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RECONSTRUCTION OF THREE-DIMENSIONAL TEMPERATURE AND CONCENTRATION FIELDS OF A LAMINAR FLAME BY MACHINE LEARNING

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ABSTRACT. Combustion diagnostics have reached high levels of refinement, but it remains difficult to simultaneously reconstruct the three-dimensional (3-D) temperature and species concentration fields. Tomographic reconstructions for high dimensional diagnostics are typically conducted with prevailing iterative methods. Due to the high data throughput, they are usually inefficient and computationally formidable. In this study, we present an inverse radiation model based on the machine learning approach to reconstruct 3-D temperature and mixture species concentrations fields from infrared emission spectral measurements for a laminar flame. Flame emission was detected with an imaging Fourier-transform spectrometer, obtaining a 2-D array of hyperspectral data. A machine learning model was trained with synthetic spectral emission for gas mixtures of CO2, H2O, and CO. The developed method demonstrates its excellent capability of solving nonlinear inverse problems, providing an efficient and global inverse radiation model, and is able to retrieve 3-D temperature and mixture species concentrations simultaneously.