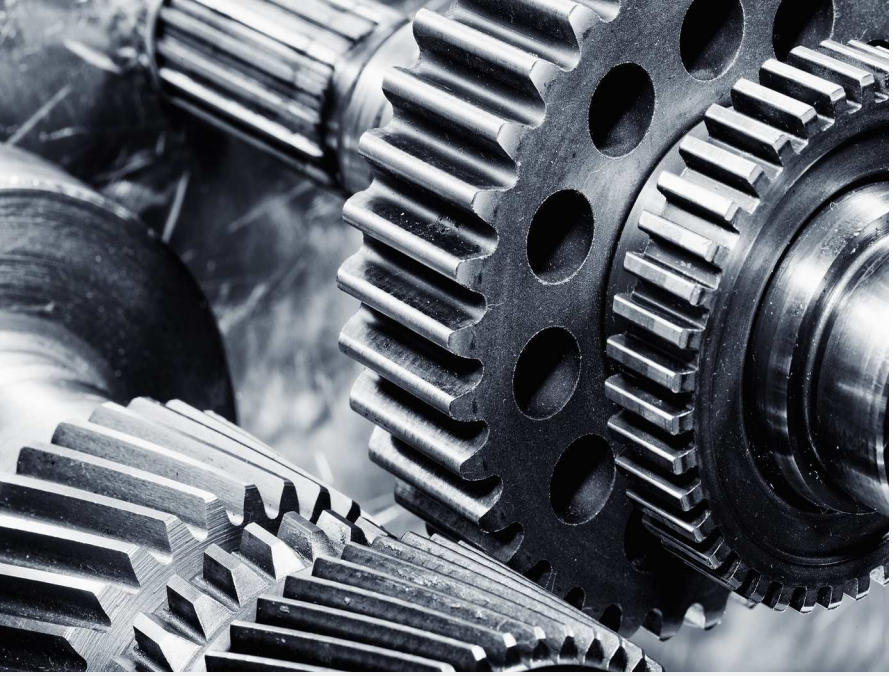

National Aeronautics and Space Administration

technology solution

Information Technology and Software

Enhanced Elliptic Grid Generation

Finite-Difference Simulation And Visualization Of Elastodynamics In Time-Evolving Generalized Curvilinear Coordinates

NASA has developed a new technology that provides modeling and simulation of free and forced structural vibrations, which is essential to an overall structural health monitoring capability. In the various embodiments, a first principles, finite-difference approach is adopted in modeling a structural subsystems such as a mechanical gear, by solving elastodynamic equations in generalized curvilinear coordinates. Such a capability to generate a dynamic structural response is widely applicable in a variety of structural health monitoring systems. Two novel and unique features of this invention include: 1) the innovative enhanced elliptic grid generation algorithm, and 2) a new finite-difference-based elastodynamic solver in three-dimensional generalized curvilinear coordinates which solves for the structural solution directly in the time domain. The overall uniqueness of the innovation lies in that the methods of the various embodiments facilitate autonomous updating of the computational grid in time as the simulation proceeds directly in the time domain.

BENEFITS

- Understanding of the dynamic behavior of a structural system
- Improved design of structural system
- Generate a large space of normal and damage solutions
- Used by Machine learning algorithms to detect anomalous system behavior
- Optimization of the system design
- Optimal sensor placement strategy
- Identification of local stress maxima all over the domain

THE TECHNOLOGY

The methodology is based on physics-based first principles governing elastodynamics in the space-time domain. This innovation provides a powerful yet simple methodology to compute structural dynamic variables of interest, such as stresses over an entire grid mapped over or inside a given body of interest directly in the time domain. The grid can be allowed to deform in time as the solution evolves. The simulation (deforming grids and stresses) can be visualized as the solution proceeds in time. The simulation can be suspended at any point in time based on the visualization of the state of the system and the simulation can be resumed or terminated altogether accordingly as the evolving solution proceeds within the expectation bounds dictated by physics. The attractiveness of the innovation lies in the intuitiveness of the approach where the physical variables such as stresses as well as the deforming body can be visualized directly in space and time as the simulation proceeds. This simulation technology incorporates an innovative elliptic grid generation methodology that automatically updates the grid during the finite difference simulation of a given structural system directly in the time domain. The structural simulation over such a geometry using elastodynamic partial differential equations (pdes) is itself innovative and gives results directly in the time domain. The various embodiments incorporate an enhanced elliptic grid generation algorithm and a new three-dimensional finite difference elastodynamic pde solution methodology in generalized coordinates.

One of the applications of the technology is in the field of Medical Prostheses

APPLICATIONS

The technology has several potential applications:

- Prognostic health management
- Industrial machinery
- Vehicle health management
- Condition-based maintenance
- Transportation vehicles
- Aerospace systems
- Electronic systems
- Aircraft
- Medical Prostheses
- Mechanical Systems

PUBLICATIONS

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More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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