National Aeronautics and Space Administration

Aeronautics

Spanwise Adaptive Wing

Shape memory alloy actuators reconfigure aircraft wings in flight

NASA's Glenn Research Center is providing the opportunity to license a novel means of articulating the outboard portion of an aircraft wing to create the optimal geometry for given flight conditions. The Spanwise Adaptive Wing (SAW) concept employs a high-force, solid-state Shape Memory Alloy (SMA)-based actuator to develop a structurally efficient and reliable method of deflecting a portion of the wing in-flight. This ability enables significant increases in lateral-directional stability and control augmentation, thereby enhancing aircraft efficiency by reducing the rudder motion to control yaw. Particularly in supersonic flight, the SAW's benefits include increased compression lift and reduced wave drag. Compared to prior hydraulic-based actuators, the SMA-based actuator features significantly reduced size and weight, high specific work output, solid-state actuation, low maintenance, and high reliability. The SAW is a breakthrough technology for boosting engine performance and reducing energy consumption.

BENEFITS

- Lightweight: the SMA actuator weighs 20% as much as its hydraulic equivalent
- Compact: takes up less space, allowing greater design flexibility
- Reliable: requires less maintenance (incapable of hydraulic leak) and is 100% reusable
- Safe: features minimal moving parts and a greater number of cycles
- Efficient: provides high specific work output and solid-state actuation

technology solution

THE TECHNOLOGY

Prior efforts to actuate wing articulation were unsuccessful, largely because the systems designed were too large, heavy, and complex to be practical for use. NASA's comparatively simple SAW concept centers on a wing actuator fabricated from lightweight SMA material, which is trained to deform to a specific shape as it becomes heated. SMA actuators are composed of high-strength alloys, such as nickel-titanium-hafnium, and can feature elements such as trained tubes, wires, cables, or sheets. For example, a high-temperature, high-force SMA torque tube can be embedded in an outboard chordwise hinge line of a wing. Every embodiment of the SMA actuator features integrated heaters and cooling devices that enable better control authority. A novel hinge line mechanism both provides a two-piece wing connection and houses the actuator assembly. When the actuator is heated, the SMA apparatus triggers the articulation of the wing to a predefined position. Once the desired position is reached, the heater maintains a constant temperature, causing the SMA to maintain its deformity. As needed, the cooling system can be used to allow the wing to return to its original geometry. Multiple actuators can be employed on a single wing, allowing the various parts of the wing to articulate independently. By adapting the geometry of the wing during all phases of operation, from ground to subsonic and supersonic/hypersonic flight, NASA's SAW offers the first practical method of using wing articulation to improve aircraft performance and fuel efficiency.

The Spanwise Adaptive Wing provides an all-electric, lightweight, efficient means of deflecting a wing portion to meet flight conditions optimally

The SAW offers a reusable and reliable alternative to hydraulic systems for actuating wing articulation in subsonic, supersonic, and unmanned aircraft

APPLICATIONS

The technology has several potential applications:

- Aerospace (e.g., commercial, subsonic, and supersonic aircraft, actuators)
- Military
- Unmanned vehicles (e.g., Unmanned Aerial Vehicles (UAVs), drones)

PUBLICATIONS

Patent Pending