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Linear proportional-integral control of turbulent channel flow for drag reduction[1] EUIYOUNG KIM, HAECHEON CHOI, Seoul National University — Choi, Moin & Kim (1994, JFM) applied an opposition control, $v_w = -v_{y^+\approx 10}$, to turbulent channel flow and obtained about 25 % drag reduction, where v_w is the blowing and suction at the wall, and v is the wall-normal velocity. The idea in that study was to provide a distributed blowing/suction at the wall opposite to the induced motion by the near-wall streamwise vortices and to reduce their strength, resulting in drag reduction. In the present study, we reconsider this control problem from the view point of linear proportional- integral-differential control. The opposition control by Choi et al. (1994) is a proportional control and thus contains steady- state errors. In other words, the target sensing velocity does not go to zero ($v_{y^+\approx 10} \neq 0$) even after control. To reduce this steady-state errors, we introduce a proportional- integral (PI) control, $v_w = -\alpha\ v_{y_s^+} - \beta \int v_{y_s^+} dt$, where α and β are the feedback gains, and y_s^+ is the sensing location above the wall. As a result of applying the PI control, the steady-state errors are significantly reduced and the effective sensing region becomes wide. The detailed results by varying the feedback gains and sensing location will be shown in the presentation.

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