Description of the $Re_\tau = 200$ turbulent channel flow database

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Abstract

In this document we describe a $Re_h \approx 3600, Re_\tau \approx 200$ turbulent channel flow database. This database has been investigated in [1].

Database description

A turbulent channel flows database has been generated by the incompressible **DNS** solver described in [2]. The code follows the paradigm introduced in [3]: it solves for the wall-normal components of velocity v and vorticity η. This quantities are Fourier-transformed (de-aliased using the *3/2* rule) along the homogeneous directions, and discretized using explicit compact finite-differences along the wall normal direction. Both the streamwise u and spanwise w velocity components are retrieved using the continuity equation with the relation $\eta = \frac{\partial w}{\partial x} - \frac{\partial u}{\partial z}$. Time integration is accomplished by an explicit third order, low-storage Runge–Kutta method, combined with an implicit second-order Crank–Nicolson scheme.

The channel walls are planar and the simulations have been conducted under the assumption of constant mass flux.

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The spatial resolution for the standard channel flow mesh is $\Delta x^+ = 6.54$ and $\Delta z^+ = 3.27$ along the homogeneous directions and $\Delta y^+ \in (0.95, 5.18)$ The time-step enforced in the simulation is in both cases $\Delta t = 0.015625$, which corresponds to $\Delta t^+ \approx 0.1$.

Table 1 summarizes the characteristics of the database.

Table 1: Auxiliary database description.

L_x/δ	L_y/δ	L_z/δ	n_x	n_y	n_z	Re_c	u_c	u_τ
π	2	$\pi/2$	96	101	96	3678.7	0.7699	0.04233

Forcing	Snapshots stored n_s	Δt^s	Memory $[GB]$
Constant Flow Rate	1200	0.15625	32

The database consists of the following files:

1. `xyz.dat`: This file contains the locations (x, y, z) of the nodes.
2. `SnapAvgXZN.dat`: Each of these files is a snapshot of the $\vec{u}(t_k)$ flow velocities.
3. `dUdyN.dat`: Each of these files contains the $\frac{d\bar{U}}{dy}(t_k)$ profile.
4. `mean.dat`: This file contains the average y profiles.

The associated matlab script `loadDB.m` illustrates how to load the database in memory.

References

[1] J. Garicano-Mena, B. Li, E. Ferrer, and E. Valero. A composite dynamic mode decomposition analysis of turbulent channel flows. *Physics of Fluids*, 31(11):115102, 2019.

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