Vector Field Representation for Concurrent Evaluation of Architectural Design Variables

Dissertation

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Abstract

This study describes a unified approach to simulate four physical phenomena: sound propagation, distribution of light, air flow, and heat radiation. A vector field representation is proposed.

The simulation aims to emulate designs as *relations* between a set of design variables (parametrical properties of solid boundaries) and a set of performance variables (e.g., sound, light, air, and heat distributions). In that context, the vector field representation maps the set of design variables to each one of the four performance variables.

The simulation proceeds in four steps: (1) scalar field computation, (2) vector field computation, (3) vector sum $\mathbf{V}_{sum}$ and (4) vector difference $\mathbf{V}_{diff}$ computations. The scalar field is computed to obtain the distribution of energy intensity generated from a source and reflections from solid boundaries. The vector field is derived from the scalar field and provides the steady state representation of the *source strength* component of the field. By vector summation over the field, $\mathbf{V}_{sum}$ is computed, and is defined as the *cumulative net flux vector* of the phenomenon in an enclosure. Computed from $\mathbf{V}_{sum}$, $\mathbf{V}_{diff}$ provides an evaluation of physical changes between architectural settings. Single illustrations of field representations and concurrent illustrations of the four phenomena are proposed. As illustrations of tradeoffs, a room is simulated. Results show meaningful information on the tradeoffs of parametrical characteristics of the room.