

The Quantitative Density Measurement of Unsteady Flow around the Projectile*

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Abstract

Three-dimensional density measurement of unsteady flow field around a sphere is carried out in the ballistic range at Institute of Fluid Science, Tohoku University. Simultaneous multi-angle measurement system using twelve digital cameras is installed in the test chamber of the ballistic range to achieve the three-dimensional density measurement. The Colored-Grid Background Oriented Schlieren (COBOS) technique using colored-grid background is utilized for the reconstruction of density. The Mach number of the sphere is set to 1.5. The short pulse LEDs to illuminate the backgrounds are also installed in the chamber to capture the unsteady flow field around a flying sphere. Three-dimensional density distribution around a sphere is successfully reconstructed.

Keywords

Background Oriented Schlieren, Flow Visualization, High Speed Flows, Unsteady Flow, Simultaneous Measurement

1. Introduction

The supersonic aircrafts and rockets are developed actively all over the world. In the development process, the density measurement around the model of aircraft and rockets under the supersonic speed is important in order to obtain aerodynamic properties [1] [2] [3].

*A part of this work was presented at 19th International Conference Fluid Dynamics (ICFD2018) in Sendai, 7-9 Nov. 2018.

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Twenty-First Symposium on Naval Hydrodynamics National Research Council,Division on Engineering and Physical Sciences,Commission on Physical Sciences, Mathematics, and Applications,Naval Studies Board,1997-09-11 **Twenty-Third Symposium on Naval Hydrodynamics** National Research Council,Division on Engineering and Physical Sciences,Naval Studies Board,Bassin d'Essais des Carènes,Office of Naval Research,2002-01-01 Vive la Revolution was the theme of the Twenty Third Symposium on Naval Hydrodynamics held in Val de Reuil France from September 17 22 2000 as more than 140 experts in ship design construction and operation came together to exchange naval research developments The forum encouraged both formal and informal discussion of presented papers and the occasion provides an opportunity for direct communication between international peers This book includes sixty three papers presented at the symposium which was organized jointly by the Office of Naval Research the National Research Council Naval Studies Board and the Bassin d Essais des Car nes This book includes the ten topical areas discussed at the symposium wave induced motions and loads hydrodynamics in ship design propulsor hydrodynamics and hydroacoustics CFD validation viscous ship hydrodynamics cavitation and bubbly flow wave hydrodynamics wake dynamics shallow water hydrodynamics and fluid dynamics in the naval context

Applied Mechanics Reviews ,1969 *U.S. Environmental Protection Agency Library System Book Catalog Holdings as of July 1973* United States. Environmental Protection Agency. Library Systems Branch,1974 **Flow**

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waves in multiphase flows and detonation engines Volume 3 contains 55 papers covering the applications part 2 of shock waves to various fields encompassing mechanical engineering aerospace engineering space sciences geosciences materials sciences life sciences and medicine [Flow Measurement Handbook](#) R. C. Baker,2016-08-25 Flow Measurement Handbook is a reference for engineers on flow measurement techniques and instruments It strikes a balance between laboratory ideas and the realities of field experience and provides practical advice on design operation and performance of flowmeters It begins with a review of essentials accuracy flow selection and calibration methods Each chapter is then devoted to a flowmeter class and includes information on design application installation calibration and operation Among the flowmeters discussed are differential pressure devices such as orifice and Venturi volumetric flowmeters such as positive displacement turbine vortex electromagnetic magnetic resonance ultrasonic acoustic multiphase flowmeters and mass meters such as thermal and Coriolis There are also chapters on probes verification and remote data access **Hydraulic Research in the United States ,1963** *Current Hydraulic Laboratory Research in the United States ,1963* **Australasian Conference on Hydraulics and Fluid Mechanics ,1966** *Technical Publications Announcements with Indexes* United States. National Aeronautics and Space Administration,1962 **Energy Research Abstracts ,1982** [Report](#) United States. National Bureau of Standards,1963 **Scientific and Technical Aerospace Reports ,1994-05**

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