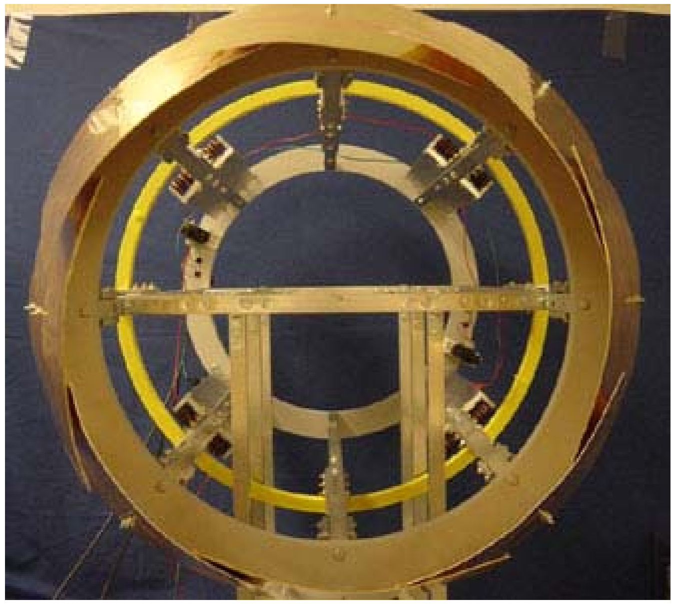
Prototype Variable-Area Exhaust Nozzle Designed



Prototype of a variable-area exhaust nozzle utilizing shape-memory-alloy wire actuators and magnetorheological fluid damper locks in a fully open configuration.

Ongoing research in NASA Glenn Research Center's Structural Mechanics and Dynamics Branch to develop smart materials technologies for adaptive aeropropulsion components has resulted in the design of a prototype variable-area exhaust nozzle (see the preceding photograph). The novel design exploits the potential of smart materials to improve the performance of existing fixed-area exhaust nozzles by introducing new capabilities for adaptive shape control, vibration damping, and flow manipulation. The design utilizes two different smart materials: shape memory alloy wires as actuators and magnetorheological fluids as damper locks.

The prototype of the variable-area exhaust nozzle consists of an assembly of eight overlapping leaves, four shape-memory-alloy wire actuators, and four magnetorheological fluid damper locks. Electrical heating is used to actuate the shape-memory-alloy wires from the fully open position shown in the preceding photograph to the 40-percent reduced-area position depicted in the following photograph. The magnetorheological damper locks are subsequently used to hold the exhaust nozzle in the reduced-area configuration. Constant-force springs return the shape-memory-alloy wires to their original length once the electrical heating is removed. A computerized data acquisition and real-time control system has been implemented using a sliding-mode-based robust controller to operate the system.

Reduced-area configuration of the variable-area exhaust nozzle after the shape-memory-alloy wires are electrically heated.

This design represents a novel approach to using adaptive shape-control research to achieve performance benefits from smart materials. This research was conducted under a grant by the University of Houston in collaboration with Glenn researchers and was supported by the Ultra-Efficient Engine Technology (UEET) Project.

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