
Image credit: Pixabay/Fuzz

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Mechanical and Fluid Systems

Flow Control Devices

Two fluidic oscillators with no moving parts optimize flow control for better system performance

NASA's Langley Research Center develops innovative technologies to control fluid flow in ways that will ultimately result in improved performance and fuel efficiency. Often called fluidic oscillators, sweeping jet actuators or flip flop oscillators, these flow control devices work based on the Coanda effect.

They can be embedded directly into a control surface (such as a wing or a turbine blade) and generate spatially oscillating bursts (or jets) of fluid to improve flow characteristics by enhancing lift, reducing drag, or enhancing heat transfer. Recent studies show up to a 60% performance enhancement with oscillators.

NASA offers two new fluidic oscillator designs that address two key limitations of these oscillators: coupled frequency--amplitude and random oscillations. One oscillator effectively decouples the oscillation frequency from the amplitude. The other design enables synchronization of an entire array. The new oscillators have no moving parts oscillation, decoupling, and synchronization are achieved entirely via internal flow dynamics.

BENEFITS

- Maintenance-free - no moving parts, simple design
- Rugged - applicable to harsh environments
- Scalable - from micro to macro scale
- No added drag oscillators can be machined as embedded arrays
- Improved control authority - can vary frequency with very little mass flow compared to previous oscillators
- Synchronized oscillations

APPLICATIONS

The technology has several potential applications:

- Aerospace -
  -- Boundary layer control
  -- Separation control
  -- Lift enhancement
  -- Drag reduction
  -- Mixing
- Shipbuilding - flow control
- Gas turbines -
  -- Heat transfer enhancement
  -- Separation control
- Hydrotherapy equipment - different modes of massaging.

THE TECHNOLOGY

Both oscillators are flow control devices based on novel geometric designs. They have no moving parts and produce spatially oscillating jets. Each was designed to address a particular limitation of current oscillators.

Gaining control authority by decoupling frequency and amplitude:

Existing oscillators are limited in that the frequency of oscillation is controlled by input pressure or mass flow rate--the frequency and amplitude (mass flow rate) are coupled, limiting control authority over the oscillators. The new oscillator design decouples the frequency from the amplitude by employing a novel design featuring a main oscillator that controls the amplitude and a small oscillator that controls the frequency of the oscillations (see Figure 1). The decoupled oscillator delivers high (or low) mass flow rates without changing the frequency and vice versa.

Gaining control authority by synchronizing the entire oscillator jet array:

Existing oscillators in an array oscillate randomly. While this is useful for mixing enhancement, synchronized flow may be more beneficial for active flow control applications. The simple design of the new Langley synchronized oscillator achieves synchronization without having electro/mechanical or any other moving parts. The new oscillator enables synchronization of an entire array by properly designing the feedback loops to have one unique feedback signal to each actuator. Once each actuator has the same feedback signal, each main jet attaches to one side of the Coanda surface at the same time, allowing synchronized oscillation, as shown in Figure 2.

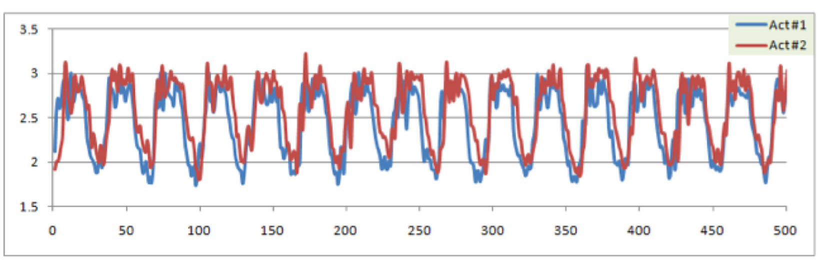

FIGURE 2 - Comparison of two hot-wire signals out of two synchronized actuators

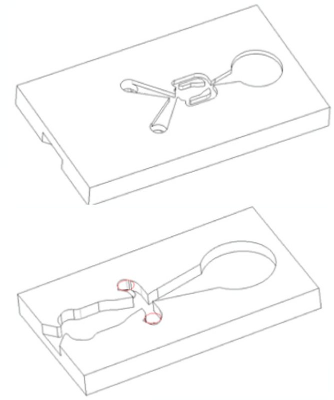

FIGURE 1 - 3D isometric view of the oscillator: main oscillator on top, control oscillator on bottom

PUBLICATIONS

Patent No: 9,802,209; 9,789,496

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.

LAR-18090-2, LAR-18089-2, LAR-TOPS-36

More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Langley Research Center

Mail Stop 020
Hampton, VA 23681
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

NP-2014-09-1259-HQ