NASA SBIR/STTR Technologies

Software for Automated Generation of Reduced Thermal Models for Spacecraft Thermal Control

Topic: S3.02 Thermal Control Systems, PI: Yi Wang, Project No. NNX10CD76P

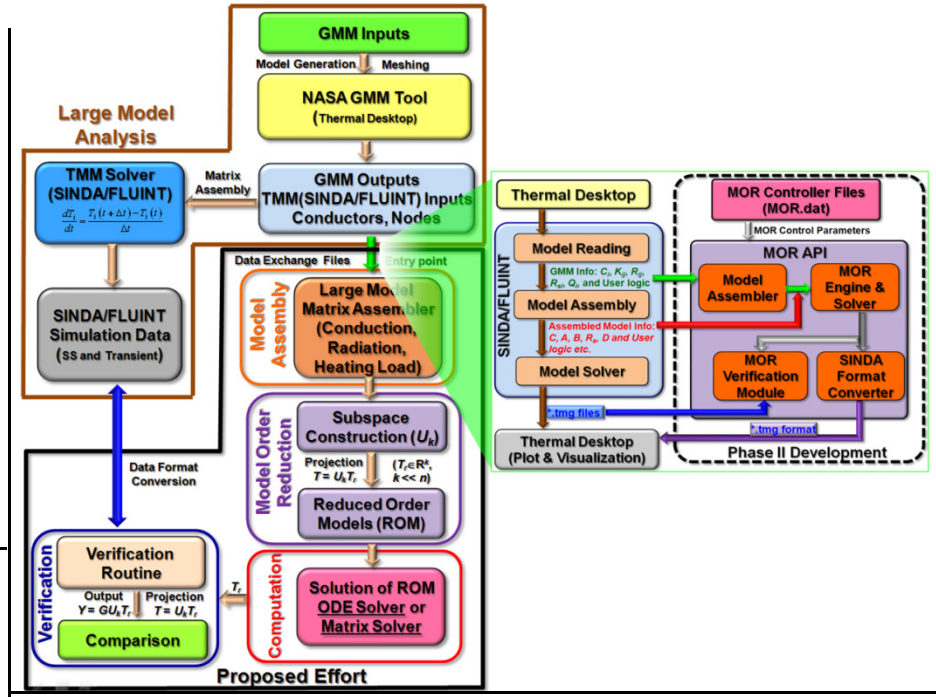
Identification and Significance of Innovation

- Thermal models and analysis are extensively used in design and thermal control of NASA spacecrafts and instruments
- Conventional approaches based on general thermal mathematical models with full discretization or simple lumped-parameter models are either computationally prohibitive or inaccurate, leading to prolonged design cycle and imprecise thermal control
- There is a critical need to develop mathematically formal reduction algorithms and thermal models for real-time temperature control and for analysis and design of spacecrafts and instruments at reduced time and cost
- Phase 2 end-product offers unique benefits for spacecraft analysis, including
  - Fully automated generation of reduced thermal models
  - Fast analysis speed and salient computational accuracy
  - Compatibility to multi-physics/multi-disciplinary analysis
- TRL: Begin at TRL-3 and end at TRL-5

Phase 2 Technical Objectives and Work Plan

Develop software for automated generation of reduced thermal models for NASA spacecrafts and instruments

- Improve the constituent MOR algorithms (e.g., balanced truncation model reduction or its variants) for enhanced accuracy and stability
- Develop a novel algorithm of domain-wise projection spaces to enhance the MOR generation speed and accuracy
- Develop new MOR capabilities to address complex variable-dependent (e.g., temperature-dependent and time-dependent) thermal models
- Investigate and develop novel nonlinear parameterized MOR algorithms to accommodate the design perturbations for reduced generation time and enhanced ROM reusability
- Develop modular software environment to integrate MOR tool and C&R Technologies products to facilitate data exchange for enhanced software utility and facile technology insertion and transition into NASA workflow
- Validate and demonstrate our MOR software for large-scale, complex spacecraft thermal analysis and design problems of NASA interest



NASA Applications

- Enable rapid and computationally affordable thermal analysis for better understanding of design spaces
- Develop advanced, reliable thermal control strategies for spacecrafts and instruments
- Properly arrange test procedures for rational use of instruments and facilities

Non-NASA Applications

- Broad industrial applications, including electronics cooling, rapid thermal processing, and other thermal management applications

Firm Contacts

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