Aerodynamically-Adaptive Platforms using Distributed Bleed Flow Control (#6238)

A system for improved control of the aerodynamic and structural loads on flight and ground platforms using distributed active air bleed driven through the aerodynamic surfaces

Georgia Tech researchers have developed a new active flow control (AFC) technology which exploits controlled aerodynamic flow-structure interactions to manipulate aerodynamic load distributions on flight and ground platforms. In addition to enhancing aerodynamic maneuvers, such control can also alter the effective properties of the platform structure to mitigate or completely avoid the adverse effects of aero-elastic instabilities. A key element of the technology is that the interactions between the aero-structures and the air flow over them and therefore the flow-effected aerodynamic loads, are regulated by distributed air bleed. The bleed actuation is driven through the aerodynamic surfaces by inherent pressure differences owing to the air flow (e.g. across aircraft wings). The system involves the incorporation of passages through the surface (i.e. pores), which are activated or deactivated in real-time using low-power, surface-integrated louver actuators.

The investigations at Georgia Tech demonstrated that the interaction between controlled bleed and the cross flow over lifting surfaces can be tailored to alter its apparent aerodynamic shape and thus the aerodynamic loads over a broad range of wind conditions. Because the bleed is driven by the air motion it is inherently low-power, robust, low-weight, and easily integrable, and obviates the need for complex mechanical or electromechanical control surfaces that suffer from significant limitations in terms of power, weight and complexity.

Benefits/Advantages

- **Safe –** mitigates or completely suppresses adverse effects of flow-induced vibrations and aero-elastic instabilities
- **High Performance –** enables aircraft maneuverability and light-weight, efficient wing designs
- **Improved Reliability –** reduces flow damage to aerostructures and allows extended lifetime
- **Lower Cost –** energy efficiency while reducing maintenance costs

Potential Commercial Applications

- Fixed wing aircraft including UAVs
- Rotorcraft rotor blades, download alleviation.
- Wind turbines (towers and blades)
- Ground base vehicles

- Ground base structures

Background/Context for This Invention

The aerodynamic and structural performance, efficiency, and safety of flight and ground platforms that interact with moving air can be enhanced by exploiting the air flow to manipulate the aerodynamic loads on the platform. The ability to alter the aerodynamic loads without complex, heavy mechanical moving control surface has tremendous applications to fixed and rotary wing military and commercial aircraft for improved aerodynamic maneuverability and stability leading to safer operations and better fuel/energy efficiency. Controlling the aerodynamic loads will also enable lightweight, agile, deformable aerostructures and mitigate risks of vibrations and fatigue.

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More Information

Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/aerodynamically-adaptive-platforms-using-distributed-bleed-flow-control

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot