Keynote

Validation of a Coupled Human Fluid Model Using PIV Experiment and Application to the Entrapment Accident in Water Channel

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Recently, a new numerical model, named DRowning hUman Model (DRUM) had been proposed [1]. The model is designed for the evaluation of the effectiveness of lifejackets against drowning in tsunamis considering both unsteady water currents and human movement. In the model, the Constrained Interpolation Profile-Combined Unified Procedure scheme was combined with the link segment model [2] to simulate interactions between the fluid and subjects. It was found that the developed model accurately reproduced the movement of the manikin observed in a large flume experiment [1]. However, while the model seems to be adequate to analyze the movement of human bodies in tsunamis, quantitative validation of the flow and motion of the objects have not been investigated in detail. In this work, to evaluate the accuracy of the model quantitatively, a small-scale flume experiment was conducted and the performance of the model was evaluated by comparing with the experimental result. In the experiment, two rigid bodies linked by a joint were launched from a bottom of a small water container, spatial and temporal change of water flow generated by the rising bodies were measured by Particle Image Velocimetry (PIV). By comparing the calculated result with the experimental result, it was confirmed that the calculated flow velocity agrees well with the observed distribution. In addition to the quantitative agreements, it is also found that the model can reproduce the spatial features of flow structure such as an eddy generation in the rear of rising bodies. Beside the validation with the PIV experiment, the quantitative accuracy evaluation of the force affecting to objects from water flow was done. The DRUM is applied to water flow with a spherical object and the calculated drag force was compared with the experimental value. After the validation mentioned above, the DRUM was applied to a simulation of entrapment accident caused by binding a part of human body to the bottom wall of water channel. The computational result shows that the model is useful for a risk assessment of water accident affected by strong water flow.

Reference:

[1] Ajima, D., Nakamura, T., Araki, T., Inoue, T., Kurisu, A., "Development of a coupled human fluid numerical model for the evaluation of tsunami drowning hazards", J. Biomechanical Science and Engineering, Vol. 14, 18-00321, 2019.

[2] Fujii, N., Ae, M., and Miyashita K., "Simulation system of human movement based on link segment model and its application to sport movements", The Bulletin of Health and Sport Sciences: University of Tsukuba, Vol. 18 (1995) , pp. 117–126 (in Japanese).

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