J Vis (2010) 13:175–176
DOI 10.1007/s12650-010-0032-3

PORTFOLIO

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Surface topography of jet shock cells in a hydraulic analogy

Received: 2 December 2009 / Accepted: 25 February 2010 / Published online: 4 April 2010

The photograph in Fig. 1 (top) shows text visualized through free surface flow, which serves as a hydraulic analogy of an underexpanded two-dimensional jet at Froude number 1.35 [analogous to Mach number (Buchanan et al. 2007)]. The text is illuminated by a halogen lamp from below a water table and used as a

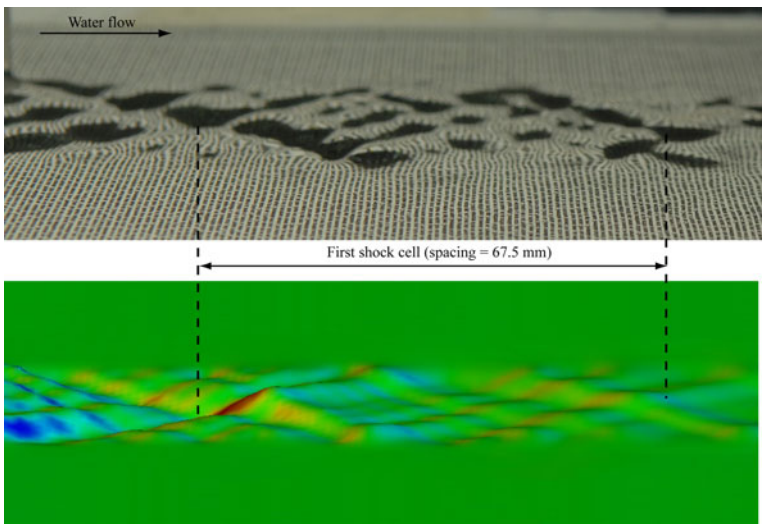

Fig. 1 Photograph (*top*) of the analogy to shock cells downstream of a nozzle at Mach number 1.35, with flow from *left* to *right*. The text below the water flow is used as a reference for surface reconstruction; time-averaged surface (*bottom*) topography of the shock cells of the same flow, the contours indicate the surface gradient in the flow direction, increasing from *blue* to *red* (negative to positive). The reconstructed surface from the reference image topography technique matches well with the real free surface flow

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reference for surface reconstruction. The text is visually deformed by the surface gradient of the jet due to refraction of light, and the images are recorded by a CCD camera from above the surface. The same text is then captured through a flat surface of the same depth, and used as a reference image. Using particle image velocimetry analysis, the deformed images of the text are mapped with the reference image, generating a time series of optical displacement vector fields. The instantaneous surface profiles of the shock cells are reconstructed from each optical displacement field and the results time averaged, as in Fig. 1 (bottom). The data show the reconstructed surface matches both the shock cell dimensions and the surface gradients very well. The technique used here is based on the reference image topography technique described in Fouras et al. (2006, 2008).

References

Buchanan A, Macartney R, Thompson MC, Brocher E, Hourigan K (2007) Hydraulic analogy study of supersonic rectangular jet screech control with cylinders. AIAA J 45:1539–1545

Fouras A, Hourigan K, Kawahashi M, Hirahara H (2006) An improved, free surface, topographic technique. J Vis 9(1):49–56

Fouras A, Lo Jacono D, Sheard GJ, Hourigan K (2008) Measurement of instantaneous velocity and surface topography in the wake of a cylinder at low Reynolds number. J Fluids Struct 24:1271–1277