ME Seminar

From Rain Formation Mechanisms to Sensor Development: Exploring Particle Field Characterization

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ABSTRACT

In various natural and industrial flows, the detailed characterization of particles suspended in a flow holds significant importance. One such example is warm rain initiation, where the growth of the average size of rain droplets suspended in turbulent airflow is of paramount importance to understand the sudden onset of rain. Drawing motivation from the complex dynamics inherent in warm rain initiation, in the first part of the talk, I will present an experimental study of the effects of background air turbulence on the polydisperse droplet size growth rate. For a given initial distribution of droplets, an optimum air turbulent intensity that maximizes the rate at which the average droplet diameter increases with time is identified. The observed trend is understood in terms of droplet collision rate statistics and droplet clustering. The existence of an inverse relationship between the collision enhancement factors, i.e., clustering and relative velocity, in the mean-flow-dominated turbulent flow, is found to suppress the intuitive effect of an increase in droplet collision rate with background air turbulence. In the second part of this talk, I will discuss our initial research endeavors on the development of a cutting-edge, portable, and cost-effective flow visualization sensor based on Digital Inline Holography (DIH). This innovative sensor aims to provide three-dimensional characterization of particle fields with exceptional spatial and temporal resolution. Central to this development is a novel, generalizable machine learning-based model designed to process holographic data efficiently, irrespective of variations in particle field characteristics such as concentration, morphology, or optical properties. In this talk, I will be covering the details of the first-generation DIH-based sensor that we have developed to analyze dental aerosols produced during high-speed dental drilling.

ABOUT THE SPEAKER

Dr. Shyam Kumar is a Postdoctoral Associate in the Department of Mechanical Engineering, University of Minnesota. His primary research focuses on flow visualization using Digital Inline Holography (DIH). In addition to this, he is involved in the development of machine learning models for processing holograms generated through DIH. Dr. Kumar earned his Direct Ph.D. in Aerospace Engineering from the Indian Institute of Technology, Madras, under the guidance of Dr. S.R. Chakravarthy and Dr. Manikandan Mathur. His doctoral research concentrated on investigating the effect of background air turbulence on polydisperse droplet size growth rates, particularly motivated by warm rain initiation. His expertise lies in multiphase flows, flow diagnostics, and image processing. He graduated from TKM College of Engineering in the year 2013 with a B.Tech degree in Mechanical Engineering.

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