NASA SBIR 2019 Phase I Solicitation

Z11.01 NDE Sensors, Modeling, and Analysis

Lead Center: LaRC

Participating Center(s): ARC, LaRC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

NDE sensors and data analysis

Technologies enabling the ability to perform inspections on large complex structures will be encouraged. Technologies should provide reliable assessments of the location and extent of damage. Methods are desired to perform inspections in areas with difficult access in pressurized habitable compartments and external environments for flight hardware. Many applications require the ability to see through assembled conductive and/or thermal insulating materials without contacting the surface.

Techniques that can dynamically and accurately determine position and orientation of the NDE sensor are needed to automatically register NDE results to precise locations on the structure. Advanced processing and displays are needed to reduce the complexity of operations for astronaut crews who need to make important assessments quickly. NDE inspection sensors are needed for potential use on free-flying inspection platforms. Integration of wireless systems with NDE may be of significant utility. It is strongly encouraged to provide explanation of how proposed techniques and sensors will be applied to a complex structure. Examples of structural components include but are not limited to multi-wall pressure vessels, batteries, tile, thermal blankets, micrometeoroid shielding, International Space Station (ISS) Radiators or aerospace structural components.

Additionally, techniques for quantitative data analysis of sensor data are desired. It is also considered highly desirable to develop tools for automating detection of material Foreign Object Debris (FOD) and/or defects and evaluation of bondline and in-depth integrity for light-weight rigid and/or flexible ablative materials are sought. Typical internal void volume detection requirements for ablative materials are on the order of less than 6mm and bondline defect detection requirements are less than 25mm.

NDE Modeling

Technologies sought under this SBIR include near real-time realistic nondestructive evaluation (NDE) and structural health monitoring (SHM) simulations and automated data reduction/analysis methods for large data sets. Simulation techniques will seek to expand NASA’s use of physics based models to predict inspection coverage for complex aerospace components and structures and to utilize inverse methods for improved defect characterization. Analysis techniques should include optimized automated reduction of NDE/SHM data for enhanced interpretation appropriate for detection/characterization of critical flaws in space flight structures and components, and may involve methods such as machine learning, domain transformation, etc. NASA's interest area is light weight structural materials for space flight such as composites and thin metals. Future purposes will include application to long duration space vehicles, as well as validation of SHM systems.
Techniques sought include advanced material-energy interaction (i.e., NDE) simulations for high-strength lightweight material systems and include energy interaction with realistic damage in complex 3D component geometries (such as bonded/built-up structures). Primary material systems can include metals but it is highly desirable to target composite structures. NDE/SHM techniques for simulation can include ultrasonic, laser, Microwave, Terahertz, Infrared, X-ray, X-ray Computed Tomography, Fiber Optic, backscatter X-Ray and eddy current. It is assumed that any data analysis methods will be focused on NDE techniques with high resolution high volume data. Modeling efforts should be physics based and it is desired they can account for material aging characteristics and induced damage, such as micrometeoroid impact. Examples of damage states of interest include delamination, microcracking, porosity, fiber breakage. Techniques sought for data reduction/interpretation will yield automated and accurate results to improve quantitative data interpretation to reduce large amounts of NDE/SHM data into a meaningful characterization of the structure. It is advantageous to use co-processor/accelerator based hardware (e.g., GPUs, FPGAs) for simulation and data reduction. Combined simulation and data reduction/interpretation techniques should demonstrate ability to guide the development of optimized NDE/SHM techniques, lead to improved inspection coverage predictions, and yield quantitative data interpretation for damage characterization.

Phase I Deliverables - For NDE sensors focused proposals, lab prototype and feasibility study or software package including applicable data or observation of a measurable phenomenon on which the prototype will be built. For NDE modeling focused proposals, Feasibility study, including demonstration simulations and data interpretation algorithms, proving the proposed approach to develop a given product (TRL 2-4). Inclusion of a proposed approach to develop a given methodology to Technology Readiness Level (TRL) of 2-4. All Phase I’s will include minimum of short description for Phase II prototype/software. It will be highly favorable to include description of how the Phase II prototype or methodology will be applied to structures.

Phase II Deliverables - Working prototype or software of proposed product, along with full report of development, validation, and test results. Prototype or software of proposed product should be of Technology Readiness Level (TRL 5-6). Proposal should include plan of how to apply prototype or software on applicable structure or material system. Opportunities and plans should also be identified and summarized for potential commercialization.

Relevance to NASA

Several missions could benefit from technology developed in the Area of nondestructive evaluation. Currently NASA is returning to manned space flight. The Orion program has continuing to have inspection difficulties and continued development and implementation of NDE tools will serve to keep our missions flying safely. Currently Orion is using several techniques and prototypes that have been produced under the NDE SBIR topic. Space Launch System is NASA’s next heavy lift system. Capable of sending hundreds of metric tons into orbit. Inspection of the various systems is on-going and will continue to have challenges such as verification of the friction stir weld on the fuel tanks. As NASA continues to push in deeper space smart structures that are instrumented with structural health monitoring system can provide real time mission critical information of the status if the structure.

References:


