Institute of
Thermophysics SB RAS

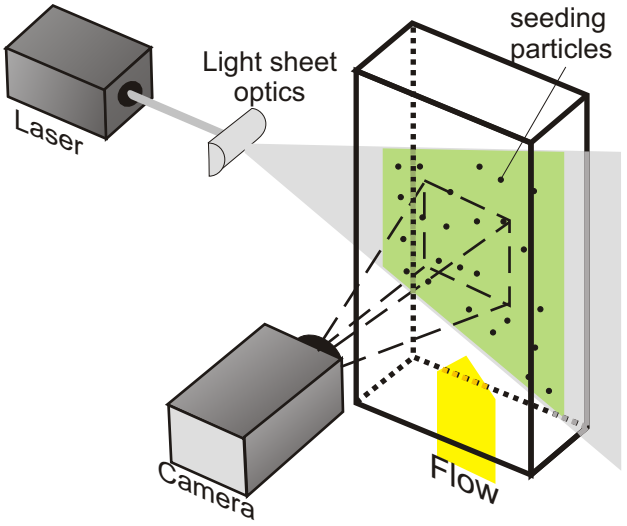
PIVIT
Particle Image Velocimeter

Particle Image Velocimetry (PIV)

Particle Image Velocimetry is a non-intrusive optical technique for fast velocity measurements in a chosen cross-section of the flow. Two (2D-PIV) or three components (Stereo PIV) of velocity field can be estimated in a measuring plane with high accuracy. PIV method is suitable for laboratory investigation of different types of laminar and turbulent flows and can be used in a wide range of industrial applications (design of modern aircrafts, cars, internal aerodynamics in power- and chemical engineering, etc).

Principles of operation

The pulsed laser sheet illuminates the small seeding particles carried by the flow. Positions of the particles during two consecutive laser pulses are recorded by a double-frame CCD camera. Local flow velocity is calculated from displacement of the particles between two light pulses. The whole flow field is divided into elementary cells (interrogation windows) where the average displacement of particles is calculated on the basis of cross-correlation analysis. The dynamic range of measured velocities depends on the time between pulses. Measured velocities are ranged from millimeters per second up to transonic.



Components of "PIVIT" system

"PIVIT" system consists of the following basic elements. Double cavity Nd:YAG laser is used for flow illumination. The pulse energy is up to 120mJ and repetition rate is up to 10Hz. The special lens system forms the laser sheet. Cross-correlation digital cameras with 1360 1024 or 2048x2048 pixel resolution are used for images recording, with subsequent images transfer to PC for evaluation. The system synchronization is done by programmable processor. Operation of experiment and data processing is controlled via software.

"PIVIT" system is compact and mobile, so that measurements can be performed at several locations in your lab. The system can be equipped by additional components to provide: PLIF - measurements of the concentration and temperature fields; LIF - velocity measurements in two-phase flows; GPDA - measurements of the droplet size and velocity fields in aerosol flows.

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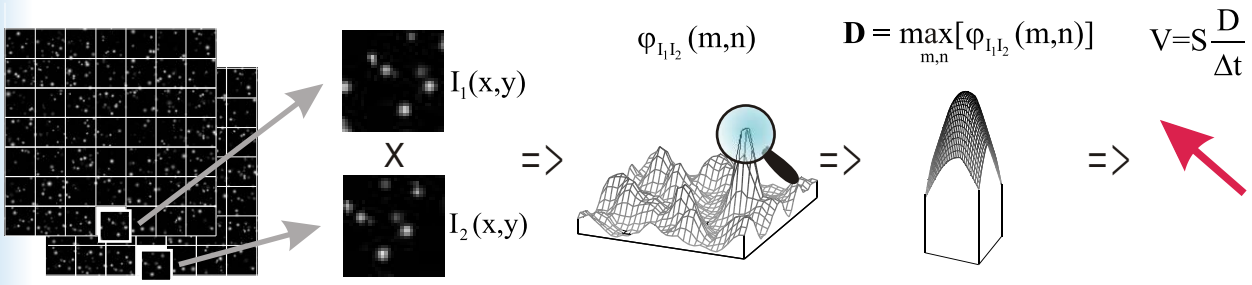
Velocity field evaluation



Images are divided into cells, the so-called interrogation areas

Cross-correlation function is calculated from the image gray scale values

Search for maxima on the correlation function

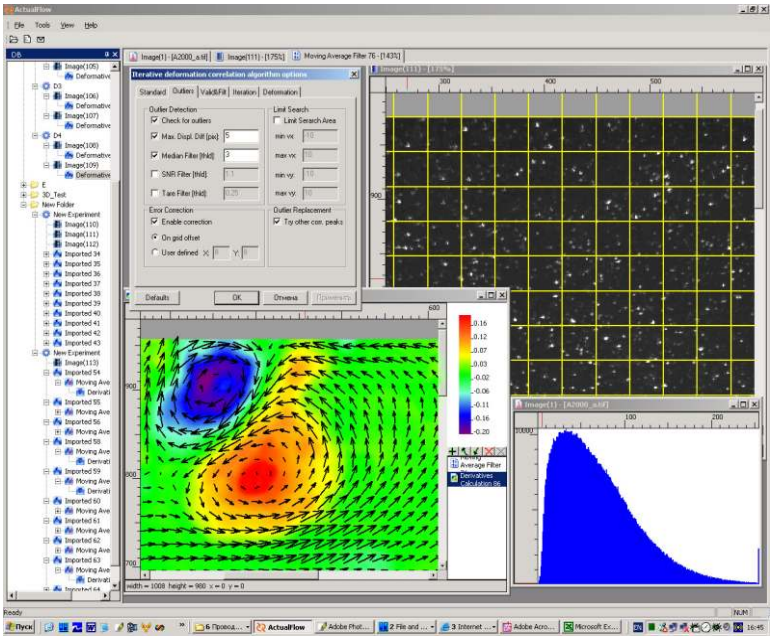
Local maximum coordinates are estimated with subpixel accuracy

Velocity vector evaluation

Velocity field is calculated by means of cross-correlation algorithms. For high-speed calculation this is done by FFT using Wienner-Kinchin theorem. Adaptive cross-correlation algorithms with grid refinement and deformation compensation are also available in the software. Average particle displacement corresponds to the maximum on the image correlation function. The displacement is calculated with subpixel resolution and gives up to 0.03 pix uncertainty.

Actual Flow software

Actual Flow software has been developed for automation of experimental process, data processing and data visualization. The set of data evaluation procedures includes: a number of cross-correlation algorithms for velocity calculation; algorithms for spurious vector identification; the modules of interpolating substitute of rejected vectors within velocity field; the modules of statistics and spatial derivatives computation. User is able to add his/her own algorithms for data processing. The data import and export possibilities allow using Actual Flow software together with other Windows applications.



System features

- Technique is non-intrusive
- Measurements of instantaneous velocity maps in a cross-section of the flow
- All three components of velocity vector can be obtained using Stereo PIV
- Operational rate up to 3.3 Hz
- Velocity field up to 170x128 vectors (256x256 with 4M cameras)
- Velocity range from 0.001 to 300 m/s
- Accuracy of velocity measurements (depends on experimental conditions) up to 1.0 %

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