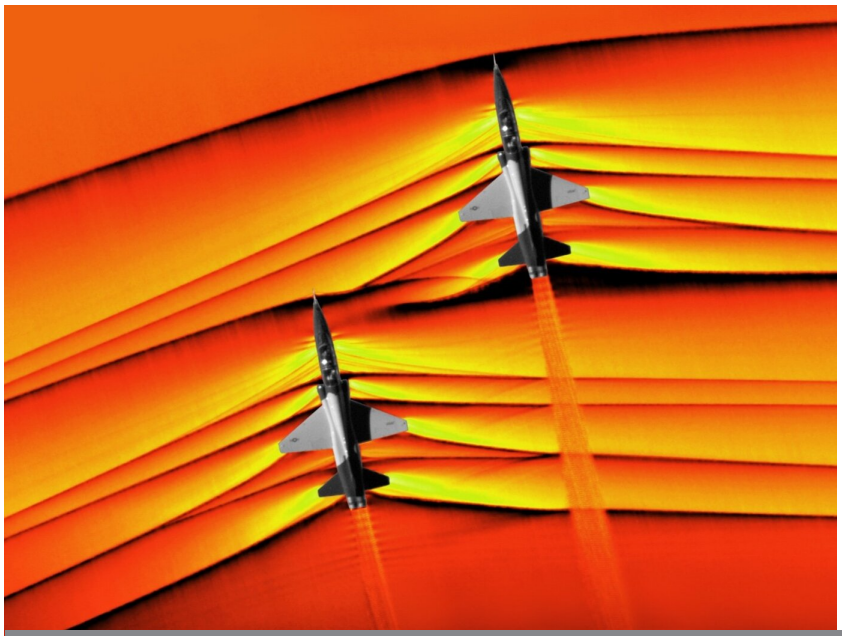

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Instrumentation

Projected Background-Oriented Schlieren Imaging

Two-camera setup enables real-time, reference-free flow visualization

Inventors at the NASA Langley Research Center (LAR) have developed a new background-oriented schlieren (BOS) imaging technique. The new technique enables vibration-tolerant, real-time, and reference-free BOS imaging for scientific investigations or industrial flow monitoring. Typically, BOS imaging requires a physical pattern on a retroreflective surface within the flow of interest to visualize that flow through changes in the pattern due to density changes between the pattern and a camera. Here, the BOS imaging technique does not require a physical pattern within the flow, and it is instead projected through the flow onto a retroreflective surface that is then imaged by a camera. Projecting the pattern allows the pattern to be changed mid-measurement and may lessen the cost of BOS imaging for a variety of flow visualization applications.

BENEFITS

- Customizable: the pattern used for imaging can be easily changed during measurements.
- Cheaper: without expensive-to-produce physically patterned retroreflective backgrounds, the flow visualization measurements can be done with less resources.
- Vibration tolerant: without a physical pattern within the flow of interest, the pattern is not affected by vibrations or other changing conditions caused by the flow.
- Real-time measurements: having an included reference camera allows for reference and signal images to be taken simultaneously.
- Multi-functional: the system can be used to do shadowgraph imaging (no pattern needed) in addition to the typical BOS technique.

THE TECHNOLOGY

The Projected BOS imaging system developed at the NASA Langley Research Center provides a significant advancement over other BOS flow visualization techniques. Specifically, the present BOS imaging method removes the need for a physically patterned retroreflective background within the flow of interest and is therefore insensitive to the changing conditions due to the flow. For example, in a wind tunnel used for aerodynamics testing, there are vibrations and temperature changes that can affect the entire tunnel and anything inside it. Any patterned background within the wind tunnel will be subject to these changing conditions and those effects must be accounted for in the post-processing of the BOS image. This post-processing is not necessary in the Projected BOS process here.

In the Projected BOS system, a pattern is projected onto a retroreflective background across the flow of interest (Figure 1). The imaged pattern in this configuration can be made physically (a pattern on a transparent slide) or can be digitally produced on an LCD screen. In this projection scheme, a reference image can be taken at the same time as the signal image, facilitating real-time BOS imaging and the pattern to be changed or optimized during the measurements. Thus far, the Projected BOS imaging technology has been proven to work by visualizing the air flow out of a compressed air canister taken with this new system (Figure 2).

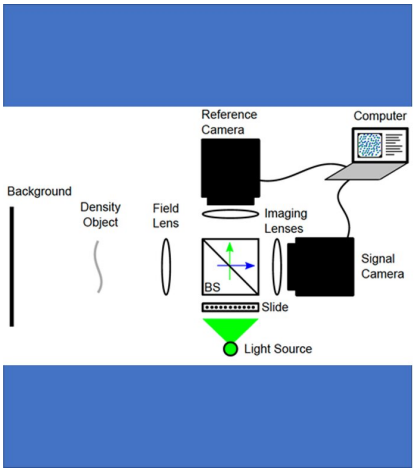

Figure 1. Schematic of the Projected BOS Imaging system. The Density Object is the flow to be visualized and BS refers to the beam splitter.

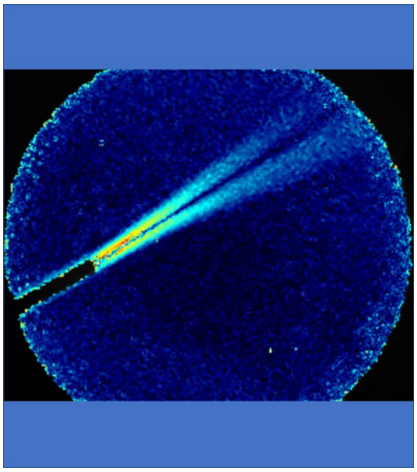

Figure 2. Projected BOS image of the air flow out of a compressed air can using a projected pattern of 0.2 mm dots on a speckled glass slide.

APPLICATIONS

The technology has several potential applications:

- Research: air flow and aerodynamics visualization
- Industrial: thermal management or heat-loss visualization
- Industrial: gas or leak detection

PUBLICATIONS

Patent No: 11,796,469

Patent Pending

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