Air Force SBIR

Transition

An example of Air Force supported SBIR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.

SBIR Topic Number:
AF-00 297

Title:
Force-Metric Free-rotating Wire Suspension Mount System for Wind Tunnel VFT

Contract Number:
F40600-01-C-0015

Company Name:
Physical Sciences, Inc., Andover, MA

Technical Project Office:
Arnold Engineering Development Center

Transition Office:
Naval Air Warfare Center

Advanced Wind-Tunnel Test Apparatus For "Virtual Flight Testing" New Missiles

- **SBIR supported development of a wind-tunnel test apparatus for "Virtual Flight testing" of new missiles. The apparatus measures a variety of forces on a missile while providing important feedback to developers**
- **Evaluating new missiles prior to flight tests is crucial to potential stability and control issue**

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Air Force Requirements

Development of missiles with aggressive maneuvering capabilities requires the design of advanced digital flight-control systems. Because dynamic characteristics of new missiles are often uncertain prior to flight tests, there exists a substantial risk of a stability and control failure in the early tests. Such test failures are expensive and can lead to project delays. Missile developers seek a means of testing guidance and control systems before flight tests. The ability to quickly perform a number of tests of flight hardware-in the-loop (HITL) and without the loss of the test missile is highly beneficial to reduction of risk as well as providing improved performance sooner in a program (safer, cheaper, faster, better). The idea to achieve this improvement was to create a Wind Tunnel "Virtual Flight Testing" (VFT) capability. A VFT test device would need to restrain the missile while allowing it to rotate in pitch, roll, and yaw. Also, it was necessary to measure the forces on the missile in these tests. Finally, these goals had to be met without inducing unwanted structural oscillations in the missile or mounting structure.

To develop this capability, the DoD sponsored a TTD&D (Test Technology Development and Demonstration) program, which provided design development from the flight hardware standpoint of structural modes and aerodynamic stability and control. This program led to an initial test with fixed cable tension and two degrees of freedom (roll and pitch). In parallel, the SBIR program provided innovative research into developing a suspension system that would fulfill the needs of the VFT concept. Physical Sciences Inc. was awarded a contract to develop a suspension system that would provide three degrees of rotational freedom and also provide a measure of static forces and yawing moment. Feedback from the measure of side force and yawing moment was to be used to generate an artificial degree of rotational freedom in yaw. Likewise, a limited range of three degrees of freedom in translation could also be achieved with the suspension system design.

SBIR Technology

Physical Sciences Inc., (PSI) used the SBIR Program to develop and test a wire suspension system for VFT. In this system a central collar assembly, containing a multi-axis pivot and a four-component force balance, is suspended by a set of six systems each consisting of a rod, cable & pulley, load cell, and hydraulic actuator. The missile is attached to the collar. The hydraulic cylinders control the tension in the six cables. The cylinders and load cells allow for computer control of cable tension, dynamic yaw positioning of the model, and damping of elastic modes in the structure. Other sensors include roll and pitch encoders, and an accelerometer in the collar assembly. The suspension system was successfully demonstrated in a test performed at the Navy's HIVAS facility at China Lake, CA 29-30 July 2003.

Air Force Transition Payoff

The technology is being used in advanced test technology demonstrations at the Naval Air Warfare Center at China Lake, CA. Test with the BOA missile have already demonstrated that behavior observed in flight, such as uncontrolled roll-locking, can be recreated in the Virtual Flight Test environment at significant savings in costs and development time.

U.S. AIR FORCE

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