Golf Ball Wake Patterns with and without Back-Spin

Gwangsoo Go[1], Hyung Taek Ahn[1], Gibeom Gu[2] and Min Ah Kim[2]

1) *School of Naval Architecture and Ocean Engineering, University of Ulsan, Ulsan 44610, KOREA*
2) *Visualization Team, Korea Institute of Science and Technology Information, Daejeon 34141, KOREA*

Corresponding Author: Gwangsoo Go, rhrhkdtn2000@mail.ulsan.ac.kr

ABSTRACT

Wake patterns for flow over a stationary and a back-spinning golf ball is presented. In order to represent a golf ball geometry on Cartesian meshes, an adaptive mesh refinement (AMR) based signed distance function (SDF) computation [1] was utilized. By using an efficient and accurate SDF transformation approach [2], a rotating golf ball was efficiently represented on Cartesian meshes without any re-initialization of the SDF for a rotating golf ball. The number of grids for entire computational domain is considered as approximately 17billions (17×10^9), and 128 grids are positioned along a diameter of a golf ball. The multi-dimensional MPI parallelization was applied to compute this very large-scale problem. The computations were conducted on the Nurion supercomputer operated by the Korea Institute of Science and Technology (KISTI), and 32,764 cores were utilized. In order to visualize wake regions of a golf ball, an open-source visualization software ParaView was utilized. Visualization was also performed on the Nurion supercomputer.

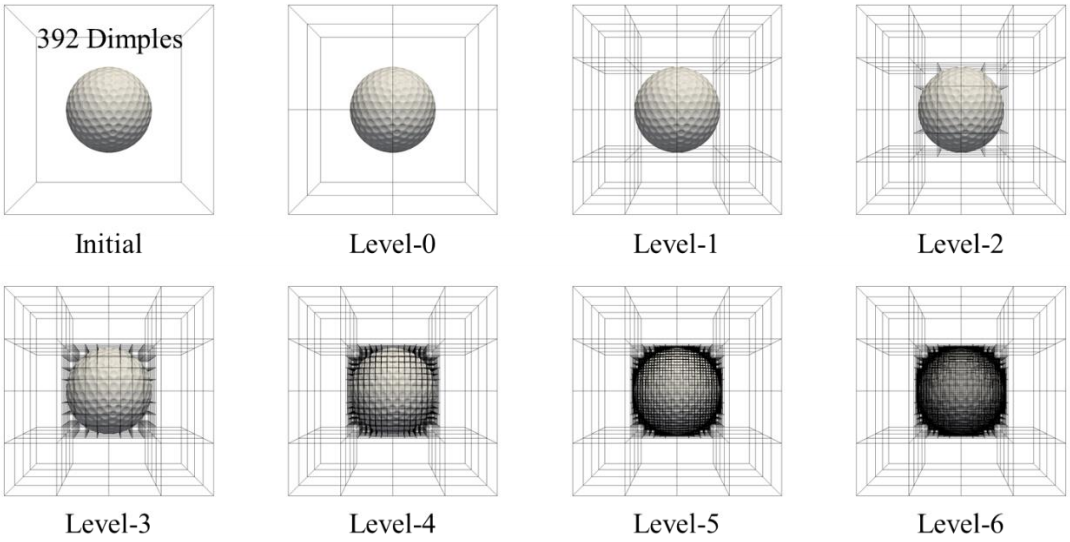

Figure 1. Adaptive mesh refinement procedure (level-0 to 6) for computing signed distance function of a golf ball

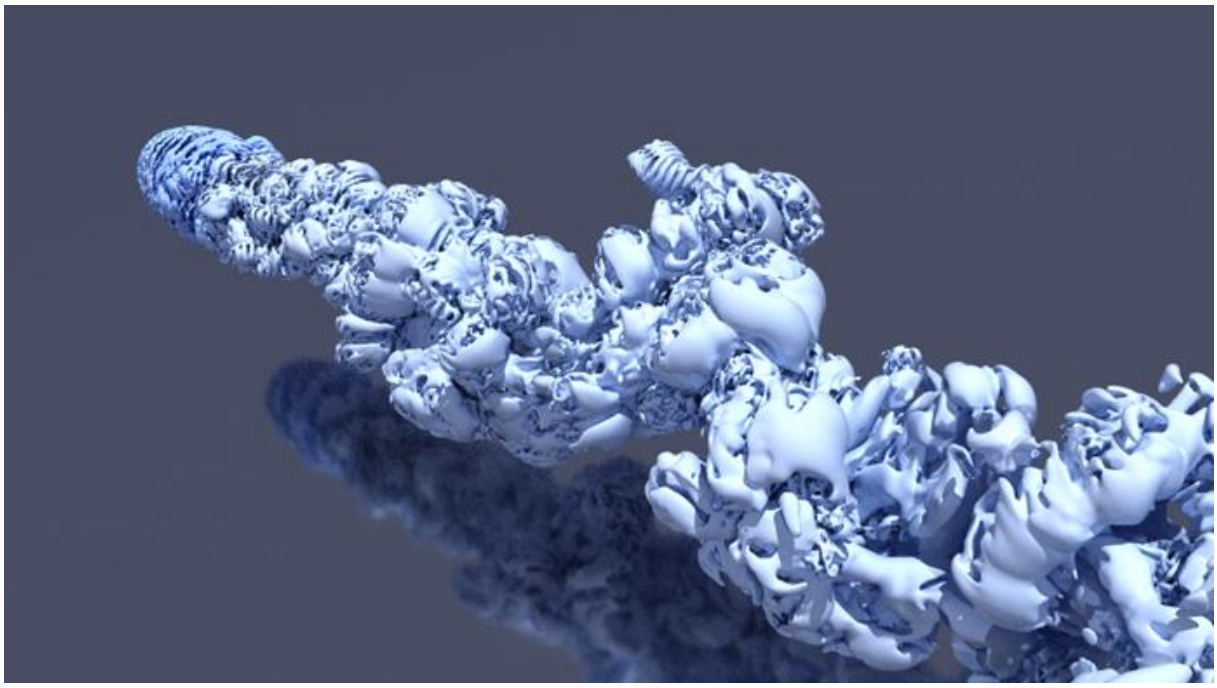

Figure 2. Instantaneous vortical structure based on λ_2-definition behind a stationary golf ball at $Re = 1.1 \times 10^5$

ACKNOWLEDGEMENTS

This work was supported by a National Research Foundation of Korea (NRF) Grant funded by the Korean Government (NRF-2017-Global Ph.D. Fellowship Program), Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2013R1A1A2007924), and the National Supercomputing Center with supercomputing resources including technical support (KSC-2018-CHA-0006).

REFERENCES

1. Go, G. and Ahn, H. T., "Efficient Incompressible Flow Simulation over an Arbitrarily Complex Geometry Using a Multigrid Method," *Journal of Computational Physics*, Under Review.
2. Go, G. and Ahn, H. T., "Cartesian Mesh-based flow simulation around a moving body using an efficient and accurate SDF transformation," *Computers and Fluids*, Under Review.