RQ16-32

AFRL CALL FOR RESEARCH

1. **Research Title:** Massively-Unsteady, Vortex-Dominated Flows

2. **Individual Sponsor:**

Dr. Michael V. OL, AFRL/RQVA
2145 5th Street, Bldg 24C
WPAFB, OH 45433-7542
Michael.OI@us.af.mil

3. **Academic Area/Field and Education Level:** Aerospace and/or Mechanical Engineering (MS or Ph.D. level)

4. **Objectives:** Pursue measurements using global velocimetry methods, direct force balance measurements and other techniques, coupled with analysis and/or computation (as appropriate), exploring a targeted parameter space of prescribed unsteady motions for airfoils, flat-plates, low aspect-ratio/swept planforms and control-surfaces using the Aerospace Systems Directorate's water tunnel.

5. **Description:** Maneuvering aircraft ranging from tactical manned aviation to Small Unmanned Air Vehicles (SUAV) feature operation at high angle of attack or sideslip, high pitch/turn/roll rate, and large control surface deflection. While these are conceptually classical problems, often with closed-form solutions based on small-disturbance theory and extrapolated to non-attached flows, adequacy of these solutions is suspect for the motion rates and geometries of modern interest. Massive separations, close-coupling of time-dependent aerodynamic loads with shedding in the near-wake, leading edge vortices and so forth, render the problem intensely complex, even for simple geometries and basic motions such as harmonic oscillations or linear ramps. We aim for a first-principles understanding of flow separation mediated by first, second and higher derivatives of the relevant state variables. The parameter space of possible flow conditions, configuration geometry, motion kinematics, and possibly even aeroelastic parameters etc., is vast. Aggressive abstraction is required to render the problem tractable. The Aerospace Systems Directorate has built a 3DOF pitch/plunge apparatus, termed the "High-Intensity Pitch/Plunge Oscillator", capable of prescribed motions of high frequency and amplitude. Proposed work would be primarily experimental, using the HIPPO rig and its instrumentation suite in the Aerospace System Directorate's Horizontal Free-surface Water Tunnel (HFWT), to (1) assess the role of vortex dynamics vs. time-dependent loads for a given parameter space of motions, (2) verify the validity of quasi-steady or locally linearized aerodynamic models, and (3) investigate models of gust response and control surface deflection for purposes of gust-response attenuation.

6. **Research Classification/Restrictions:** This research is at the public-release (Distribution Statement "A") level, with intent to publish in the open literature.

7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided.

- [x] **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati)
- [ ] **AFIT** (only)
- [ ] **USAFA** (only)

If you are submitting a topic for the USAFA, indicate if you are also interested in sponsoring a USAF Cadet in summer 2015 (Average cost for USAF Cadet for 33 days is $5000)

☐ Yes ☐ No