Aerospace Engineering Thesis Defense

Design and Validation of an Instrumented Towing Tank for Fluid Dynamics Experiments at Reynolds Number, Re < 3e5

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Abstract

Towing tanks are experimental platforms historically used in naval ship testing, demonstrating that properly scaled models could accurately predict ship drag and wave resistance during testing. Compared to wind tunnels, towing tanks offer advantages in achieving higher Reynolds numbers and superior flow visualization capability.

This thesis presents the design, analysis, integration and testing of a towing tank suit-able for experimental studies of various geometries at Reynolds numbers ranging from5 × 10^4 to 2.5 × 10^5. This towing tank provides Arizona State University with a versatile testing platform for aerodynamics, hydrodynamics, biomechanics, robotics and autonomous systems. The system consists of a 3-meter-long, 0.5-meter-wide, and 0.8-meter-high cast acrylic tank with aluminum welded-frame supports, a belt-driven multi-axis linear actuator, a 6-axis load cell, and supporting hardware and software interfaces.

Validation tests were conducted on 100-mm and 175-mmspheres, and a 175-mm flat plate. Force measurements were acquired and processed to obtain drag coefficients as functions of Reynolds number. These results establish a performance baseline for the system and provide insights and recommendations for future design iterations. An operational manual has been published for future student, faculty, and researchers' access.

This experimental platform is available for use at Arizona State University's Mechanical and Aerospace Engineering Graduate and Undergraduate laboratory facilities.

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