Cooperative Variable Bandwidth Actuators Designed for Aerospace Applications

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Control surface actuators are a critical component of the control system design for any aerospace vehicle. Typical applications include fins, canards, ailerons, stabilizers, and rudder actuator controllers on aircraft, missiles, or guided projectiles. Many different configurations exist in which combinations of two, three, four, or more control surfaces are used collectively or differentially to control roll, pitch and yaw motions of the air vehicle. When each actuator is controlled independently and driven by position and/or speed commands from the external autopilot, it is difficult to control desired airframe response in pitch, roll and yaw precisely. Due to parameter variations and different aerodynamic loading on each surface, unwanted perturbations airframe response may occur. Another issue is that actuators designed for a fixed bandwidth to meet worst case loading response characteristics, may be inefficient in use of energy and susceptible to noise in less stressing regions of flight. The proposed solution alleviates both problems by combining cooperative control methods with extended high gain observers in the design of Cooperative Variable Bandwidth Electric Motor Actuator Controllers. This presentation describes the design of a cooperative controller that receives roll, pitch and yaw commands from the autopilot, motor position and current feedbacks from each of the multiple actuators, and then provides optimum motor voltage commands to drive each of the actuators. Embedded high gain observers are able to estimate both the loading torque and torque disturbances on each motor, and compensate to eliminate unwanted airframe perturbations. This approach allows for the bandwidth (or response time) of each axis (pitch, roll, yaw) to be controlled independently, and even to be modified during flight by commands from the external autopilot to achieve energy efficiency. Simulation results under hypothetical conditions will be presented to demonstrate these advantages.

Bio: Dr. Richard A. Hull is currently a Senior Technical Fellow with Collins Aerospace, supporting development efforts in guidance, navigation, control, actuation and sensors across several sites. He received his B.S. in Engineering Science and Mechanics from the University of Florida in 1972, and his M.S. and Ph.D. in Electrical Engineering from the University of Central Florida in 1993 and 1996, respectively. He has served as a GNC System Engineer in the Aerospace Industry for over 50 years, working for Martin Marietta, Lockheed Martin, Coleman Aerospace, McDonnell Douglas, Boeing, SAIC, Goodrich and UTC Aerospace companies. He is a Life Senior member of Institute of Electrical and Electronics Engineers (IEEE), a member of the IEEE Control System Society (CSS) and former Chair of the IEEE CSS Technical Committee on Aerospace Control (TCAC).