Air Force SBIR

Impact

An example of Air Force supported SBIR technology that met topic requirements and is being commercialized by the small business partner.

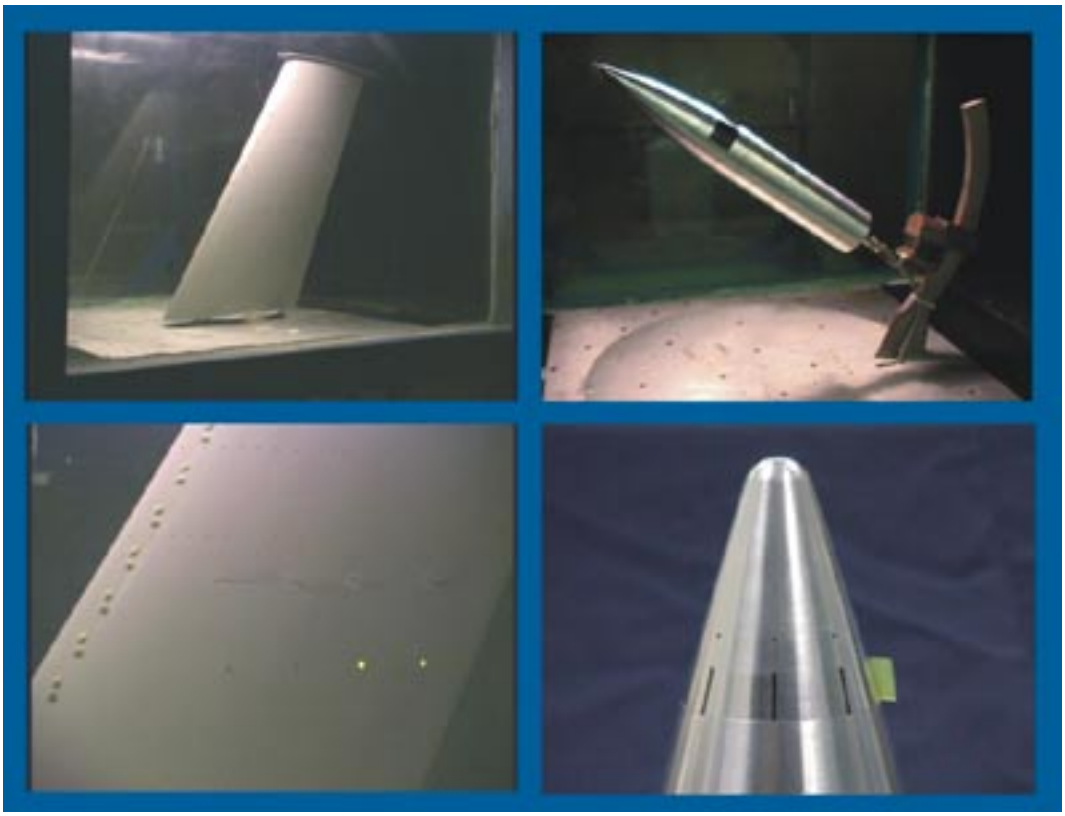
SBIR Topic Number:
AF98-178

Title:
Active Flow Control for Aerodynamic Enhancement

Contract Number:
F33615-99-C-3008

Company Name:
Orbital Research, Inc., Cleveland, OH

Technical Project Office:
AFRL/Air Vehicles Directorate



Active Flow Control for Aerodynamic Enhancement

- Both aircraft and missiles require micro-electromechanical based flow control systems capable of operating in extreme conditions
- The Air Force wanted control systems incorporating smart surfaces and advanced control systems to improve aerodynamic efficiency

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Air Force Requirements

Future Air Force fixed-wing air vehicles and advanced weapons need innovative Microelectromechanical Systems MEMS-based aerodynamic flow control systems that can operate under high alpha and extreme flow conditions where conventional controls become ineffective. The U.S. Army, U.S. Navy, DARPA, and a significant portion of commercial and military sector were also actively pursuing research in the area of active flow control to explore the potential of such smart flight control systems. MEMS based active flow control actuators can be directly integrated into to air vehicle structure, providing improved aerodynamic performance. This need specifically called for smart surfaces and advanced control systems that can provide control authority to air vehicles with improved aerodynamic efficiency by means of weight-and-volume minimization for Control Actuation Systems (CAS), drag reduction, fuel savings, and enhanced control and maneuverability. The technologies developed from this program have the potential to benefit both commercial and military air vehicle systems.

SBIR Technology

Orbital Research, Inc. (ORI), in collaboration with the AFRL Air Vehicles and Munitions Directorates, designed, developed and demonstrated innovative flow control systems to enhance the aerodynamic performance of air vehicles. To demonstrate the performance of integrated MEMS actuators and sensors, two specific demonstration systems were chosen. Two control systems were developed in particular; one tailored for fixed-wing applications and second for weapons (missiles) applications. Both systems utilized a Co-Located Sensor and Actuator (CLAS) module(s) approach, where a complete system was designed by incorporating fast-response pressure sensors (for flow sensing), a real-time feedback controller (for smart actuation), and novel, MEMS based control actuators (for aerodynamic control) into a compact conformal package that could be embedded within the aerodynamic surface.

Fixed-Wing Application: ORI developed and demonstrated a transparent stall control system for wings that automatically delays flow separation or stall angle, thereby extending the operational flight envelope of wings at high angles of attack. A key innovation in this system is the ability to detect stall conditions prior to 'actual' stall and delay stall by employing countermeasures using embedded micro actuators.

High Alpha Weapons Application: ORI developed and demonstrated a novel, yaw control system for weapons (slender bodies) at high angles of attack. This system cancels out unwanted yawing moments on weapons at high alpha conditions and also provides the desired (user commanded) yawing moments under both steady and dynamic pitch conditions within the actuator saturation limits. This system was successfully demonstrated on a scale model of a typical air-to-air missile (Air Force's platform of interest).

Company Impact

With the successful completion of this SBIR program, ORI is now uniquely positioned to design and develop a comprehensive set of flow control solutions comprising both actuators and feedback controllers that can be commercialized and applied to a number of military and civilian air vehicle platforms. ORI has received two patents and currently has one patent pending, which protects ORI's intellectual property for this technology. These patents provide ORI a competitive advantage when discussing various research and technology exchange agreements with other entities. The successful demonstration of the technologies developed in this SBIR helped ORI spin-off iACTIV, manufacturer of MEMS air control valves for applications spanning from simple stand-alone general purpose industrial valves to highly specialized integrated flight control actuation sub-systems. The foundation of knowledge gained through this SBIR program has provided tools and expertise necessary for ORI to jumpstart the development of active flow control systems for specific future military weapons and air vehicle platforms. The program has also attributed to the growth of Orbital Research by expanding ORI's research and development portfolio. The depth and breadth of ORI's capabilities has allowed the company to grow in a stable and rapid fashion and the achievements were recognized by *Inc. Magazine* and the Weatherhead School of Management at Case Western Reserve University.

Technology Payoff

Orbital Research, Inc is currently involved with collaborative efforts with prime contractors such as Lockheed Martin and General Dynamics to transition these technologies from laboratory research to practical applications through flight testing. ORI received research and development funds from prime contractors, through joint sponsored research agreements, to custom-develop this technology for specific air vehicle platforms. ORI has developed a solid foundation to commercialize this technology to both civilian and military customers.

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