National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Aerospace

Green aviation - improved aerodynamic efficiency and less fuel burn

Variable Camber Aerodynamic Control Surfaces and Active Wing Shaping Control

NASA has created and combined two new concepts aircraft aerodynamic control surfaces and active wing-shaping control to reduce aircraft drag and lower fuel consumption. The first concept is referred to as a variable camber continuous trailing edge flap or, alternatively, a variable camber continuous leading edge slat. Aerodynamic simulations and wind tunnel experiments have shown that this type of flap can reduce aerodynamic drag substantially as compared to a conventional flap. The second element is a new active wing-shaping control concept that is proposed in connection with the presently disclosed variable camber continuous trailing edge flap (or leading edge slat). The active wing-shaping control is designed to aeroelastically change a wing shape in-flight in order to achieve a desired wing shape for optimal drag reduction.

BENEFITS

- Provides the same lift capability for lower drag
- Provides a continuously curved trailing edge
- Improved aerodynamic efficiency by optimizing span-wise aerodynamics
- An aeroelastic wing shaping method for analyzing wing deflection shape under aerodynamic loading

THE TECHNOLOGY

Currently, as fuel is burned, wing loading is reduced, thereby causing the wing shape to bend and twist. This wing-shape change causes the wings to be less aerodynamically efficient. This problem can be further exacerbated by modern high-aspect flexible wing design. Aircraft designers typically address the fuel efficiency goal by reducing aircraft weights, improving propulsion efficiency, and/or improving the aerodynamics of aircraft wings passively. In so doing, the potential drag penalty due to changes in the wing shapes still exists at off-design conditions. The unique or novel features of the new concepts are:

1. Variable camber flap provides the same lift capability for lower drag as compared to a conventional flap. The variable camber trailing edge flap (or leading edge slat) comprises multiple chord-wise segments (three or more) to form a cambered flap surface, and multiple span-wise segments to form a continuous trailing edge (or leading edge) curve with no gaps which could be prescribed by a mathematical function or the equivalent with boundary conditions enforced at the end points to minimize tip vortices
2. Continuous trailing edge flap (or leading edge slat) provides a continuously curved trailing edge (or leading edge) with no gaps to minimize vortices that can lead to an increase in drag.
3. The active wing-shaping control method utilizes the novel flap (or slat) concept described herein to change a wing shape to improve aerodynamic efficiency by optimizing span-wise aerodynamics.
4. An aeroelastic wing shaping method for analyzing wing deflection shape under aerodynamic loading is used in a wing-control algorithm to compute a desired command for the flap-actuation system to drive the present flap (or slat) system to the correct position for wing shaping.

Inflected-wing Elastically Shaped Aircraft Concept

APPLICATIONS

The technology has several potential applications:

- Aircraft
- Aerospace Engineering
- Unmanned Aerial Vehicles (UAV)

PUBLICATIONS

Patent No: 9,227,721; 10,787,242

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More Information

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