Tansel Yucelen Received a Grant from the Air Force Research Laboratory

TAMPA, FLA. (May 2017) - Department of Mechanical Engineering Assistant Professor, Tansel Yucelen, received a new grant from the Collaborative Research and Development for Innovative Aerospace Leadership (CRDInAL) program of the Air Force Research Laboratory/UTC entitled "Verification and Validation of Adaptive Hypersonic Vehicle Control Algorithms" (awarded April 2017).

Although hypersonic vehicles offer a promising and cost-effective technology for future high-speed systems, their models utilized in the flight control design do not adequately represent the actual vehicle dynamics. This stems from an inability to test hypersonic vehicles in ground test facilities and high amount of uncertainties in the vehicle flight characteristics resulting from dynamical complexity, highly coupled loops, and flight regimes with high Mach numbers. From this standpoint, adaptive flight systems offer a promising control design methodology for hypersonic vehicles to achieve high-performance in the presence of inaccurate models and uncertainties. However, unmodeled system dynamics, specifically including flexible vehicle dynamics and actuator dynamics, significantly limit the achievable stability and performance of these control algorithms. In particular, most adaptive flight control algorithms assume that the effect of unmodeled systems dynamics is negligible, where this assumption does not hold for hypersonic vehicles due to their slender/lightweight structure and their high-speed nature. As an example, these vehicles exhibit significant vibrations when operating at high speeds due to the strong coupling between rigid body and flexible vehicle dynamics. As another example, their highly maneuverable nature can yield to control responses that exceed the bandwidth of their actuator suites. Therefore, it is a challenge to verify and validate adaptive hypersonic vehicle control algorithms in the presence of system uncertainties and unmodeled system dynamics to achieve robust and high vehicle performance.

With this 2-year and $185,000 support, Dr. Yucelen and his two doctoral students, Benjamin C. Gruenwald and K. Merve Dogan, will develop tools and methods to understand the fundamental interplay between the stability of adaptive flight control algorithms, system uncertainties, and unmodeled system dynamics in order to establish verifiable and validatable intelligent hypersonic vehicle control algorithms with robustness and performance guarantees. In addition to hypersonic vehicles, the results of this proposal will also impact a broad set of applications including a general class of unmanned and manned aerial, ground, and underwater vehicles, where high confidence is required and tolerance to complexity and uncertainty is paramount.