

Desktop High-Speed Aerodynamics by Shallow Water Analogy in a Tin Box for Engineering Students

Authors : Etsuo Morishita

Abstract : In this paper, we show shallow water in a tin box as an analogous simulation tool for high-speed aerodynamics education and research. It is customary that we use a water tank to create shallow water flow. While a flow in a water tank is not necessarily uniform and is sometimes wavy, we can visualize a clear supercritical flow even when we move a body manually in stationary water in a simple shallow tin box. We can visualize a blunt shock wave around a moving circular cylinder together with a shock pattern around a diamond airfoil. Another interesting analogous experiment is a hydrodynamic shock tube with water and tea. We observe the contact surface clearly due to color difference of the two liquids those are invisible in the real gas dynamics experiment. We first revisit the similarities between high-speed aerodynamics and shallow water hydraulics. Several educational and research experiments are then introduced for engineering students. Shallow water experiments in a tin box simulate properly the high-speed flows.

Keywords : aerodynamics compressible flow, gas dynamics, hydraulics, shock wave

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