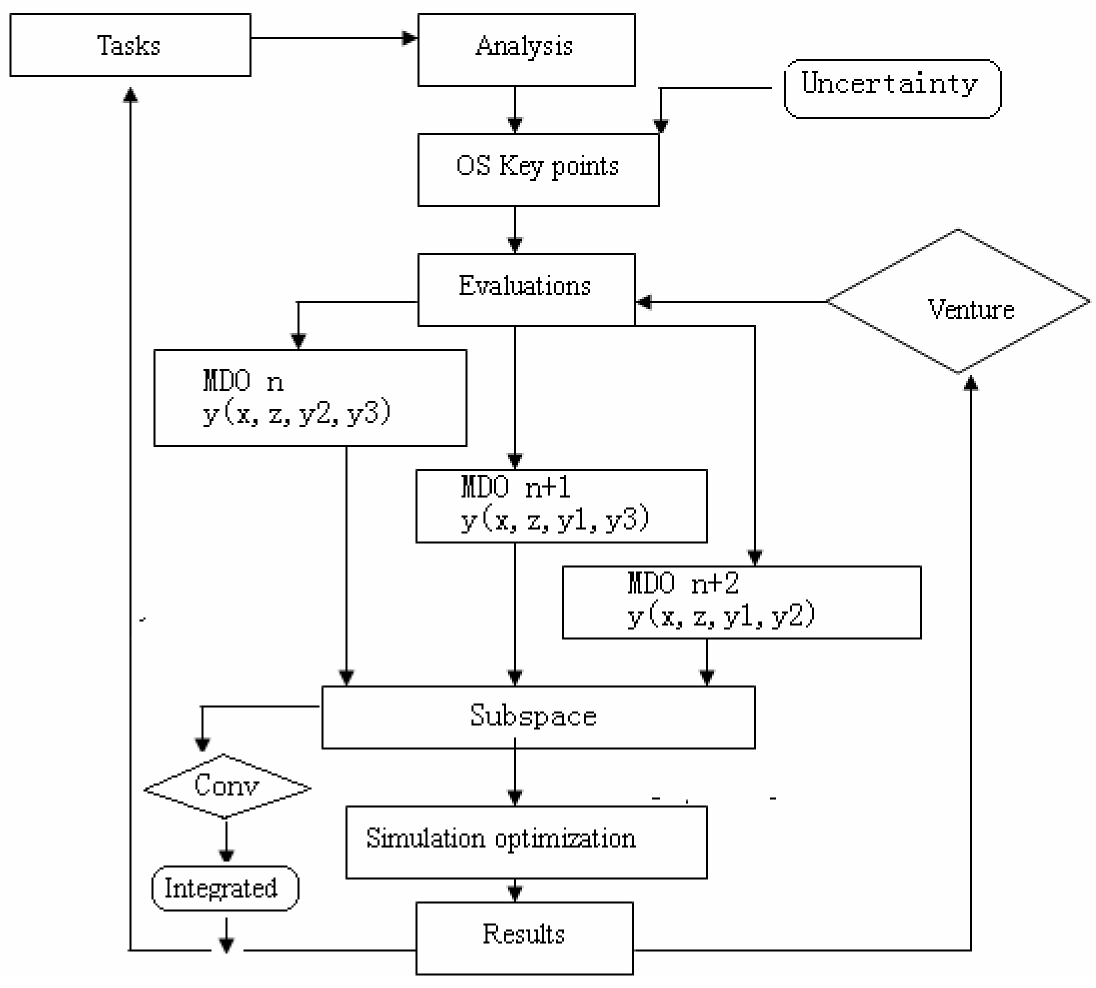

Figure2 – The adaptive algorithm A+

2.4 Optimizations

The basic methods of general optimization are depended on the systems in their configuration, design, and optimization of the core of the whole system, while the mathematical model of a target. To establish a criterion strictly, in order to establish appropriate evaluation function, so that the optimization in a core system is extended to the whole system optimization method. See Figure 3.

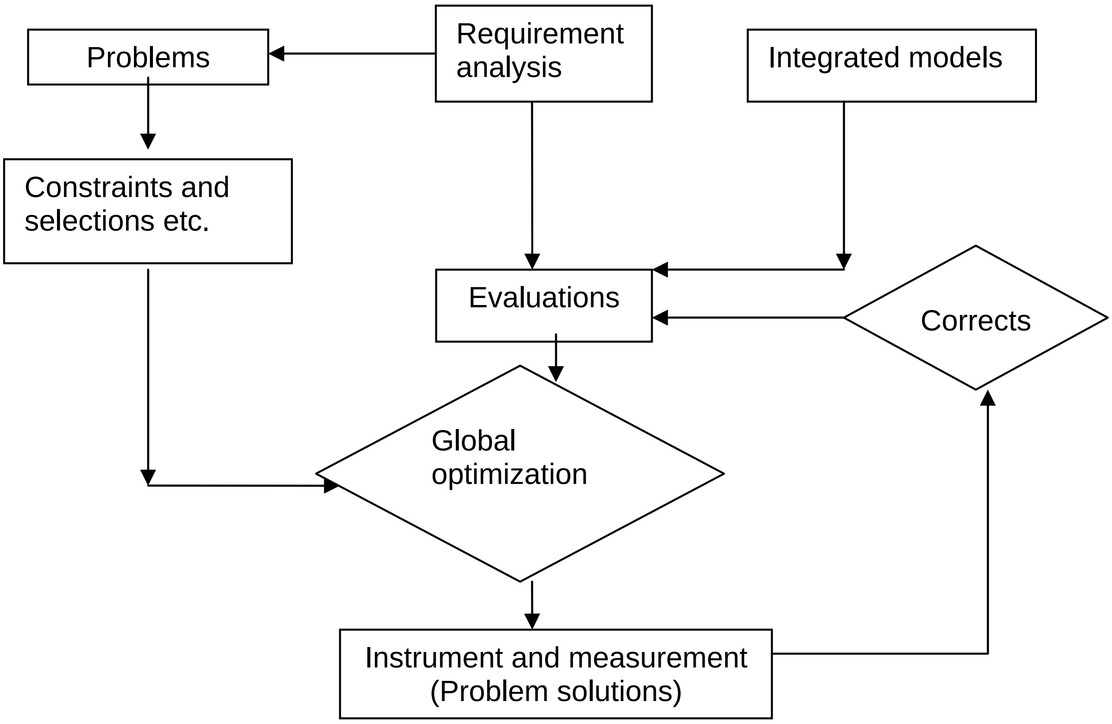

Figure3 – Optimizations

3. Results

Aberration analysis of compound system is a comprehensive analysis of static error and dynamic error. From the simulation results, it is mainly to observe the change of the MTF value of the system, and the trend of its rising and descending can be used as an important criterion to distinguish the influence of the optimization of the system. As shown in Figure 4, the effect of the optimization is expressed.

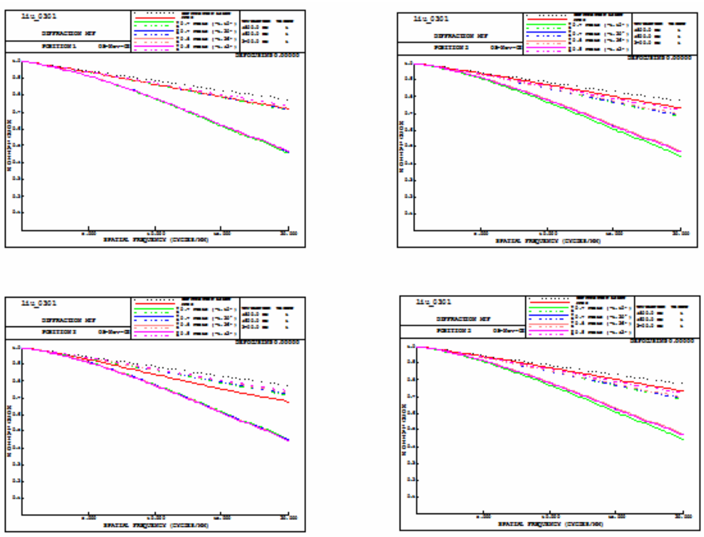

Figure4 – Results

After the efforts to the establishment of the simulation and judgment in photoelectric system performance of the system level criterion, especially on which mean the Modulate the transform function, referred to as MTF, and root mean square, referred to as RMS, and the Point spread function, referred to as PSF. The results showed systematically that, the integration of the photoelectric sensor control system, in terms of the criterion index can meet the application requirements, not only in the MTF, RMS, PSF etc, but also achieve significant advantages in the volume, weight, system efficiency reached significant advantages. In the module control level on the simulation results show that, the simulation results show that, firstly, the decentralized and joint filter can be designed in different order of complexity which has higher precision as we wish, and secondly, the relationship between system model and their parameters in different situations, such as mobile speed, path distance and so on is analysis logically and quantitatively. Multiple configuration photoelectric control system calculated in optimization is recommended as the most efficient and economical method, while by used to improve the sensors performance in system level.

Results presented for system-level-configuration analysis and verified the consistency and conservancy of the load transfers. The new software procedure showed that it can be handled.

To achieve the goal of having the design optimization capability that we developed in the past in our new configuration we are currently developing modules for sensitivity analysis and extending our system models which shows the benefit of multi discipline optimization.

4. Conclusions

This paper introduces a kind of effective adaptive methods for MDO, which are the adaptive algorithm A and the adaptive algorithm A+, and their general framework and the effective applications. The cases and engineering applications of multi-objective and multidisciplinary design optimization are proposed. It provides a theoretical base and some valuable experiences for the following engineering projects.

The main advantages are as follows,

Firstly, the target variability is reduced by controlling uncertain parameters.

Secondly, robust design results provide better choices for designers.

Thirdly, it is expected to provide effective applications in a wider field, and even subvert the traditional R & D concept.

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