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IMPROVED LQR CONTROL SYSTEM DESIGN FOR LONGITUDINAL FLIGHT DYNAMICS OF A FIXED-WING UAV AUTOPILOT.

Abstract

An Unmanned Aerial Vehicle as the name suggest is pilotless, hence automatic control is use to steer the vehicle all through its mission.For UAVs, the design of flight controllers consists of synthesizing algorithms or control laws that compute inputs for vehicle actuators (rudders, aileron, elevator, etc.) in order to produce torques and forces that act on the vehicle for controlling its 3-dimensional motion (position, orientation and their time-derivatives). Automated flight in obstacle-free environments and relatively at high altitudes using conventional avionics and sensors (GPS, IMU, and altimeter) is a solved problem and many autopilots are commercially available today for various UAV platforms. However, several challenges still remain for low altitude flights. Despite the successful use of UAV for many applications, they are still based on rudimentary Guidance Navigation and Control (GNC) technologies that limit their applications to simple missions and environments. In an obstacle plagued terrain, the UAV will be required among others to have a shorter time response while maintaining adequate stability all through the mission. Hence, a tight control requirement is placed on the time response characteristics. This paper explores the application of a novel Linear Quadratic Regulator (LQR) control algorithm synthesized for an autopilot for the longitudinal flight dynamics of a fixed-wing, Unmanned Aerial Vehicle (UAV). Modeling results for the small UAV are presented and numerical values of the aerodynamic derivatives are computed via the DIGITAL DATCOM and Tornado softwares. The autopilot system is designed with an improvement from the stand point of the Linear Quadratic (LQ) feedback gain. In this research, the gains are obtained from numerical solutions to a Riccati Differential Equation (RDE). Contrary to what is obtained from solving an Algebraic Riccati Equation (ARE). This will give rise to an LQ feedback gain that is updated throughout the regime of simulation. The synthesis and analysis of the stability and other qualitative control parameters were done using MATLAB/Simulink. Computer simulations results show the effectiveness of the proposed algorithm.