Dimensionality Reduction of Hybrid Rocket Fuel Combustion Data

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Abstract

The project ATEK at the German Aerospace Center (DLR) focuses on novel techniques for space transport vehicles to allow for cost reductions. One promising approach in this context is the use of hybrid rockets that combine solid propellants and liquid propellants. However, the process of hybrid rocket fuel combustion is still a matter of ongoing research and not fully understood yet.

Recently, various experimental combustion tests on hybrid rocket fuels were performed at DLR. For a better understanding of the experiments, the combustion process was captured with a high-speed video camera. The decomposition of these videos leads to a larger number of about 30000 images for each measurement. Furthermore, each single image already contains a complex data matrix since hybrid combustion is dominated by transient flow dynamics like Kelvin-Helmholtz instability and vortex shedding. In the end, a high-dimensional dataset has to be evaluated.

In this talk, we present the results of different dimensionality reduction techniques such as a principal component analysis to reduce the complexity of the experimental dataset. Even then, it is still essential to parallelize the statistical routines to obtain the results within a reasonable amount of time. In a second step, we investigate the statistically independent structures of the flow field that has been reduced in complexity by using an Independent Component Analysis (ICA). More precisely, the data is either separated into spatially (sICA) or temporally (tICA) independent components. Finally, both ICA approaches are compared in order to better understand and interpret them.

References

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