Mechanical Engineering Thesis Defense

Imaging and Reconstructions associated with Emission and Absorption Tomography

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Abstract

Four-Dimensional Emission Tomography (4DET) and Four-Dimensional Absorption Tomography (4DAT) are measurement techniques that utilize multiple 2D images (or projections) acquired via an optical device, such as a camera, to reconstruct scalar and velocity fields of a flow field being studied, using either emission- or absorption-based measurements, respectively.

Turbulence is inherently three-dimensional, and thus research in the field benefits from a comprehensive understanding of coherent structures to fully explain the flow physics involved, for example, in the phenomenon resulting from a turbulent axisymmetric jet.

This thesis looks at the development, application and validity/practicality of emission and absorption tomography as an experimental approach to obtaining a comprehensive understanding of coherent structures in turbulent flows.

A pseudo test domain is decided upon, with a varying number of camera objects created to image the region of interest. Rays are then modeled as either thin rays or cylindrical volumes to build the weight matrix. Projection images are generated with Gaussian concentration defined as a spatial function of the domain to build the projection matrix. Finally, concentration within the domain, evaluated via the Least Squares method, is compared against original concentration values.

The reconstruction algorithm is validated and checked for accuracy with DNS data of a steady turbulent jet. Reconstruction accuracy and a statistical analysis of the reconstructions are also presented.

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