AI based Combustion CFD & Laser Ignition Experiments

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Abstract: Combustion, especially near limits like ignition, extinction, and shock waves, involves multi scale transient processes and states that depend on initial and boundary conditions. Combustion systems include fuel and air flow regulation by means of variable area orifices, multiple passages, and complex swirler designs to allow a location for addition of external energy aimed at promoting stable self sustaining reactions and associated heat release. Use of one or more of gaseous, liquid and solid fuels is ubiquitous and the resulting multiphase flows affect the combustion process by design. Applications include 10 W to 10 TW boilers, 1000 W to 100,000 W reciprocating engines, and 10,000 W to 1,000,000 W flying machines. These complex systems are often designed with combinations of empirical, analytical, computational and statitical tools. The statistical combustion tools have historically been simple and have been used in support of the other three. Time and space series analysis have been used for closure of average values of nonlinear terms resulting from turbulence. We have used data dependent systems and artificial intelligence tools recently to augment the computational methods. The computations involved: (i) shock boundary layer interactions; (ii) laser ignition of turbulent premixed jets; and (iii) piloted axis-symmetric reactor assisted turbulent (PARAT) burner AI enabled OH PLIF imaging. The results are encouraging.

Biography: Jay Gore has been serving as a faculty member at Purdue University since 1991 following his work as an Assistant Professor at the University of Maryland starting in 1987. Prior to that he was a Post Doctoral and Doctoral Fellow at the University of Michigan and at Penn State starting in 1981. Jay served a systems engineer in Singer Link Simulation Systems between 1983 and 1984 and as a plant engineer between 1978 and 1981 in Tata Engineering and Locomotive Corporation in Pune, India. Jay has advised the work of over 50 students at Purdue University and at the University of Maryland. He is a Fellow of the ASME, the AIAA and the International Combustion Institute. Jay's awards include the Presidential Young Investigator Award in 1991 and the ASME Best Paper in Heat Transfer Literature Award in 1988, and AIAA Best Paper at the Aerospace Sciences Meeting award in 1989. Professor Gore has served as the Principal Transformation Advisor and Vice Chancellor at Maharashtra Institute of Technology, World Peace University (MIT WPU), Pune, India during 2016 and 2017 and is currently serving as the Principal Advisor to MIT WPU. Dr. Gore was the founding Director of the Energy Center in Discovery Park at Purdue. Jay is a past Chairman of the Central States Section of the International Combustion Institute and the ASME K11 Committee on Heat Transfer in Fire and Combustion. Dr. Gore has served as an Associate Editor of the AIAA Journal. He has served as an Associate Editor of the ASME Journal of Heat Transfer. He was the U.S. Editor of the 28th International Combustion Symposium. He has also received Faculty Fellowships from the Japanese Ministry of Education and the U. S. Department of Energy.

Jay's research is in the area of combustion and radiation heat transfer with applications to CO_2 emissions reduction, pollutant reduction, efficiency enhancements, fire safety, and improved fundamental understanding. He has received over $20M in research funding and is currently serving as the PI for grants in gas turbine combustion, sprays and fire safety. He has applied infrared radiation sensing knowledge to a wide range of multidisciplinary problems in aerospace, power, and medical diagnostics areas. He has authored or coauthored over 150 archival papers, 4 book chapters, and 250 conference papers.