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AERODYNAMICS SUPPORT OF RESEARCH INSTRUMENT DEVELOPMENT

by

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Development of new research instrumentation is typically a long and difficult process requiring contributions from a range of scientific and engineering disciplines. Aerodynamic velocimetry systems are no exception to this thesis. Physicists, Chemists, Electrical Engineers, and Aerospace Engineers are now commonly involved in aerodynamic instrumentation development. The Aerospace Engineer's role is, typically, to evaluate system performance and define measurement applications.

A new velocimetry system, originally conceived by Northrop Research and Technology Center, is currently being developed at the NASA LaRC. The device, known as a Doppler Global Velocimeter (DGV), can record three velocity components within a plane simultaneously and in near real time. Current velocimetry methods, such as the Laser Velocimeter, provide only point measurement of the flow behavior. Under many circumstances, an instantaneous global measurement of the flow field is preferred.

To make measurements the DGV, like a many other velocimetry systems, relies on the scattering of light from numerous small (0.5-2.0 micron diameter) particles in a flow field. The particles or seeds are illuminated by a sheet of Laser light and viewed by two CCD cameras. The scattered light from the particles will have a frequency which is a function of the source Laser light frequency, the viewing angle, and most importantly the seed velocities. One of the CCD cameras is fit with an atomic line filter which passes light as a function of frequency. The exact relationship between the transferred light intensity and frequency is easily identified through calibration. Thus by determining the scattered light intensity the velocity can be measured at all points within the light sheet simultaneously. The second camera is used to compensate for seed size and distribution uniformity problems. The complete velocimetry process is extremely quick allowing up to 30 global measurements per second.

Upon completion of DGV component construction and initial check out a series of tests in the Basic Aerodynamic Research (wind) Tunnel (BART) are scheduled to verify instrument operation and accuracy. If results are satisfactory, application of the DGV to flight measurements on the F-18 High Alpha Research Vehicle (HARV), at the NASA Ames-Dryden research center, are planned.

The DGV verification test in the BART facility will utilize a 75 degree swept delta wing model. A major task undertaken this summer included evaluation of previous results, obtained using established techniques, for this same model. Understanding this data is important since it will be utilized as a baseline for DGV evaluations. A specific series of tests matching exactly previous tests and exploring new DGV capabilities were developed and suggested. Upon completion of the BART investigation test matrix a good measure of the DGV system accuracy and ability will be established.

Another task undertaken was to study DGV system installation possibilities in the F-18 HARV aircraft. To meet projected velocity measurement requirements and to identify mounting locations for the DGV transmitting and receiving optics, in available aircraft spaces, a three dimensional assessment tool was implemented. The DGV Laser and CCD camera systems were arranged, using a Computer Aided Design (CAD) software package, at numerous locations and the measurement capabilities evaluated in three dimensions quickly and easily. A number of potential DGV installation schemes for the F-18 were established using this method.

In addition to the above work, a simple seeding system modification was "developed" and utilized to make Particle Imaging Velocimetry (PIV) measurements in the BART facility. Flow seeding may at first seem like a simple task, but unfortunately it can become a time consuming and difficult problem. The simple modification allowed for proper seeding and good measurement capability. Since the seeding requirements for the DGV are basically the same, this modification has the potential for application in the future scheduled tests.