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# ORTHOGONAL ARRAYS BASED DESIGN METHODOLOGY FOR COMPLEX COUPLED SPACE SYSTEMS

**Abstract**

The process of designing a complex system, constituted by many elements and sub-elements interacting between each other, is usually completed at a system level and in the preliminary phases in two major steps: design-space exploration and optimization. In a classical approach, especially in a company environment, the two steps are usually performed together, by experts of the field inferring on major phenomena, making assumptions and doing some trial-and-error runs on the available mathematical models. To support designers and decision makers during the design phases of these kind of complex systems, and to enable early discovery of emergent behavior arising from interactions between the various elements being designed, the authors implemented a parametric methodology for the design-space exploration and optimization. The parametric technique is based on the utilization of a particular type of matrix design of experiments, the orthogonal arrays. Through successive design iterations with orthogonal arrays, the optimal solution is reached with a reduced effort if compared to more computationally-intense techniques, providing sensitivities and robustness information on the entire design region. Sensitivity and robustness information of local and global optima are considered to be a valuable cutting edge if compared to the output of the more standard stochastic or deterministic optimization techniques (the least are not even applicable to this particular problem due to the presence of discontinuities in the design-space) represented by a single design point. The paper describes into the details the design methodology providing examples of ad-hoc test cases and an application on a real space exploration architecture problem, composed of several building blocks whose mathematical models are presented in a separate paper.