International Journal of Innovative Computing, Information and Control
Volume **5**, Number **12(B)**, December **2009**

ICIC International ©2009 ISSN 1349-4198
pp. **4927–4934**

ERROR DETECTION AND PERFORMANCE ANALYSIS SCHEME FOR PARTICLE TRACKING VELOCIMETRY RESULTS USING FUZZY LOGIC

Achyut Sapkota[1] and Kazuo Ohmi[2]

[1]Graduate School of Engineering
[2]Department of Information Systems Engineering
Osaka Sangyo University
3-1-1 Nakagaito, Daitoshi 574-8530, Japan
sapkota@ieee.org; ohmi@ise.osaka-sandai.ac.jp

Received July 2008; revised December 2008

Abstract. *Particle Tracking Velocimetry (PTV) is a tool to measure the velocity fields of fluids by observing the motion of the tracer particles seeded in them. The displacement of individual particles gives the velocity information if divided by a known time interval. The accuracy as well as efficiency of the PTV systems depend upon the reliability of the algorithms to track the motion of those particles. There exist different algorithms for this purpose but there is a lack of a standard system to judge or compare the accuracy of the results obtained. The velocity information is always prone to outliers. The outliers degrade the quantitative information of the velocity field and gives misleading information of velocity based quantities like vorticity, streamlines, divergence etc. In this paper, a technique based on rule-based fuzzy logic has been proposed for the detection of such outliers. A novel evaluation scheme is proposed which is applicable to test the reliability of the given algorithms.*

Keywords: Particle tracking velocimetry, Particle image velocimetry, PIV, PTV, Fuzzy logic, Flow measurement

1. **Introduction.** The visualization of the flow field has become an indispensable tool for the investigation of flow structures. The traditional methods of the quantitative information of the flow field include the techniques using pitot-static tubes and hot-wire anemometers. Both of these techniques require the insertion of a physical probe which can intrude on the flow itself. Later, with the invention of laser technology, a new measurement technique called laser Doppler anemometer was developed. Laser Doppler anemometer uses a laser probe enabling the non-intrusive measurement of the velocity fields, but they are able to give the information of the flow only at a point of the location of the beam intersection. Though these methods still retain some important positions in the field of experimental mechanics, Particle Image Velocimetry (PIV), an image-based flow field measurement technique, has become increasingly popular and useful. The PIV technique has gone through significant progress in the past decade and is still being developed further, see for example, [1–4] and the references therein.

In PIV, a pulsed laser light sheet is used to illuminate a flow field seeded with tracer particles small enough to accurately follow the flow. The positions of the particles are recorded on digital CCD cameras at each instant of illumination. The two camera frames are then processed to find the displacement vector map of the flow field. The displacement that can be estimated by different means and the time separation between the images gives the velocity information. The PIV method involves two approaches. One is cross-correlation based technique which gives mean velocity of the group of particles.