Chair of Aerodynamics and Fluid Mechanics
TUM School of Engineering and Design
Technical University of Munich

Application of Dynamic Mode Decomposition on Experimentally Gained High Speed Schlieren Videos

Interdisciplinary Project (IDP) - English/Deutsch

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Start Date: asap

Description

The project will focus on the application of the Dynamic Mode Decomposition (DMD) [1] on experimentally gained high-speed Schlieren videos, used to investigate the aerodynamics during gas atomization of metal powders [2]. Efficient analysis of the recorded high speed videos requires robust computational routines. One potential approach to analysis large space-time-resolved results, like the given high speed videos, is DMD [3]. For this project the existing Phyton package PyDMD should be used [4, 5]. After successful application of the PyDMD package on pre-selected single experiments a parametric study of a full design of experiments is planned. This includes running the DMD on one of TUMs HPC systems followed by implementation of graphical analysis of the gained results.

Tasks

- Familiarize yourself with the PyDMD package
- Identify optimal application of the DMD for the given experimental data. Including the different DMD options in the PyDMD package as well as pre-processing routines of the data (image preprocessing, noise reduction, etc.)
- Implement processing and analysis routines to analyze multiple experiments on HPC systems
- Allow efficient analysis of the parametric study of the experiments by implementing plots and visualization of the DMD and experimental results

Requirements

- Solid programming experience in Python; Beneficial: Knowledge of the NumPy and SciPy Python packages
- Experience with TUMs HPC Systems
- Interest in applied engineering and fluid dynamics
- Ability to work independently

References

[1] Schmidt, P. J. “Dynamic mode decomposition of numerical and experimental data”. In: *Journal of Fluid Mechanics* 656 (2010), pp. 5–28. ISSN: 0022-1120. DOI: 10.1017/S0022112010001217.

[2] Henrichs, J., Hilbert, J., Rosenberg, R., Forêt, P., Giglmaier, M., and Adams, N. “Experimental Investigation and Visualization of the Transonic Gas Flow in an Industrial Scale Test Bench for Metal Powder Atomization”. In: *Euro PM2023 Proceedings*. EPMA, 1-04 October 2023. ISBN: 9781899072576. DOI: 10.59499/EP235768771.

[3] Schmidt, P. J. “Dynamic Mode Decomposition and Its Variants”. In: *Annual Review of Fluid Mechanics* 54.1 (2022), pp. 225–254. ISSN: 0066-4189. DOI: 10.1146/annurev-fluid-030121-015835.

[4] Ichinaga, S. M., Andreuzzi, F., Demo, N., Tezzele, M., Lapo, K., Rozza, G., Brunton, S. L., and Kutz, J. N. *PyDMD: A Python package for robust dynamic mode decomposition*. DOI: 10.48550/arXiv.2402.07463. URL: http://arxiv.org/pdf/2402.07463.

[5] Demo, N., Tezzele, M., and Rozza, G. “PyDMD: Python Dynamic Mode Decomposition”. In: *The Journal of Open Source Software* 3.22 (2018), p. 530. DOI: 10.21105/joss.00530.