Statistical Engineering Division Seminar

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Tomographic Reconstruction of the Local PDFS of Soot Volume Fraction and Temperature

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A tomographic method to obtain the local probability density functions (PDFs) of soot volume fraction and temperature from path integrated measurements is presented. The joint PDFs of emission intensities at 900 nm and 1000 nm were measured in a horizontal plane perpendicular to the axis of an ethylene/air diffusion flame. These joint PDFs are used in an onion peeling algorithm in conjunction with the discrete probability function (DPF) method to obtain the local PDFs of soot volume fraction and temperature. The statistical problem is to recover the local density functions of the two properties T (temperature) and F (soot volume fraction) given the joint density function of the observed intensities, I (the radiation intensity at 900 nm) and U (the radiation intensity at 1000 nm). The relationship between I and U, obtained from the equation of radiative heat transfer, is highly non-linear in both T and F. An iterative scheme is used to obtain the density function of T and F. The approach involves starting with initial guessed PDFs for T and F which covers the entire solution range (known from fundamental physical laws). These PDFs are used to obtain the joint density of I and U using forward convolutions by the DPF method which is compared to the observed joint density function. From the differences, between the two joint density functions, a general way of correcting the initial guess of the PDFs of T and F is presented. The convergence characteristics of the solutions and test results using synthetically created data will be discussed.

Yudaya Sivathanu obtained his B.S. degree in Mechanical Engineering from the University of Kerala, India in 1984. He received his M.S. and Ph.D. in Aerospace Engineering from the University of Michigan in 1988 and 1990, respectively. His Ph.D. dissertation topic was on the radiation and soot properties in turbulent buoyant jet flames. From 1990 to 1991, he worked as a research engineer at the University of Maryland, Baltimore County. He is currently a research professor in the Mechanical Engineering Department at Purdue University.

Dr. Sivathanu is a ASA/NSF/NIST Senior Research Fellow in the Statistical Engineering Division. His research interest is in the statistical properties of turbulent flows. His project during his sabbatical at NIST is the tomographic reconstruction of the probability density functions of soot volume fraction and temperature in turbulent luminous diffusion flames. Yudaya is a member of ASME, AIAA, Combustion Institute and Sigma Xi and has over 50 publications in various journals and conferences.

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