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Visualization of wall turbulence under artificial disturbance by piezo actuator array

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ABSTRACT

A possibility of turbulent flow control by an actuator array was experimentally examined. A turbulent channel flow of water at *Re*=7500 in a rectangle channel (cross section: 500 mm x 40 mm) was used to clarify the optimum driving condition of the actuator array. Using a particle image velocimetry (PIV) system, we could visualize the low-speed fluid element penetrating into the outer layer from the inner layer. Six actuators are installed on the wall and aligned in spanwise direction. Each actuator element can be independently oscillated vertically at 100 m amplitude. The mean spacing of streak-like structures existing in the vicinity of the wall are known to be in the order of 100 times the viscous length scale, 100 / u_τ. Suitable size of the actuator was determined to have half size of the mean spacing of low-speed streaks near the wall. Driving frequency was changed to find the condition of interactions between low-speed streaks and structures generated by actuators. In such a project, observation of instantaneous velocity distribution gives essential information and PIV is the only method usable to this purpose. The present PIV system allows to detect instantaneous velocity as well as vorticity concentrated near the wall in the interval of less than 0.1sec. As a result of analyzing spatial velocity distribution in *x*-*z* plane near the wall by PIV, the regularity of the velocity distribution in y^+=50 observed in plane channel flow becomes indistinct for the frequency (f_a) of actuator more than 12.5 Hz.

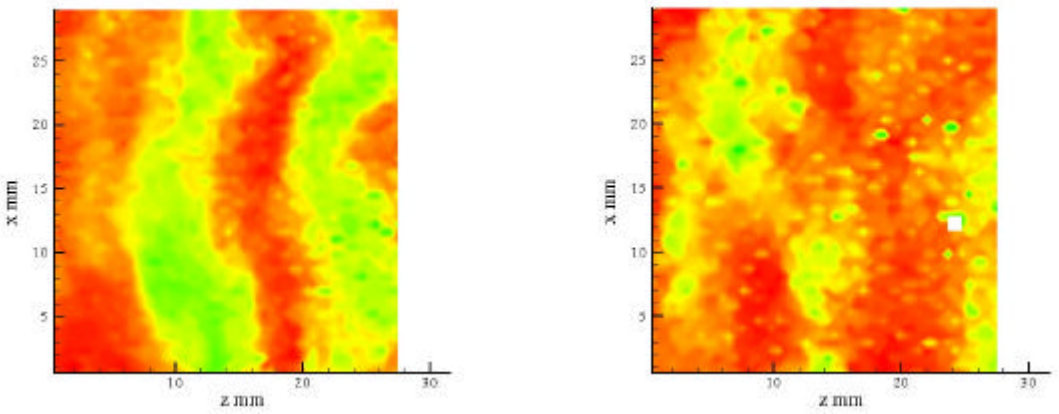

Figure 1 Spatial distributions of instantaneous velocity for *Re*=7500.
(a) f_a=0 Hz, (b)125 Hz. Fluid flows from bottom to top.