Research Report (April, 2021- March, 2022)

Enrollment from April 2020 | Department of Applied Mechanics and Aerospace Engineering | Takahiro USHIOKU

I. List of Papers

[1] T. Ushioku and H. Yoshimura, "Numerical investigation of cloud cavitation and its induced shock wave", Proc. ASME 2021 Fluid Engineering Division Summer Meeting, No. 65731, Online, August, 2021. (Receive ASME FEDSM2021 Best Presentation Award)

II. List of Talks

[2] T. Ushioku and H. Yoshimura, " Numerical Analysis of Unsteady Behavior of Cloud Cavitation and Its Induced Shock Waves by Two-Dimensional Smoothed Particle Hydrodynamics Method", JSME Annual Meeting 2021, J022-09, Chiba University (Online), September, 2021. (In Japanese)

[3] T. Ushioku and H. Yoshimura, "Numerical Analysis of Unsteady Behavior of Cloud Cavitation Based on Two-Phase Mixture Theory, JSIAM Annual Meeting 2021, G-2-1-4, Shibaura Institute of Technology (Online), September, 2021. (In Japanese)

[4] T. Ushioku and H. Yoshimura, "Modeling and Numerical Simulation of Single Bubble Dynamics and Shock Wave Propagation", JSME Dynamics and Design Conference 2021, No. 142, Tokyo University (Online), September, 2021. (In Japanese)

III. Research Results in AY2021

A cloud of cavitation bubbles shows a collective unsteady motion repeating the process of growth and collapse. In particular, a high-pressure shock wave is emitted associated with the collapse of the cloud, however its mechanism has not been precisely understood. In this study, we have investigated the unsteady behavior of the cloud induced by a submerged water-jet injection and the shock wave emission by an experimental observation and a two-dimensional multiphase flow analysis based on a mixture model of liquid and gas by using Smoothed Particle Hydrodynamics (SPH) method. In the numerical test, we have found that the motion of the twin vortices plays an essential role to trigger the collapse of the cloud since it changes the behaviors of the boundaries of the cloud from expanding to shrinking. Further, we also have found that multiple shock waves are generated by the collapse of the cloud and propagate at the sonic speed of the medium.

IV. Research Plan for AY2022

In AY2021, we will plan to experimentally investigate flow velocity vector fields surrounding the cloud by Particle Image Velocimetry (PIV) method and shock waves associated with the collapse of the cloud by a high sensitivity schlieren method in order to observe the motion of twin vortices and the multiple shock waves phenomenon found in the numerical test. Further, we will plan to make a three-dimensional multiphase flow analysis and try to clarify the three-dimensional shape and structure of the cloud.