



JetStick: Using Air Jet Tactile Feedback to Prevent Aircraft Stalls

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What is an aircraft stall ?

An aircraft stall is a aerodynamic phenomenon in which the wing loses lift because the angle of attack is too high (Fig.1). Even if pilots are trained to recognise the warning signs of a stall, flying at the limits of the flight envelope can be the cause of accidents.

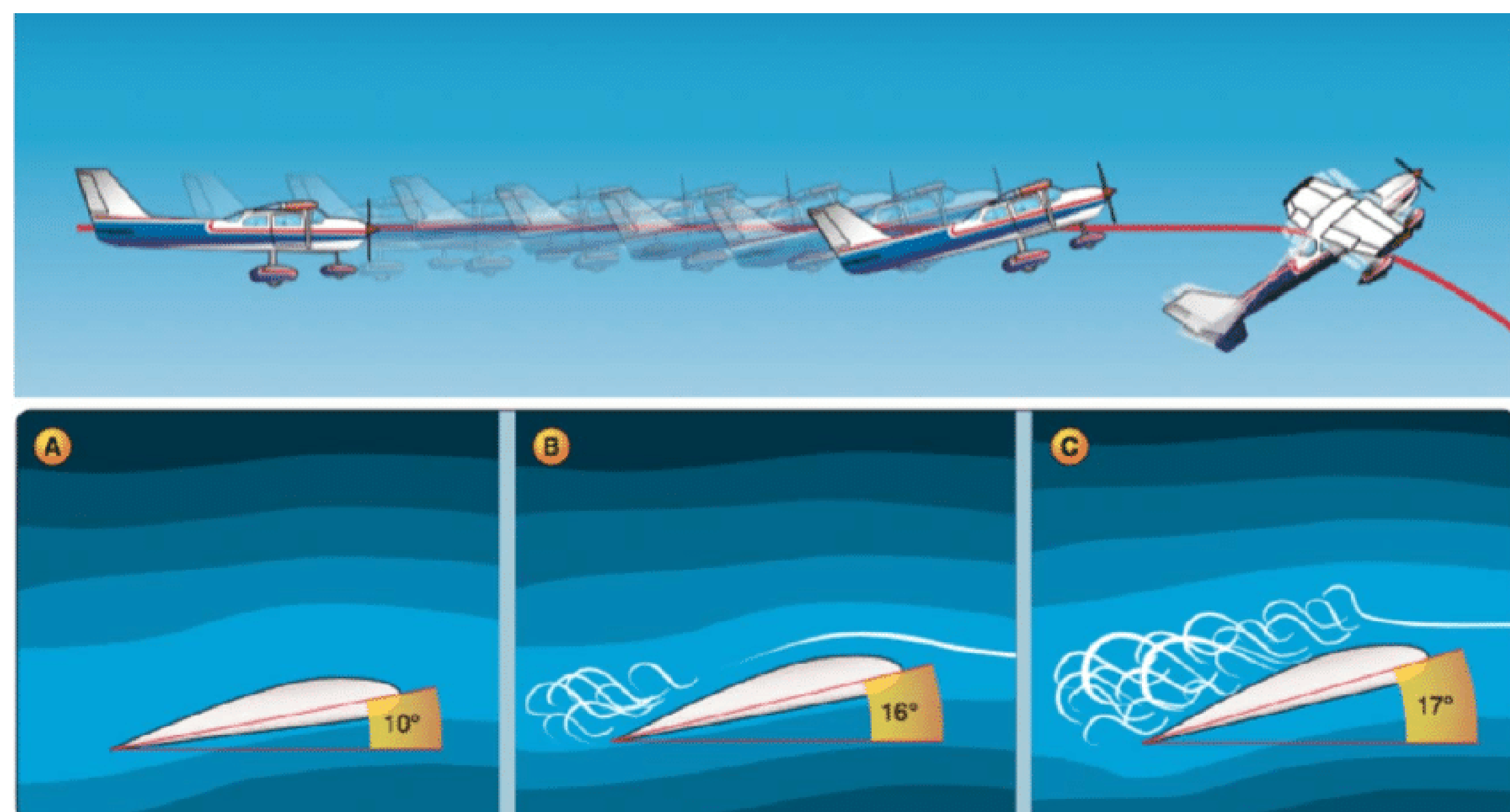


Figure 1. A stall is an aerodynamic condition that occurs when the smooth flow of air over the aircraft's wings is disturbed, resulting in turbulent flow and a loss of lift.

A few studies have looked at vibrotactile feedback to indicate inappropriate flight states (Cook, 2012; Zikmund et al., 2019; Van Baelen et al., 2021). However, these systems do not provide tactile information that can help pilots understand the flight state of the aircraft.

JetStick to prevent Aircraft Stalls

To raise pilots' awareness about the aircraft flying status in critical flight phases, we introduce JetStick. This flight stick is equipped with 4 proportional valves that can blow air to the pilot's hand to simulate airflow.

The JetStick system comprises air jets on the four sides of the joystick (Fig. 2). We have designed 3D-printed nozzles which we have integrated to a Speedlink Dark Tornado joystick (Fig. 2).

The system is connected to X-Plane and the airflow is configured according to the value of the angle of attack. The airflow increases progressively on the front nozzle as the aircraft approaches the stall zone. When the critical angle is reached, air bursts are emitted from the side nozzles to indicate the loss of lift on the wings.

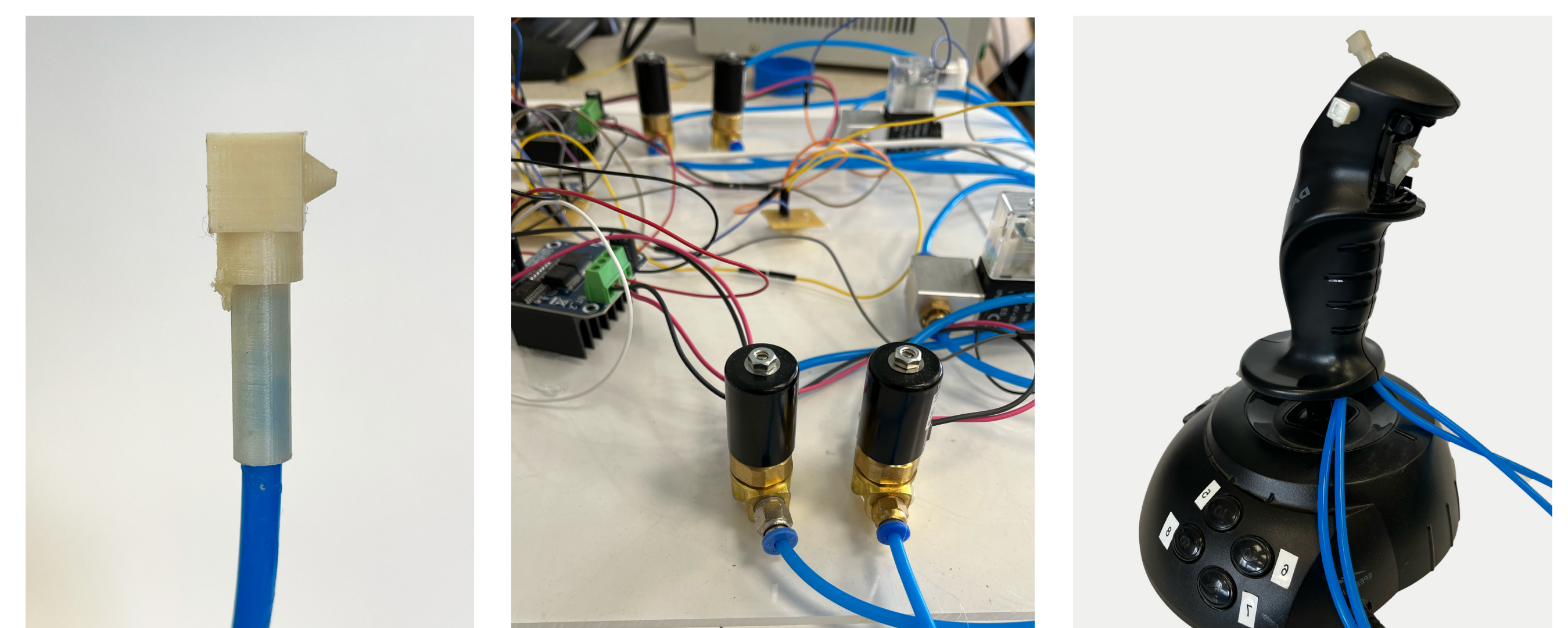


Figure 2. Left: 3D-printed nozzle ; middle: The airflow is regulated by four SMC PVQ30 proportional solenoid valves ; right: air circulation is integrated into the joystick

Preliminary Results and Future Work

We conducted a study with two flight instructors to collect qualitative feedback about their experience with JetStick.

hand was like the wing of the aircraft

the system is **very realistic** and allows you to feel **the approach of the stall**

The system is a very good indicator of the **airflow around the aircraft**, and gives the pilot an indication of the **flight status**

These preliminary results show that JetStick could be **useful to help understand the aerodynamic phenomena**s happening outside the cockpit and avoid dangerous flying situations which can lead to stalls. Our future research will **explore how to simulate aerodynamic phenomena inside the cockpit with air jet tactile feedback**.