Abstract

A Rotary Wing Unmanned Aerial Vehicle (RW UAV) as a platform and its payload consisting of sophisticated sensors would be costly items. Hence, a RW UAV in the 500 kg class designed to fulfil a number of missions would represent a considerable capital outlay for any customer. Therefore, in the event of an engine failure, a means should be provided to get the craft safely back on the ground without incurring damage or causing danger to the surrounding area. The aim of the study was to design a controller for autorotative landing of a RW UAV in the event of engine failure. In order to design a controller for autorotative landing, an acceleration model was used obtained from a study by Stanford University. FLTSIM helicopter flight simulation package yielded necessary RW UAV response data for the autorotation regimes. The response data was utilized in identifying the unknown parameters in the acceleration model. A Differential Dynamic Programming (DDP) control algorithm was designed to compute the main and tail rotor collective pitch and the longitudinal and lateral cyclic pitch control inputs to safely land the craft. The results obtained were compared to the FLTSIM flight simulation response data. It was noted that the mathematical model could not accurately model the pitch dynamics. The main rotor dynamics were modelled satisfactorily and which are important in autorotation because without power from the engine, the energy in main rotor is critical in a successful execution of an autorotative landing. Stanford University designed a controller for RC helicopter, XCell Tempest, which was deemed successful. However, the DDP controller was designed for autonomous autorotative landing of RW UAV weighing 560 kg, following engine failure. The DDP controller has the ability to control the RW UAV in an autorotation landing but the study should be taken further to improve certain aspects such as the pitch dynamics and which can possibly be achieved through online parameter estimation.