Experimental setup design and utilization of computer vision algorithms for the characterization of coupled interactions between bubbly shocks and cavitation cloud

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Abstract

The complex coupled interactions between non-spherical bubbles in cavitation clouds and bubbly shocks present significant challenges for experimental measurements. It requires both an adjusted experimental setup with optical access and data processing capabilities that allow simultaneous monitoring of the spatial-temporal evolution of bubbly shock waves within the cavitation cloud alongside bubble dynamics. This project was focused on fulfilling these two requirements. For this task, we designed and constructed an experimental setup to study cavitating flows in a generic converging-diverging nozzle system, allowing high-speed imaging and high-frequency pressure measurements of cavitation flows in various liquids, including water, dodecane, and aviation fuels. The facility design is based on the setup that is used in [1] and [2]. In addition, we have reproduced and expanded the Computer Vision (CV)-based data processing code of [1] for bubble detection with new shock-wave detection capabilities that utilized the enhanced gradient shadowgraphy technique proposed by [2]. This code is an extension of the previous code that we discussed in [3]. We demonstrate the new code capability to accurately capture the spatio-temporal evolution of the leading and trailing edges of bubbly shock waves in aerated cavitating flows in CD-nozzle, as well as effectively track their centers of mass. This in turn, allows us to quantify bubbly shock morphology due to their interaction with cavity clouds, which understanding is of high importance for modeling bubbly shocks and cavitation physics in internal flows or different liquids.

References

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