NASA SBIR/STTR Technologies

T4.03-9945 - Particle Flow Physics Modeling for Extreme Environments

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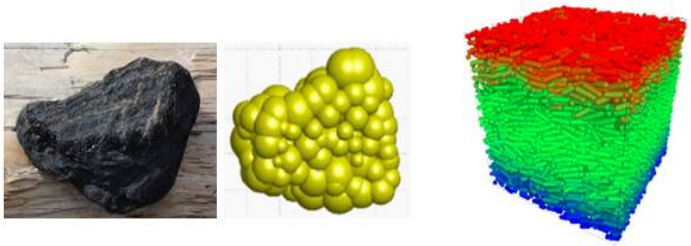
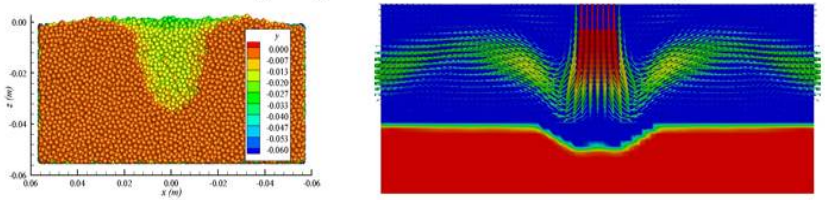
Identification and Significance of Innovation

* Advanced computer modeling software required to predict flow of granular materials in extra-terrestrial environments (spacecraft landing).
* Soil particle erosion/cratering occurs in "extreme environments" that combine low gravity, little or no atmosphere, supersonic and partially rarefied rocket exhaust gas, unusual properties of highly irregular regolith, complex particle shape and size dispersions.
* Expand existing advanced simulation technology :
  - CFDRC developed multi-phase gas-granular CFD code
  - UF granular flow 3-D Discrete Element Modeling (DEM) with unique modeling for irregular particle shape and distributed particle size effects



Innovative DEM Modeling Irregular Particle Shape And Size Dispersion Effects



DEM Particle Sim. => Granular Constituent Model => Gas-Granular Flow CFD

Estimated TRL at beginning and end of contract: (Begin: 4 End: 6)

Technical Objectives and Work Plan

* Develop accurate constituent physics modeling for gas-soil erosion/mixing and implement in application oriented simulation tool
* Develop integrated CFD model for liberation /cratering of realistic granular material compositions in extreme extra-terrestrial environments

Work Plan

* Identify improvements to multi-phase flow CFD solver numerical modeling framework for extreme gas-granular simulations
* Demo/validate multi-phase flow solver for cratering simulations
* Develop granular mechanics constituent models to capture irregular particle shapes and realistic particle size dispersion effects
* Develop macro-scale granular flow CFD model of combined irregular shaped, distributed size particle effects
* Integrate granular phase models, gas-granular multiphase CFD, and continuum-rarefied environments modeling in unified CFD code

NASA Applications

The gas-granular flow simulation tool will enable prediction of particle debris flow environments during spacecraft propulsive landing and takeoff for robotic and human mission to Moon, Mars, and other destinations. It will allow risk identification and design of mitigation measures. Granular flow modeling will be equally important for modeling regolith material manipulation for ISRU such as pneumatic transport, granular flow conveying regolith, and processing of regolith.

Non-NASA Applications

Many potential non-NASA commercial applications exist in civil and military industries. Dust, sand and snow stir-up during helicopter landing and take-off in a desert or arctic environment result in severe visibility impairment and danger of debris ingestion. Civil and environmental engineering applications include wind-borne landscape erosion and dust transport to populated areas.

Firm Contacts

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