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1. Transonic Nonequilibrium Two-phase Wake Flow in Axial Cascades

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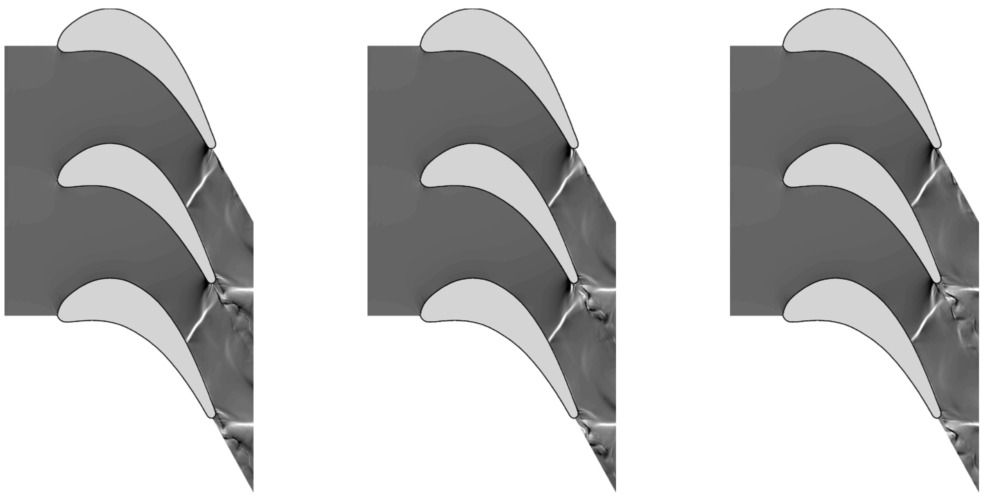
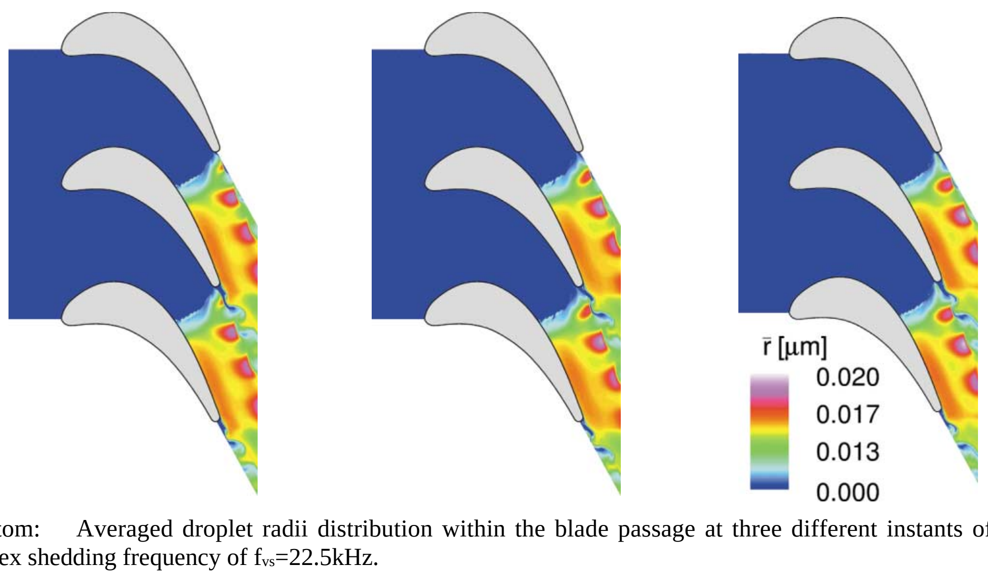
During the expansion in a low pressure steam turbine the thermodynamic state path of the vapor crosses the saturation line and the subsequent stages operate in the nonequilibrium two-phase regime with a highly dispersed mixture of steam and very tiny droplets. Rotor diameters of several meters yield, together with synchronizing to the line frequency of 50 or 60 Hz, circumferential speeds of 500-600 m/s which indicates the transonic/supersonic nature of the flow. Turbulent wakes interact with nucleation and droplet growth in the blade passage. From the color scale it can be seen that the biggest droplets develop near the wake and are convected downstream with a frequency of 22.5 kHz. The polydispersed radii spectrum at the exit plane covers about one order, from $2 \cdot 10^{-8}$m to $2 \cdot 10^{-7}$m.

Flow parameters: VKI turbine cascade, homogeneously condensing turbulent steam flow, $Re_2=1.15\times 10^6$, $M_{2,is}=1.13$. Reservoir conditions of the steam: $T_{01}=357.5$K, $p_{01}=0.417$bar, $T_{01}-T_{sat}(p_{01})=7.5$K; vortex shedding frequency fvs=22.5kHz.



Top: Numerical Schlieren picture, local orientation of the knife edge normal to the local flow velocity vector.



Bottom: Averaged droplet radii distribution within the blade passage at three different instants of the vortex shedding frequency of $f_{vs}=22.5$kHz.

2. Influence of an Acoustic Perturbation on the Flow Mixing in a T Junction

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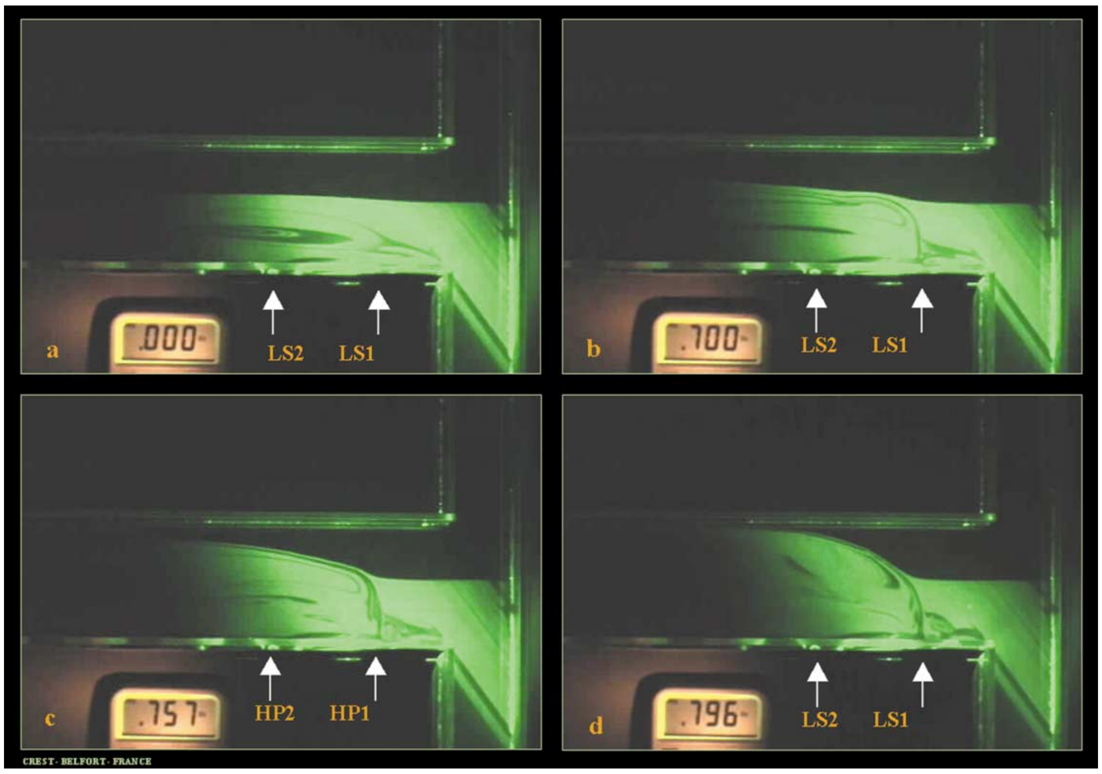

Keywords : Flow mixing, Acoustic perturbation, T junction

Laser tomography was performed to study the influence of an acoustic perturbation on the flow mixing in a T junction. The flow velocity in the inlets (vertical ducts on the image) is fixed at 0.1 m/s corresponding to a Reynolds number Re of 180. Two small loudspeakers (LS1, LS2) are placed at a wall of the exit duct. The flow is seeded with oil particles only in one inlet. First, we consider the LS1 loudspeaker influence : Without acoustic perturbation (image a), the flow is laminar and a recirculating zone is observed in front of LS1 but the flow mixing is not efficient. The first noticeable effect of the acoustic perturbation appears near 530 Hz. Its influence increases with frequency and reaches a maximum near 800 Hz (images b, c, d). In fact, this value corresponds to the acoustic resonance of the exit duct. It induces a maximum acoustic pressure. Over 800 Hz, the perturbations decrease and disappear near 1kHz. If the loudspeaker is moved, for example in LP2 position, the acoustic influence becomes negligible whatever the operating frequency. This means that the acoustic perturbation position is very important : recirculating zones (as LS1) where the flow is not stable are particularly sensible.

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3. Tornado-like Multiple Vortices in a Simulated Supercell Thunderstorm

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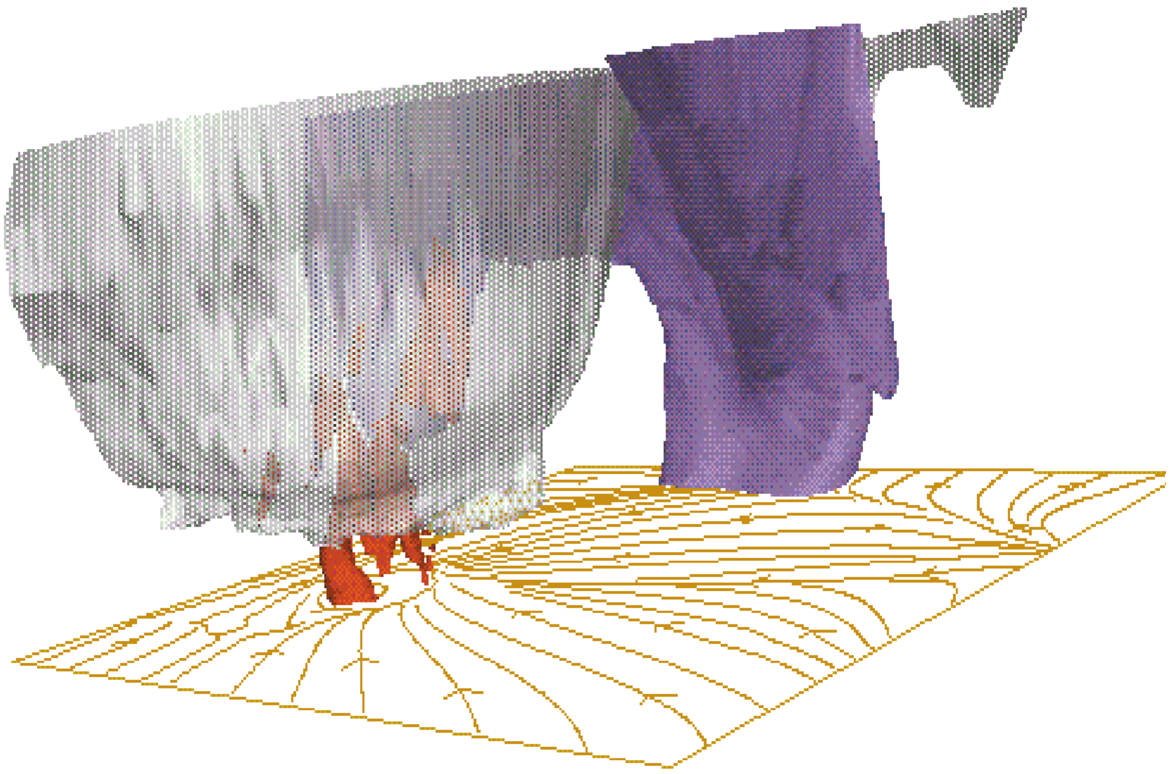

It has been known that a violent tornado is spawned by a special type of thunderstorms called a supercell. The supercell possesses several remarkable characteristics such as a vault-shaped rainwater distribution caused by a strong updraft and a strong circulation called a mesocyclone (MC). A tornado is often formed near the MC. The recent development of computer technology enables us to simulate not only a supercell but also a tornado-like vortex spawned by the supercell.

The figure shows a close-up view of a simulated supercell near the MC. The whole calculation domain is 64 $\times$ 65 km in the horizontal direction and 14 km in the vertical direction, but only the domain of 15 km $\times$ 15 km $\times$ 3 km is shown. The near right corner is the northeast and the left corner the southeast. The gray, purple and red color show isosurfaces of 0.5g/kg cloud water, 5 g/kg rainwater, 0.05 s^{-1} vertical vorticity respectively, and the orange color shows streamlines near the ground. The skirt-shaped cloud called a wall cloud can be seen at about 500 m above the ground level around the southeast end of the vault-shaped rainwater. Below the wall cloud, three tornado-like vortices, which remind us of a multiple-vortex tornado, are simulated.

(Acknowledgment: This simulation was made using the Advanced Regional Prediction System(ARPS) developed by the Center for Analysis and Prediction of Storms (CAPS), University of Oklahoma. CAPS is supported by the National Science Foundation and the Federal Aviation Administration through combined grant ATM92-20009. The Vis5D developed by Hibbard, B. (1997) was used to produce the figure.)

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4. Numerical Visualization of Blood Flow in the Cerebral Artery

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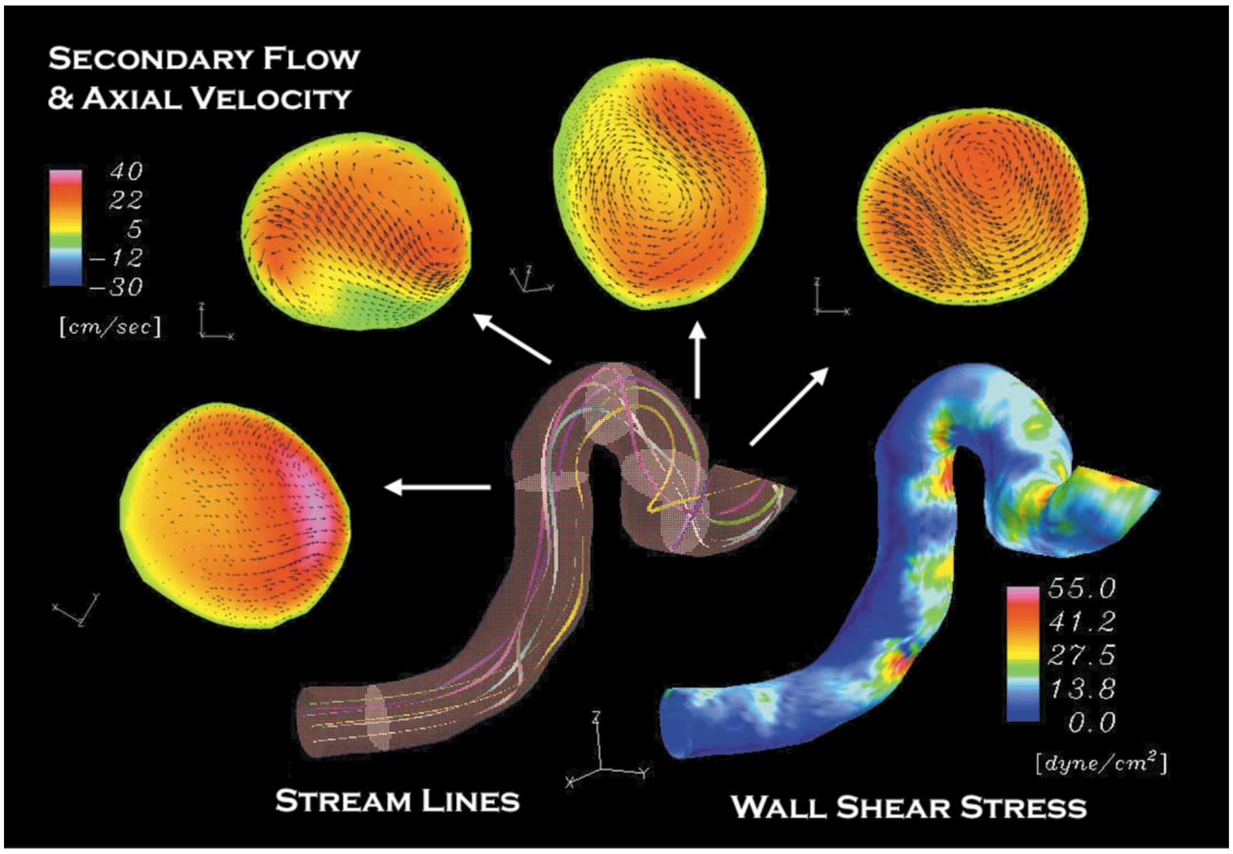

Clinical statistics show that the cerebral aneurysm are frequently generated at some specific areas. The abruptly curved shape of the artery shown in this figure is called "carotid siphon" and here is the area with high risk of generation of the cerebral aneurysms. We have developed a numerical analysis system which includes pre-processing, numerical simulation and post-processing. In the procedure of pre-processing, computed tomographic angiography is used. These figures show the results of numerical simulation. Complex secondary flow exists in the flow field and the wall shear stress concentrates on some specific areas in the artery.

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5. Qantitative Visualization of Human Structure Using Segmented Volume Data Obtained by MRI

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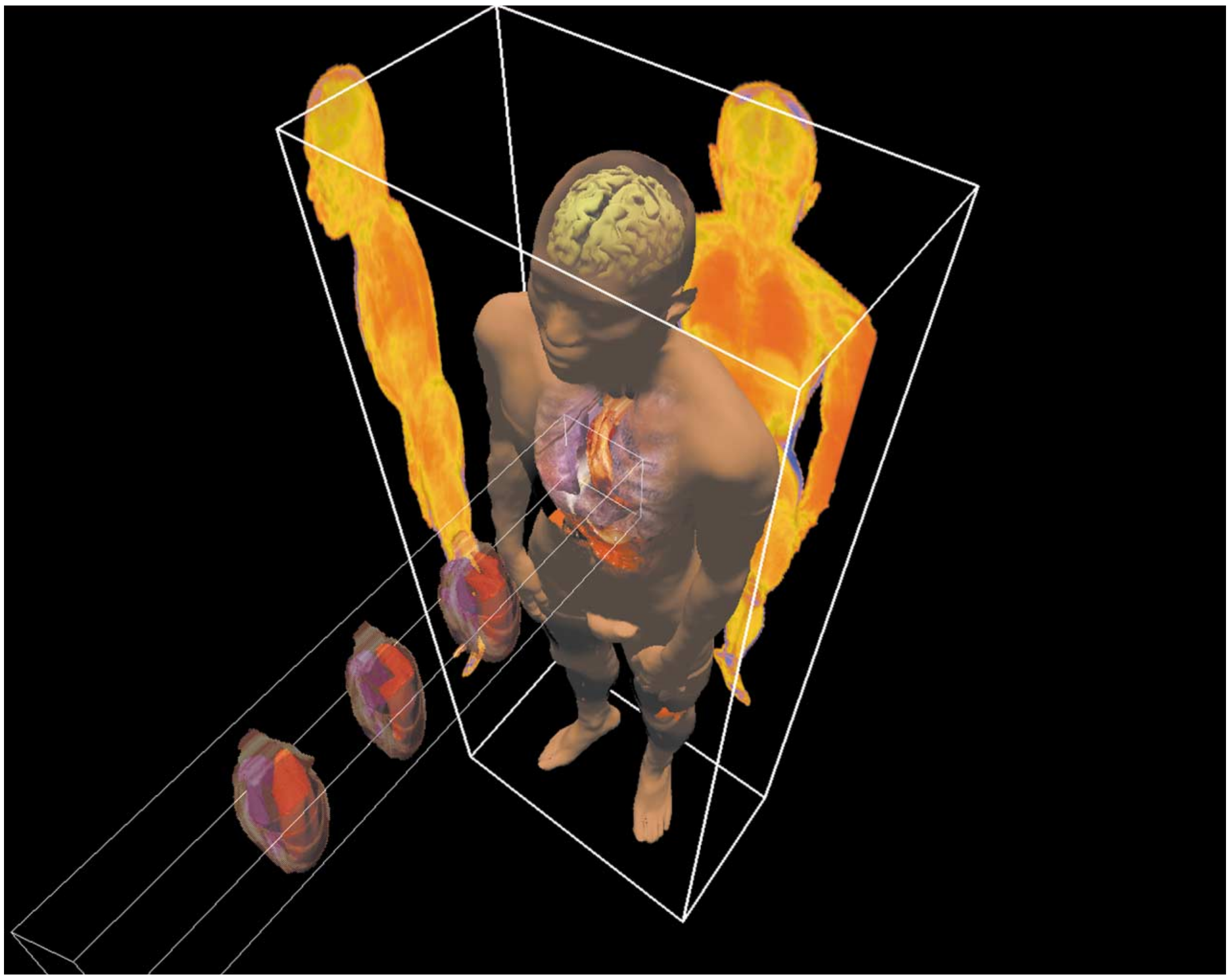

It is needless to say that to visualize inside of a human body is one of the dreams in the medical world. Currently, it is getting easier to obtain a 3 dimensional or 4 dimensional data set using the latest MRI or CT systems. By preserving volume data of each segmented data according anatomical structure as a format of data storage, we are now developing a new technique for quantitative analysis that can show the morphology and functions of living body more effectively and precisely. The figure shows an example of a whole male human body. The image was obtained from an MRI data set and segmented by each main organ. Instead of reading sectional planes of a huge MRI data set, this reconstructed image shows the indicative result that was acquired by recognaizing the whole body structure intuitively. The image can not only catch an accurate position or form of organs direct to its whole structure, but also measure a size and a volume of a piece of an organ that was taken out. Then, it enables us to observe and analyze 4 dimentional cardiac functions such as transparent heart image that is placing time sequentially in anterior part of chest. Since the data set is volume data, this also permits to show MIP (maximum intensity projection) from optional directions and obsereves body structures in full details.

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6. High Functional 3D Human Model System for Dynamic Visualization of Locomotions

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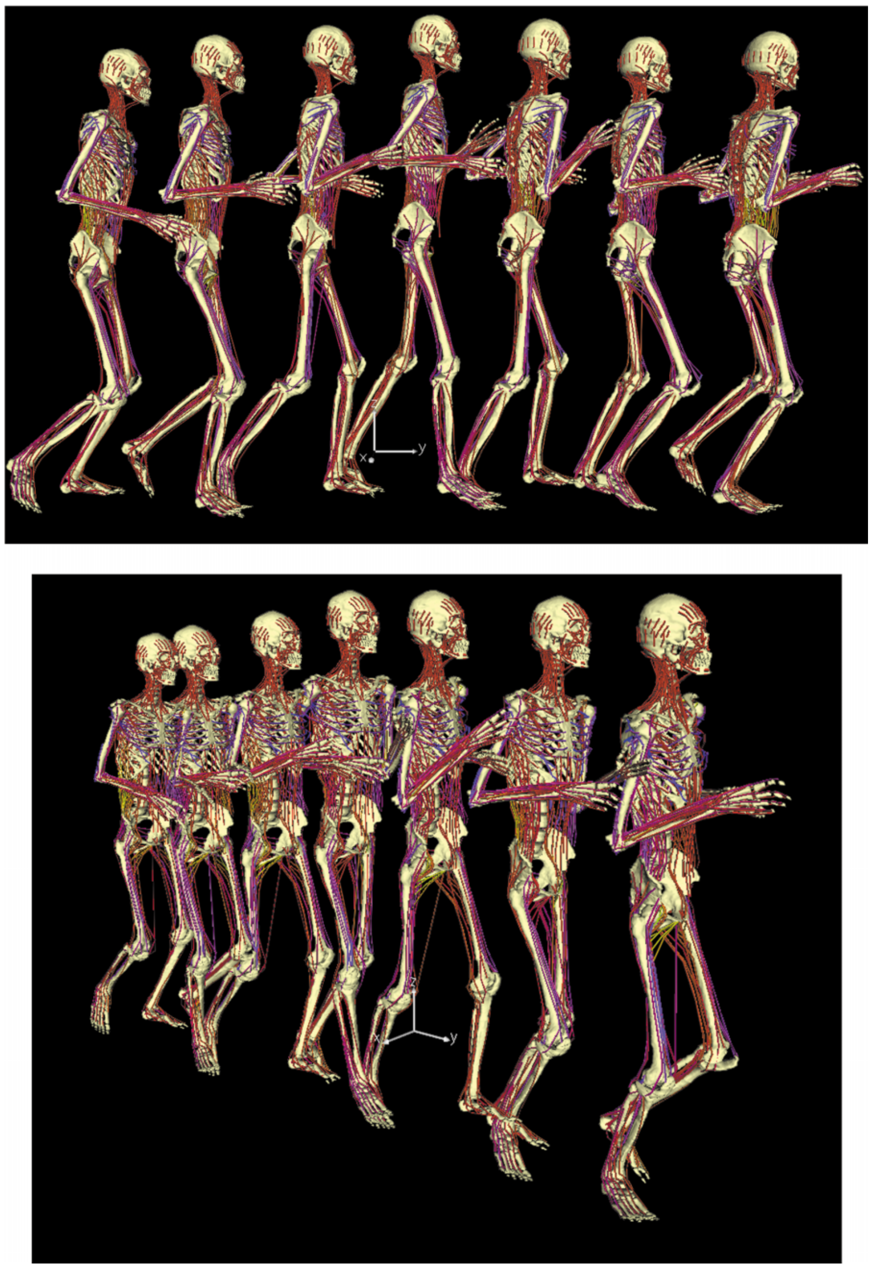

Development of the High-functional 3D Human Model System

We constructed a high-functional 3D human skeletal and musclar model system using 3D MRI data set of a whole human body. By modeling the joints of each skelton, this system allows us its spatial operation in real time. At the same time, such method made possible to operate a serial motion of multiple joints in the human model by providing a range of motion in each joint structure as a parameter. This whole human model itself was consisted of 151 parts of skeletons and 89 joints. In addition, we developed a technique of measuring a range of motion and a system to indicate a condition of motion for each joint using 8 Polhemus sensors. Next, a flexible string-typed muscle model was added to the skeletal model. All images in this type of muscle model can be operated in real time with its string shape to reduce an amount of calculation at the time of motion simulations. At last, having motion capture data using VICON system with multi video cameras to operate the model four dimensionaly, users can effectively recognize activities of the string-shaped muscle model as moving the skeleton. The figures show a 4D motion model of running slowly.