Multiplane Scanning Stereo PIV for Biofluid Applications

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Background

Stereoscopic Particle Image Velocimetry (Stereoscopy PIV) is a whole-field laser optical technique. It permits the three velocity components measurements in a cross section flow. The flow is usually seeded by small tracer particles illuminated by a sheet of laser light. The light scattered by the particles is recorded on two separate frames on a special CCD camera sensor.

The reconstruction of the 3D object from the digital images requires prior knowledge of the mapping function between the image planes and the physical space cameras. This is achieved by means of a calibration procedure.

Double Windows Prism

The Stereoscopic PIV needs a precise calibration procedure whose accuracy is directly linked with measurement errors. The usual calibration procedure consists in taking several images of a calibration target, placed first in the light sheet plane. Since cardiovascular flows are wall in by complex geometries, the calibration operation into the measurement plane is limited or often impractical.

A Double Windows prism was developed to permit us to implement Multiplane scanning measurements of Stereoscopic PIV within a complex geometry without repeating a laborious calibration. It ensure the relative positions the Stereo PIV apparatus throughout the scanning, preserving the below formula.

Biomedical application

“Intracardiac Flow Mirror Healthiness”

The evolution and spatiotemporal characteristics of the intracardiac flow field have physiological, clinical embryological, and pathological interest. Several studies aimed to evaluate and describe cardiac flow based on intracardiac flow, using measurements obtained by modern medical imaging (4D-MRI, echocardiographic[2]) or flow diagnostic techniques such as particle image velocimetry[3].

The aim of this project is to map the 3D intracardiac spatiotemporal structure flow by mean phase-locked Stereo-PIV. The Double Windows Prism developed permits the flow field measurement in the whole left ventricle model without repeating the complex stereo calibration. It consisted of coupling Stereo-PIV apparatus and cardiovascular simulator Vivitro system.

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References


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