AEROSPACE SCIENCES

Aerodynamic measurement technology

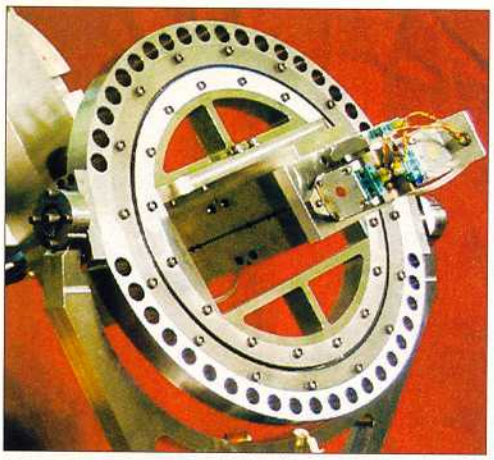
The Viosense microoptical wall shear stress sensor held in the stream of droplets shows the operation of the laser probe beams.

Researchers at NASA-Langley achieved a significant advancement in force balance calibration technology by integrating a unique single-vector load application device with a modern design of experiments, or MDOE, approach. This innovative system delivers a tenfold reduction in the duration and cost of balance calibration yet also increases data quality. The single-vector force balance calibration system overcomes the productivity and accuracy limitations of prior calibration methods and provides a foundation for further advancement throughout force measurement technology.

Tao Systems has developed waterproof hot-films sensors that are operated by constant voltage anemometers. In successful experiments in an ocean environment, tests were conducted to obtain flow angularity and boundary-layer state on the keel and bulb of a high-performance racing sailboat.

At Viosense, a miniature traversing laser Doppler anemometer (LDA) and a microoptical shear stress sensor were used jointly to measure the profile of the boundary layer and the velocity gradient at the wall of a flat plate (Reynolds No. 10,000). The conceptual development and fabrication of the shear stress sensor grew out of recent developments in diffractive optics and microdevice technology. When mounted directly on the plate, the miniature LDA was capable of measuring the flow velocity to within 150 μm of the surface. The optical shear stress sensor measured the flow velocity 66 μm off the surface by beating the Doppler-shifted scattered light from particles traveling through the intersection of two noncollimated coherent laser beams at and above the sensor surface. The data obtained in a laminar boundary layer with a weak favorable pressure gradient show perfect agreement between the wall velocity gradient calculated from the boundary-layer velocity survey performed with the LDA and the measurements obtained with the sensor.

The single-vector force balance calibration system from NASA-Langley reduces the errors in, and time of, calibration of multicomponent wind-tunnel balances.



NASA-Langley's Advanced Measurement and Diagnostics Branch successfully demonstrated the simultaneous use of projection moiré interferometry (PMI), temperature-insensitive/pressure-sensitive paint (TIPSP), digital particle image velocimetry (DPIV), and a dynamic pressure sensor array (DPSA) in the subsonic basic research tunnel. PMI, TIPSP, DPIV, and a 56-sensor DPSA were used simultaneously to investigate the on- and off-body flows over a flat plate with a hinged leading edge. A recirculation region above the plate grew in size with increasing leading-edge angle. PIV was used to measure the off-body flow velocity in the recirculation region, while TIPSP, DPSA, and static pressure taps were used to investigate the on-body pressure distribution and flow reattachment location. PMI was used for remotely measuring the leading-edge deflection angle.

Researchers at Ohio State University demonstrated the capabilities of acetone-based molecular tagging velocimetry for quantitative determination of velocity profile in high-speed microflows. Measurements were obtained in a 2D Mach-2 nozzle with exit dimensions of 1×5 mm, in both air and nitrogen, in the static pressure range from 1 to 110 Torr, with spatial resolution of approximately 10 μm. Statistical uncertainty in velocity was found to be 5-10 m/sec.

Seedless velocimetry based on laser-induced thermal acoustics was used to determine flow velocity, speed of sound, and temperature in the NASA-Langley Basic Aerodynamics Research Tunnel facility. Comparison with pitot-static tube results in the freestream and with LDV behind a rearward-facing step showed excellent agreement.

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The year in review