Effective and fast large scaled Tsunami run-up analysis using explicit ISPH method

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ABSTRACT

After Tohoku earthquake 2011 Japan, our research group has been developed a three-dimensional tsunami run-up analysis tool using the stabilized ISPH[1] which is one of the semi-implicit Lagrangian particle method. Our target simulation site is Kochi city where huge tsunami disaster is anticipated with the next big Nankai Trough Earthquake. Through our several numerical tests, we found that tsunami run-up analyses in the urban area required at least 2m resolution in order to resolve the complicated tsunami flow through buildings and the other structures. According to this minimum resolution, a tsunami run-up simulation at Kochi city needs to at least 1 billion particles.

However, since the original semi-implicit algorithm of ISPH method requires huge computational cost with 1 billion particles, it is almost impossible to simulate the long-time history of tsunami disasters even with modern supercomputers like K-computer. The difficulties in the large scaled tsunami simulation are not only the computational time, but also for the memory usage related to the semi-implicit time integration of the Navier-Stokes equations.

Then, an explicit version of the stabilized ISPH method called EISPH, which explicitly solves the incompressible Navier-Stokes equations, is developed to reduce the computation time and memory usage.

Figure 1is the result of 4m resolution Kochi city tsunami run-up simulation using EISPH method which performed to compare with ISPH method. It is shown a similar tendency to ISPH method.

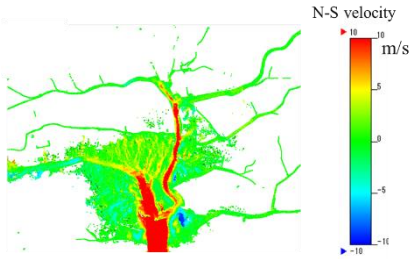

Figure.1

Kochi city tsunami run-up simulation may be solved at much higer resolution around 0.5m with help of the developed EISPH tool.These high resolution simulation results can be utilized as a realistic VR for the disaster mitigation and prevention education. Figure 2 shows one of sample of our VR system.

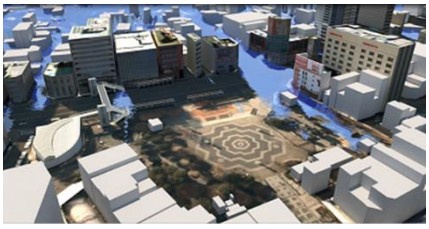
Figure.2

REFERENCES

[1] Asai M., Aly A.M., Sonoda Y., and Sakai. Y., “A Stabilized Incompressible SPH method by relaxing the Density invariance condition,” Journal of Applied Mathematics, 2012, 24.doi:10.1155/2012/139583(2012).