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Visualization of Patient-Specific Volume Images In Image-Guided Diagnosis and Therapy

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An exciting and rapid evolution is underway for imaging and visualizing the human body from physically visible to realistically virtual to fully functional forms, extending from micro to macro orders of scale. A major goal is to integrate and synthesize for visualization and quantitative analysis both structure and function of all living tissues from image data sets that span this wide range of scale – from molecules to complete organ systems. The procedure includes patient- specific volume scans converted to accurate high resolution anatomic and physiologic models which can be used in real-time for a variety of clinical applications, as depicted in the figure. This rapid and accurate virtualization of all body tissues and structures of interest and their functions, regardless of dimensional size and/or separation, will be so faithful as to render the virtual representations indistinguishable from the real objects. The image fusion of functional properties and physical characteristics with anatomic and micro structures will provide rapid and accurate analysis of structure to function relationships, including expression of cell function at the organ level, connecting specific micro-cellular level mechanisms and/or abnormalities with specific diseases and malfunctions at the macro-organ level. Such capabilities will provide synchronous detection, differentiation and treatment of disease and is expected to become the evolutionary successor of current image-guided diagnosis and therapy.

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Visualization of Large-Scale Internal Seiche in Lake Inawashiro

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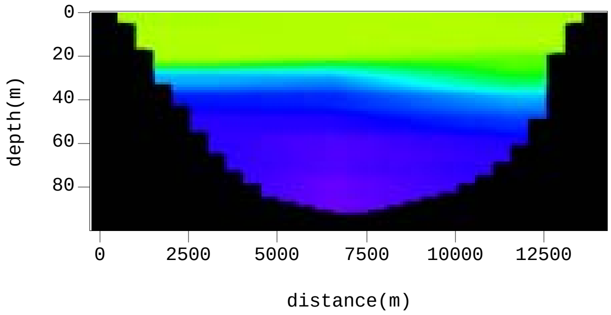


Fig. 1. 4:00 Oct. 28th

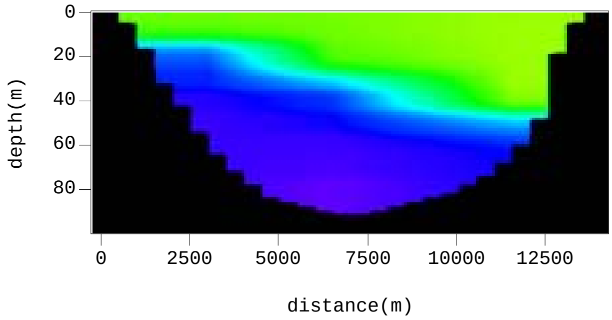


Fig. 2. 8:00 Oct. 28th

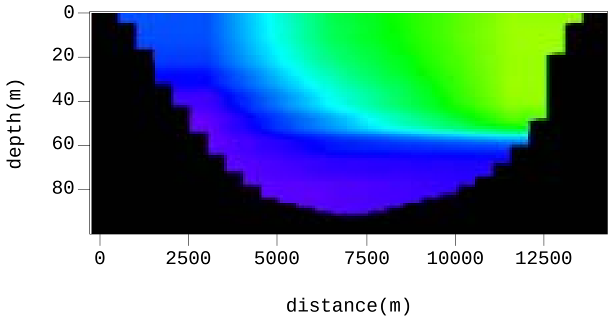


Fig. 3. 12:00 Oct. 28th

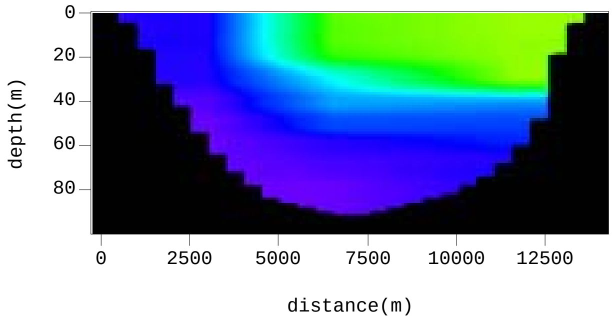


Fig. 4. 16:00 Oct. 28th

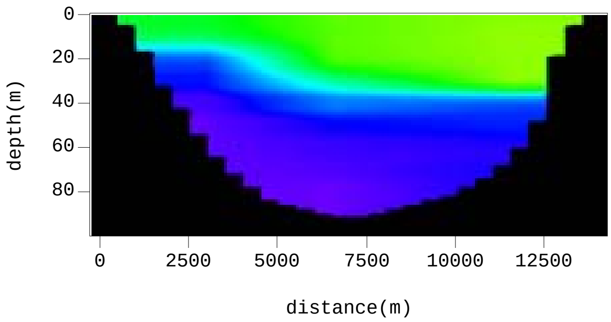
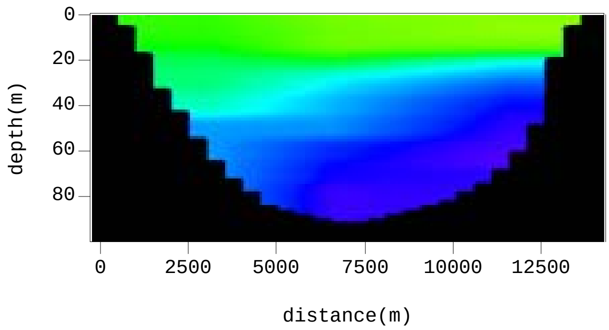


Fig. 5. 20:00 Oct. 28th



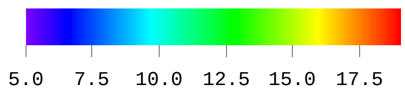


Fig. 6. 4:00 Oct. 29th (deg.)

Field observation of water temperature in Lake Inawashiro has been carried out in 1999. Spatial variation of the temperature in the whole area of the lake can be obtained using a simple linear interpolation method, as seen in the figures. In Figs.1 and 2, strong wind from the left caused deepening of the interfacial layer on the right hand side. Subsequently, upwelling of cold water was observed on the left hand side in Figs.3 and 4, followed by the recovery of thermocline in Figs.5 and 6. It should be noted in Fig.6 that the distinct vertical mixing of the lake water occurred after the large-scale oscillation, suggesting that the internal seiche has important role for the change in water quality in the lake.

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Flow Patterns of Cross-Flow Around Four Equispaced Cylinders at Low Reynolds Number

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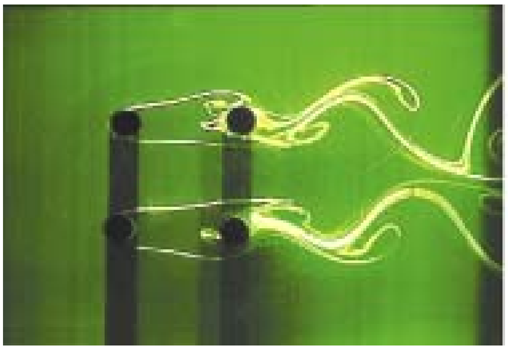
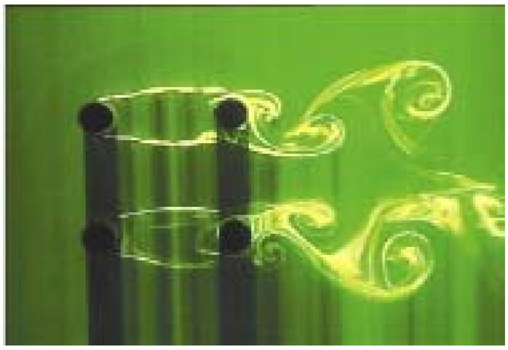
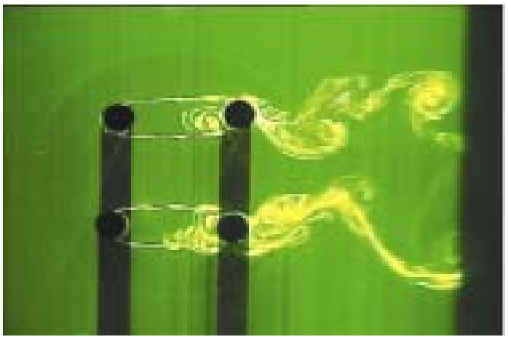


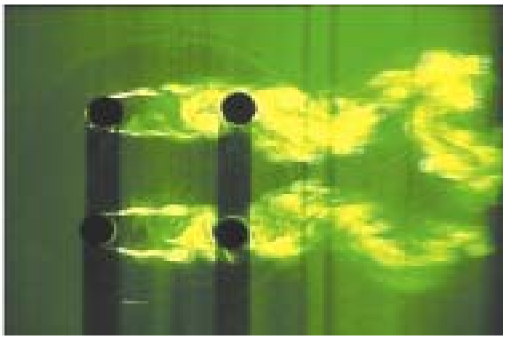
α=0° *Re*=100



α=0° *Re*=400

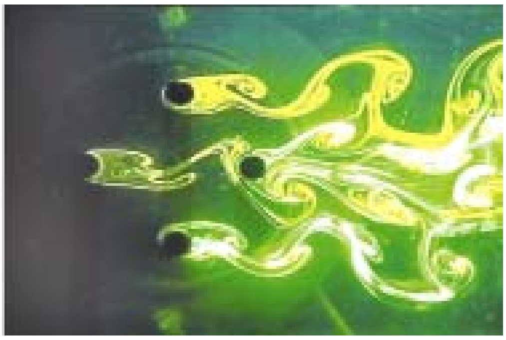


α=0° *Re*=600



α=0° *Re*=1400

α=20° *Re*=200



α=45° *Re*=200

Flow patterns around four equi-spaced (L/D = 4) cylinders vary with Reynolds number and incident angle. Laser Induced Fluorescence (LIF) visualization was employed to study the various flow patterns and the vortex interactions. Investigations show that different flow patterns result in large difference in velocity fields, pressure fields and force characteristics of the cylinders. The patterns also provide an important database for the validation of numerical simulations.

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Counterflow Diffusion Flame under Reduced Gravity

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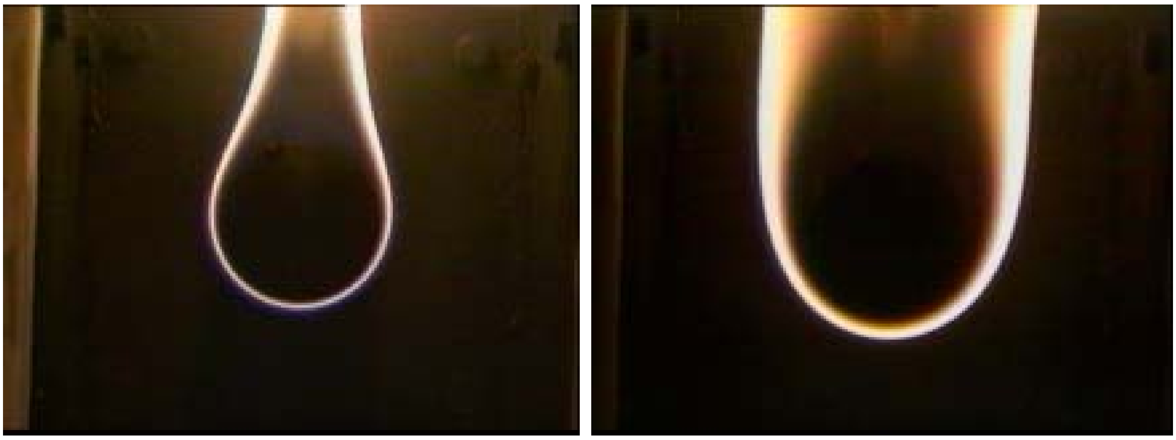
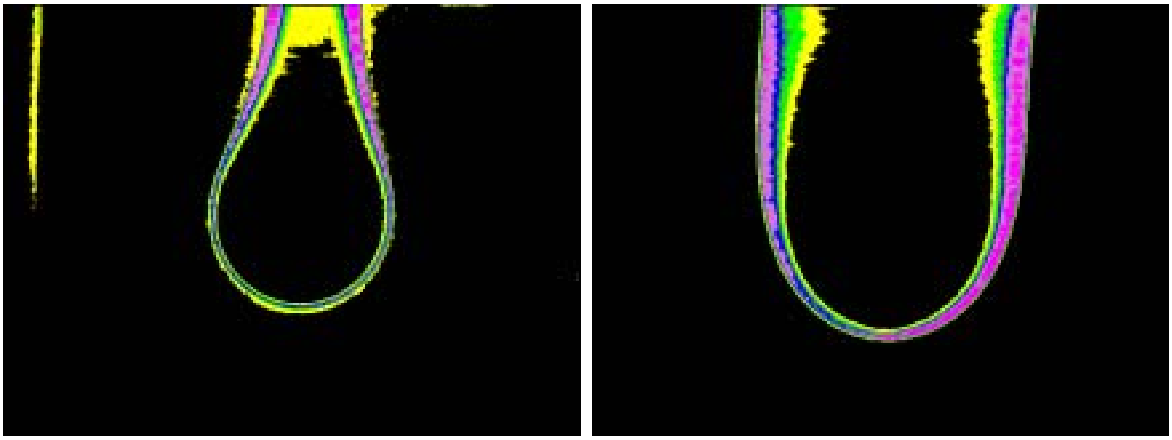


(a) Onset of free fall (b) after t=0.6 sec.

Fig. 1. Timewise variation of counderflow diffusion flame under reduced gravity



(a) Onset of free fall (b) after t=0.6 sec.

Fig. 2. Brightness of counterflow diffusion flame under reduced gravity

Figure 1 illustrates the counderflow diffusion flame in the forward stagnation region of a porous cylinder placed in the vertical wind tunnel under reduced gravity. The counterflow diffusion flame of propane at t=0 seconds appears in the vicinity of the porous cylinder. After t=0.6 seconds, the flame thickness and area increase due to non-buoyancy forces, as shown in Fig. 1(b). The corresponding flame luminosity obtained by an image processing method is amplified under reduced gravity, that is, the flame brightness, namely, the area of the red region, becomes wider (Fig. 2).

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Real time color holographic interferometry devoted to 2D unsteady wakes flows

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Fig. 1. Uniform background and straight fringes

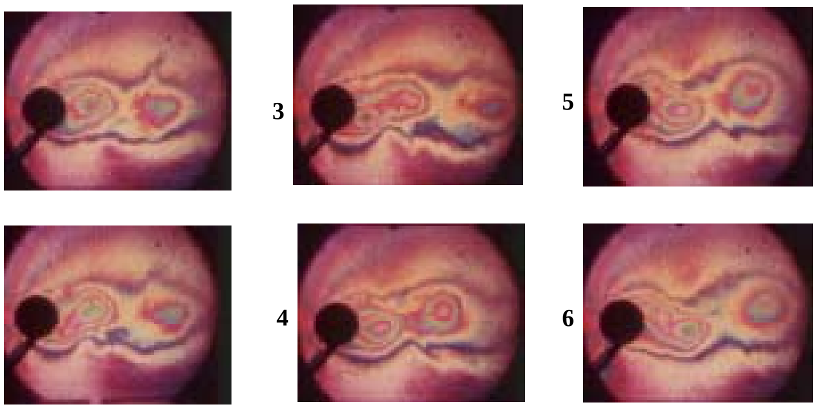

Fig. 2. High speed holographic interferograms

A new optical technique based on real time holographic interferometry in trues colors has been developed at the Institut de Recherches de Saint-louis and implemented around the transonic wind tunnel of the ONERA-Lille center to analyze 2D unsteady wake flows. Tests realized in color interferometry, real time and double exposure, simultaneously use three wavelengths of a continuous waves laser (argon and krypton mixed) and holograms are recorded on silver-halide single-layer panchromatic Slavich PFG03c plates. The very principle of real-time true color holographic interferometry uses three primary wavelengths (red, green, blue) to record, under no-flow conditions, the interference among the three measurement beams and the three reference beams simultaneously on a single reference hologram. After the holographic plate is developed, it is placed on the test setup again in the position it occupied during exposure and the hologram is illuminated again by the three reference beams and three measurement beams. A flat, uniform color can then be observed behind the hologram (see Fig.1). So a horizontal, vertical, or even circular fringe pattern can be formed and the achromatic central white fringe can be made out very clearly. This single color is used to determine the zero path difference on the interferograms (Fig.1). The flow studied was the unsteady flow downstream of a cylinder of diameter D = 20 mm placed crosswise in the test section. Fig. 2 gives a sequence of six interferograms shifted of 100 μs of flow around the cylinder at Mach 0.37. The vortex formation and dissipation phases can be seen very clearly, along with the fringe beat to either side of the cylinder.

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Visualization of invisible reaction zone of H_2 molecules on the front of diffusion flame of propane

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(a)

(b)

(c)

Fig. 1. Visualization of H_2 combustion zone by the diffusion flame of propane, by evaporating molecules of NaCl (a, b) and (c) Na_2CO_3 in the flame zone.

Visualization of invisible zones in front of a flame of hydrocarbon substance (propane) in diffusion flame conditions are presented. Evaporating molecules of salt (Fig. 1(a), (b)) and two-carbonic sodium (Fig. 1(c)) in a zone of burning because of processes $H + H + Na \rightarrow Na^* + H_2$ and $H + OH + Na \rightarrow Na^* + H_2O$, and the subsequent radiation stabilization of the excited atoms of sodium $Na^* \rightarrow Na + h\nu$, is drawn a zone of combustion for hydrogen molecules formed in non-equilibrium quantities and creating a new zone of front of the flame. The zone of burning of hydrogen in the horizontal direction is clearly less than 2 millimeters due to diffusion, but convective flow expands this zone up to 6 millimeters.