National Aeronautics and Space Administration

Method for Constructing Composite Response Surfaces by Combining Neural Networks with Other Interpolation or Estimation Techniques

NASA has patented a new technology for design optimization that incorporates the advantages of both traditional response surface methodology (RMS) and neural networks. The invention employs a unique strategy called parameter-based partitioning of the given design space. In the design procedure, a sequence of composite response surfaces based on both neural networks and polynomial fits is used to traverse the design space to identify an optimal solution. The composite response surface has both the power of neural networks and the economy of low-order polynomials. The present invention handles design problems with many more parameters than would be possible using neural networks alone and permits a designer to rapidly perform a variety of trade-off studies before arriving at the final design.

This patented technology is available for licensing from NASA's space program to benefit U.S. industry.

Technology Details

The invention provides a method and system for constructing composite response surfaces that incorporates the advantages of both traditional response surface methodology (RSM) and neural networks. The term "design space" refers to a multi-dimensional region that encompasses all possible designs and is the region defined by the coordinates and associated coordinate ranges of the various design parameters and bounded by their individual upper and lower limits. In the method, composite response surfaces are constructed using parameter-based partitioning. These composite response surfaces are based on both neural networks and on other interpolation/estimation techniques. A sequence of such response surfaces is used to traverse the design space to identify an optimal solution, or to model a process or a response of physical object. The composite response surface thus has both the power of neural networks and the economy of other estimation techniques, such as low-degree polynomials (in terms of the number of simulations needed and the network training requirements). The invention handles design problems with many more parameters than would be possible using conventional neural networks alone, and the invention permits a designer to rapidly perform a variety of trade-off studies before arriving at a final solution. It also allows the use of less-expensive, low-fidelity simulations in the early stages of the design and a smooth transition to higher fidelity simulations as the search for the optimal design evolves thus significantly reducing the computational costs incurred in simulation-based design.

Commercial Applications

- Aerospace
- Astronautical Engineering
- Mechanical Engineering
- Systems Engineering
- Information Engineering
- Dynamic Machinery

Patent

This technology has been patented.
U.S. Patent No. 7,191,161
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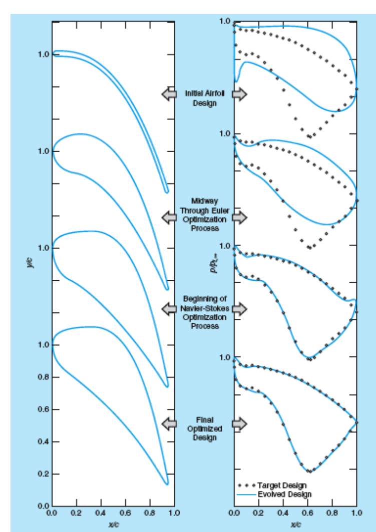
Benefits

- Rapidly perform design trade-off studies
- Ability to handle a variety of design objectives
- Design optimization using composite response surfaces
- Multi-disciplinary optimization
- Parameter based partitioning of the given design space
- Insensitivity to noise in the data
- Ability to include time-varying data in the design process
- Flexibility to handle additional data as it becomes available
- Ability to leverage the multi-tiered parallelism possible on modern distributed and parallel computers



Aerodynamic Design Using Neural Networks

Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov