# Multi-resolution analysis of turbulent channel flows with spanwise wall oscillation

Sejong Chun[1] and Yongmann M. Chung[2]

[1]Division of Physical Metrology, Korea Research Institute of Standards and Science, Daejeon, 305-340, Korea
[2]Centre for Scientific Computing, University of Warwick, Coventry CV4 7AL, United Kingdom

## Abstract

Spanwise wall oscillation is a control strategy to suppress streamwise vortices near the wall in a channel flow, leading to significant reduction of skin friction forces in the channel. Because the sweeping and ejection motions of the streamwise vortices are related with mixing between low and high-momentum fluids in the near-wall region, the suppression of streamwise vortices induces smoother velocity profile in the central region of the channel. This means that the spanwise wall oscillation can be used as a means to control mean velocity profiles of the channel flow by suppressing the mixing between the low and the high-momentum fluids.

Even though many investigations focused on the effect of skin friction reduction by spanwise wall oscillation, there has not yet been a study regarding a multi-resolution analysis using a discrete wavelet transform. In the present study, the multi-resolution analysis was performed to investigate the scale-resolved streamwise vortices controlled by the spanwise wall oscillation. The maximal overlap discrete wavelet transform (MODWT) was used as a means for the multi-resolution analysis. From this scale-resolved analysis, it was found that the smallest scales rather than larger scales of streamwise vortices were effectively suppressed by the spanwise wall oscillation. It was also conjectured that the Stokes flow, induced by the spanwise wall oscillation, accelerated viscous dissipation of the smallest scale motions, because the spanwise wall oscillation increased frictional motion between the turbulent channel flow and the Stokes flow.

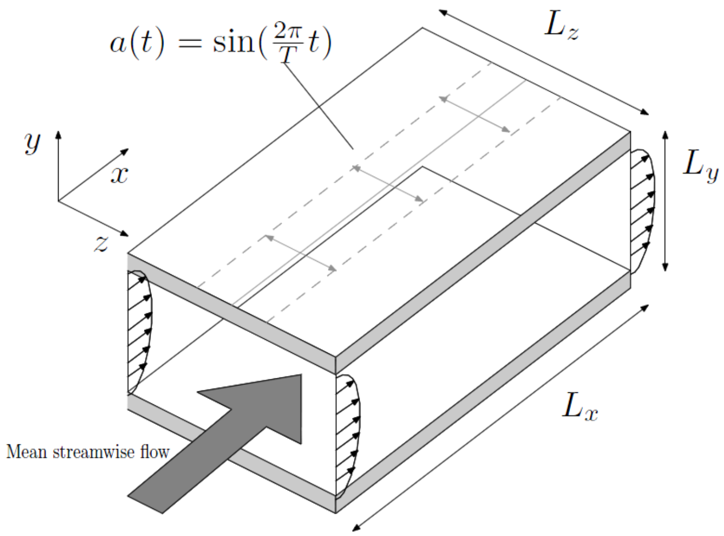


Fig. 1 Schematic of the system for a turbulent channel flow with spanwise wall oscillation, $L_x$, $L_y$ and $L_z$ are the dimensions of the computational domain.

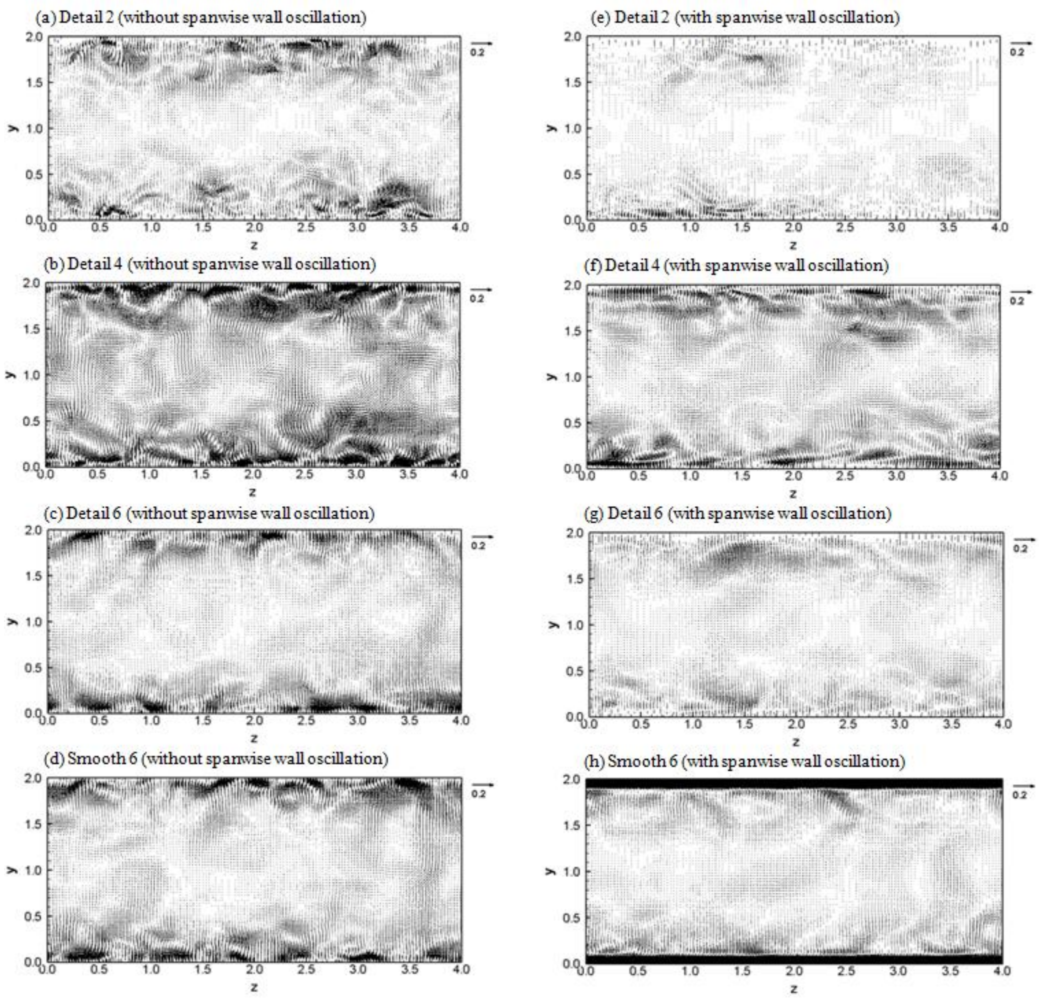


Fig. 2 Velocity plots of the cross section in the turbulent channel flow at $x$ = 4.5 with and without the spanwise wall oscillation.