講演番号	280

文献番号	20226280

Temporal and Spatial Front Wheelhouse Wake on Changes in Vehicle Aerodynamic Performance

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KEY WORDS: **Heat-fluid, aerodynamic performance, wind tunnel test,** Wake, Particle Image Velocimetry [D1]

Temporal and spatial wake patterns and behaviors around rotating tires and wheels are some of the most critical flow phenomena on aerodynamic performance and vehicle dynamics. In particular, aerodynamic drag is one of the most important factors on greenhouse effect gas and fuel efficiencies, in these days remarkably focused on the shift from conventional fossil fuel power plants to electric ones to prevent the global warming. From the point of view of aerodynamics, OEMs' wind tunnel facilities with moving ground and high fidelity CFD tools are employed to optimize the exterior body shape and aerodynamic device in order to reduce the aerodynamic drag. Recently, high fidelity CFD tools which include tire rotations are easily employed by users, not only specialists, to analyze the flow around the vehicle and to optimize the exterior design at the development phase. However, more accurate and detailed understanding of complicated flow phenomena around vehicle during motion are required to predict these flow phenomena accurately by CFD tools at early development phase.

Moreover, the more detailed experimental investigation is essential for the aerodynamicists, not only to develop the prediction tool but also to understand the flow phenomena around vehicle in its essence. Therefore, in this study, the on-board 2D-3C PIV measurement system in wind tunnel facility has been developed to investigate the wake patterns around rotating front tire and wheel. As result, the critical wake patterns have been clarified by POD analysis of the mentioned on-board 2D-3C PIV measurement data. These front wheelhouse wake patterns were classified in terms of the wake generation locations that produced the aerodynamic drag. These results indicate that there is the potential for an improvement in not only aerodynamic drag and but also vehicle dynamics by flow control to suppress the wake generations around front wheelhouse and the flow fluctuation around bodyside, moreover, this system can be pplied to real world running condition in near future.