National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Aerospace

Outer Aileron Yaw Damper

A lightweight alternative to rudders for aircraft with spanwise adaptive wings

In recent years, NASA, along with partners Boeing and Area-I Inc., have developed the spanwise adaptive wing (SAW). SAWs leverage a thermally-triggered actuator made from a NASA-developed shape memory alloy (SMA) to allow outer portions of aircraft wings and control surfaces to be folded to achieve optimal angles during flight. For supersonic aircraft, SAWs can reduce drag and increase performance during the transition from subsonic to supersonic speeds. For subsonic aircraft, SAWs offer increased control and reduced dependency on the tail rudder and associated hydraulic systems - a particularly heavy part of the aircraft.

Engineers at NASA AFRC realized the aircraft weight savings that could be achieved by reducing or eliminating rudder dependency, since this would allow for rudder size to be reduced. So, they set out to develop an alternative system capable of providing the same "yaw control" functionality as traditional rudders. This work resulted in the invention of NASA's outer aileron yaw damper system, which includes novel control algorithms that drive flight control surfaces to produce desired flight conditions.

BENEFITS

- Reduced aircraft weight: Less rudder dependency enables aircraft designs with smaller rudders and vertical tail structures, significantly decreasing vehicle weight.
- Decreased drag: Rudder and vertical tail structure size reductions may reduce parasitic drag.
- Fuel efficiency: Less weight and drag lead to reduced aircraft fuel consumption.

THE TECHNOLOGY

Rudders have long served as the primary flight control surface as is pertains to aircraft yaw. Breaking this mold, NASA's SAW technology is a game-changing development in aircraft wing engineering that reduces rudder motion required to control aircraft. The benefits of reduced rudder dependency led NASA to develop the outer aileron yaw damper to further decrease or eliminate rudder dependency for aircraft using SAWs.

As mentioned, SAWs use shape memory alloy actuators to articulate the outer portion of the wing, effectively creating a movable wingtip. NASA's invention uses an outer aileron located on the wingtips, which is driven (along with the inner ailerons) by a novel control algorithm. The control algorithm, taking into account the wingtip positions, manipulates the outer ailerons to achieve the desired yaw rate. At the same time, it positions the inner ailerons to counter roll rate resulting from the outer aileron. In other words, the control algorithm calculates a control surface ratio (i.e., position of inboard aileron and outboard aileron) that produces desired yaw and roll accelerations.

The system can also be used to offset the existing rudder in current or future aircraft designs. A second part of NASA’s novel outer aileron control algorithm modifies the aircraft’s rudder loop gain in proportion to outer aileron usage. This allows the outer ailerons and rudder to work in tandem, while at the same time reducing rudder usage.

As a result of this NASA invention, required rudder usage can be reduced or eliminated for aircraft with SAWs. Consequently, the size of rudders and vertical tail structures can be reduced, which in turn reduces weight and parasitic drag. The result is an aircraft with increased performance and fuel efficiency.

A rendering of an aircraft equipped with SAWs, wherein the wingtips are folded downwards. Outer ailerons are placed on the wingtips, and are driven by NASA's novel control algorithms to achieve desired yaw and roll accelerations.

APPLICATIONS

The technology has several potential applications:

- Subsonic aircraft design
- Supersonic aircraft design

PUBLICATIONS

Patent Pending

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

DRC-018-017, DRC-TOPS-1

More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Armstrong Flight Research Center

PO Box 273, M/S 1100
Edwards, CA 93523-0273
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

NP-2021-11-2998-HQ