Demand of new sensing technology for the measurements of unsteady solid-plus-liquid flows

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Abstract

A solid-plus-liquid flow is the motion of a mixture composed of solid particles and co-existing fluid. Flows of this type can be found in a wide range of engineering applications and natural event, often hazardous. While the bulk steady behavior has been largely investigated for its prevalence in industrial processes, our knowledge of the mixture dynamics in a highly-unsteady flow condition is somewhat limited. Since most of the naturally-occurred flows are intrinsically unsteady, the lack of a unified understanding in this flow regime leaves us in a difficult position when facing environmental flow problems and their interaction with civil infrastructures.

The major difficulty that hinders research progress on unsteady solid-liquid flow stems from the flow dual nature (coexisting solid and liquid behaviors) and the hidden multi-scale physics. The development of a continuum model on the bulk behavior requires a constitutive relation at proper time and length scales. Nonetheless, there has not been a feasible theory or simulation technique for the strong and frequent interaction between the constituents. Thus, accurate and timely measurements of the *mixture* stress and strain may provide a means to investigate such a heterogeneous and unsteady flow problem.

To achieve this, a new sensing technique is highly desired that can measure and distinguish simultaneously the stress components resulted from liquid shearing and particle collision (including friction and impact) within a flowing mixture.

Bibliography

Fu-Ling Yang received her Ph.D. in the division of Engineering & Applied Science at California Institute of Technology in 2006. She worked under the supervision of Prof. M.L. Hunt in the Granular Flow Group in Mechanical Engineering, focusing on the interaction between solid particles within a viscous liquid. She worked as a post-doc with Prof. C.-L. Guo in Bioengineering at California Institute of Technology on developing a dynamic model for cytoskeleton-mediated process to explain cell polarization phenomenon.

She joined the department of Mechanical Engineering at National Taiwan University in 2007 and has developed the Solid-Liquid Two-Phase Flow Lab. The current research focus of her lab is investigating the dynamics of solid-liquid flows, targeting the interstitial liquid effects, via image analysis. Direct measurements on liquid-enhanced particle coupling are under construction. The learning from both research directions will be integrated to develop a model on the dynamics of a solid-liquid mixture.