Smart In-Situ Visualization Framework on the Fugaku Environment

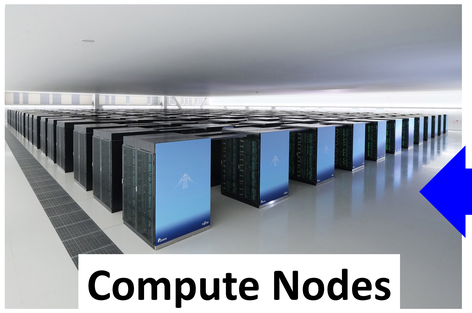
Ken Iwata
Kobe University
Kobe, Japan

Go Tamura
Kobe University / RIKEN R-CCS
Kobe, Japan

Naohisa Sakamoto
Kobe University / RIKEN R-CCS
Kobe, Japan

Jorji Nonaka
RIKEN R-CCS
Kobe, Japan

Traditional Post-hoc Visualization



Simulation

2nd Layer Storage

Visualization

Pre/Post Processing Nodes

Ex.: Time-Varying Multivariate Volumetric Data Sets

Visualization

In-Situ Visualization

It can greatly minimize the I/O cost

Ex.: Multi-Viewpoint Image Data Sets

KVS-based Visualization Framework

Simulation Code (C/C++/Fortran)

In-Situ KVS API

Our proposed smart in-situ visualization framework is based on the KVS (Kyoto Visualization System) [3], and we have evaluated on the Fugaku environment by using the same OpenFOAM simulation code and models used on the K computer. For this purpose, we have used the tools and libraries described in the table on the right side.

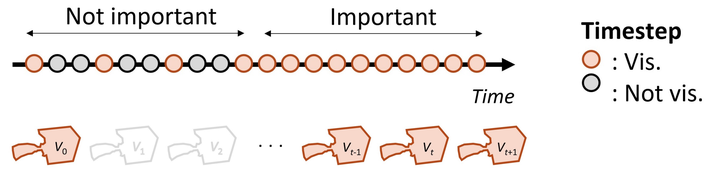
Tools / Libraries	Version
Fujitsu compiler	4.3.1
Spack	0.16.2
Mesa	18.3.6
Python	3.6.8
KVS	3.0.0
OpenFOAM	2.3.1

Smart In-Situ Visualization

This approach is focused not only on simple data reduction, but especially on the elimination of unnecessary timesteps and viewpoints for reducing the time required to obtain scientific knowledge from the numerical simulation results.

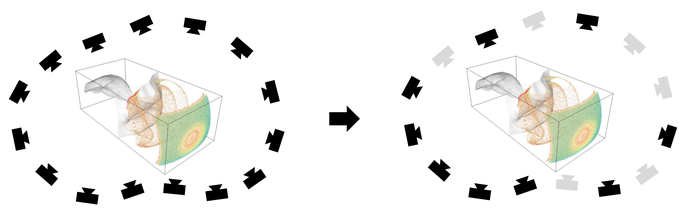
• Adaptive Timestep Selection

We have developed an adaptive timestep sampling based on the amount of change between the simulation timesteps, which is estimated via Kernel Density Estimation (KDE) and Kullback-Leibler (KL) divergence [1].



• Adaptive Viewpoint Selection

We are also working on an adaptive viewpoint selection for obtaining the potentially most important rendering viewpoints when using our proposed multiple viewpoint rendering approach for in-situ visualization[2].



REFERENCES

[1] Yoshiaki Yamaoka, Kengo Hayashi, Naohisa Sakamoto, and Jorji Nonaka. 2019. In Situ Adaptive Timestep Control and Visualization based on the Spatio-Temporal Variations of the Simulation Results. In Workshop on In Situ Infrastructures for Enabling Extreme-Scale Analysis and Visualization (ISAV '19), held in conjunction with SC'19 (Denver, Colorado, USA). 12–16.

[2] Taiki Sako, Naohisa Sakamoto, and Jorji Nonaka. 2021. Development of a Multiple Viewpoint Rendering Framework for Exploratory In-Situ Visualization (in Japanese). In VSJ Symposium on Visualization 2021.

[3] Naohisa Sakamoto and Koji Koyamada. 2015. KVS: A Simple and Effective Framework for Scientific Visualization. JSST Journal of Advanced Simulation in Science and Engineering 2, 1 (2015), 76–95.

ACKNOWLEDGMENTS

This work used computational resources of the supercomputer Fugaku provided by RIKEN. This work was partially supported by JSPS KAKENHI (Grant Numbers 19H03976, 20H04194). We are grateful to Prof. Tsukasa Yoshinaga and Prof. Kazunori Nozaki for the OpenFOAM CFD simulation models. We are also grateful to Hitoshi Murai for his support with the OSS and Spack on the Fugaku.