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Fault-Tolerant Aircraft Flight Control (20150238, Dr. Peter Seiler)

IP Status: Issued US Patent; **Application #:** 15/610,315

Aircraft Flight with a Subset of Aerodynamic Control Surfaces

An automatic flight control system that enables safe and reliable aircraft flight using a subset of aerodynamic control surfaces. A unique feature is that this subset includes cases where only one aerodynamic control surface is functional. The technology, implemented in software, helps prevent loss of aircraft (manned or unmanned) and is not restricted to any particular size. In the event that multiple aerodynamic control channels fail and only one control surface is operable, the system provides a method by which the aircraft can be flown safely to a landing spot.

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Technology ID
20150238

Category
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Software & IT/Algorithms
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Aircraft Ailerons, Elevators and Rudders

While the general consensus says it is not possible to safely and reliably fly an aircraft with a single aerodynamic control surface, this technology has shown that it is possible. In general, most manned and unmanned aircraft rely on aerodynamic control surfaces for maximizing flight performance. However, if several control surfaces fail, the technology provides a method to control the aircraft using only the functioning subset of control surfaces and is particularly useful for fixed-wing unmanned aircraft that are equipped with only two aerodynamic control surfaces. In the absence of fault tolerance, a fault in either surface will lead to loss of aircraft. In addition, this technology reduces costs, covers a larger set of faults as compared to existing technology, and features plug-and-play implementation, so that its successful implementation requires minimal design and/or hardware modifications to the aircraft.

BENEFITS AND FEATURES:

- Safely controls manned/unmanned aircraft with a subset of control surfaces
- The subset is reducible to one control surface
- Plug-and-play implementation with minimal/no hardware modifications
- Software algorithms
- Helps prevent catastrophic failure/loss of aircraft

APPLICATIONS:

- Manned and unmanned aircraft
- Fixed-wing UAVs
- Smaller/lower end UAVs with a limited number of control surfaces
- Civilian grade drones
- Potential for commercial aircraft

Phase of Development

Prototypes built and tested. Experimental demonstrations completed on three different unmanned aircraft systems (UAS) where all but one control surface was disabled.

1. UAS #1: Seven of eight surfaces were disabled and the fault-tolerant autopilot controlled the aircraft while performing basic maneuvers.
2. UAS #2: A human pilot safely landed the UAS using only one control surface; an autopilot should be able to do the same.
3. UAS #3: One of the two surfaces was disabled. The fault-tolerant autopilot autonomously controlled, maneuvered, and landed the aircraft.

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Publications

Safe Flight Using One Aerodynamic Control Surfaceq
AIAA Guidance, Navigation, and Control Conference, AIAA SciTech Forum, 2016, Paper No. AIAA-2016-0634q

External Links

Safety Critical Systems
UAV Laboratories
Single Control Surface UAV, Technical Report