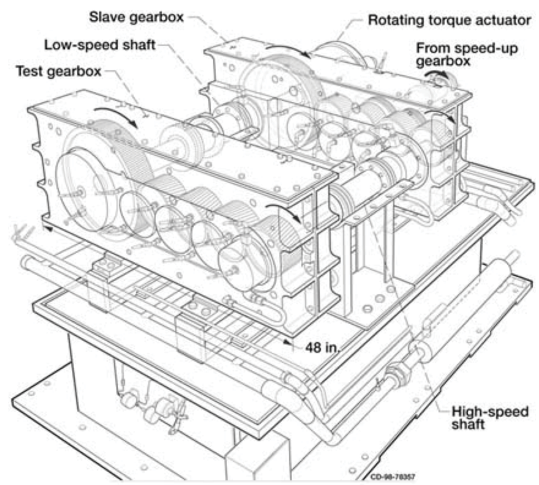
National Aeronautics and Space Administration

technology opportunity

Finite-Difference Simulation

Alternative Modeling and Simulation Methods for Structural Systems

The software can help diagnose and detect hidden defects.



The new software will be able to detect defects in a complicated machine with multiple moving parts

Modeling and simulation of free and forced structural vibrations 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 subsystem 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. This capability will lead to an understanding of the dynamic behavior of a structural system and hence its improved design. It will generate a sufficiently large space of normal and damage solutions that can be used by machine learning algorithms to detect anomalous system behavior and achieve a system that is optimally designed. It will also lead to an optimal sensor placement strategy, based on the identification of local stress maxima all over the domain.

Benefits

- Provides a high fidelity direct capability to predict vibrational modes of a given system or structure
- Can aid in detecting and diagnosing damage in a given structural system

Applications

- Helicopter transmission gearing health monitoring
- Computer disk drive industry
- Turbine blade health monitoring
- Cutting tool industrial applications
- Aerospace applications with non-rotating components

Technology Background

Conventional simulation methods to solve structural dynamics problems are in the domain of finite element technology where the problem is solved in the modal domain and the results are then mapped into the time domain by appropriate transformations. Limitations of the prior art have been in the difficulty in deriving new three-dimensional elements for different applications of interest and the lack of ease in obtaining the temporal solution directly from the solution of governing elastodynamic pdes. The need to know the state of a structural system during its operation in terms of the physical output variables such as stresses and the geometric configuration of the system itself is essential for monitoring the system health.

Such systems can be tested, prior to launching them in their operational domain, in a laboratory or through relatively inexpensive computational simulations. Such systems when subjected to space and time varying loads during their operation can throw the system into unsafe states from the system's health perspective. It is therefore essential to have a prior knowledge of such system states before the systems are commissioned. For the reasons mentioned, it is clear that there is a strong need for alternative modeling and simulation methods for structural systems.

Patents

This technology has been patented (U.S. Patent 7,574,338).

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for Finite Difference Simulation for commercial applications.

For More Information

If you would like more information about this technology, please contact:

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