

https://dspace.org/

Adaptive model predictive control for a delivery quadrotor

Chikasha, Piwai Nigel

2018
https://hdl.handle.net/10539/28549

Downloaded from a DSpace repository. https://dspace.org/

Abstract

This work explores the application of Adaptive Model Predictive Control (AMPC) to a quadrotor, given some delivery (varying load) task. In simulations, this is investigated as a pick-and-place task for a delivery quadrotor, then in experiments, as a load-drop-off stabilisation task. Model Predictive Control (MPC) is a very powerful method of Advanced Control, utilizing an implicit model to make output predictions which are in turn used in computing control action. Dynamic Matrix Control (DMC) is very common in process control today, especially for chemical plants. Due to changes in operating points, the implicit model in MPC typically becomes insufficient, costing the quality of the controller. This work proposes Adaptation (based on the Recursive Least Squares (RLS) algorithm), for online system identification to update the model in real time hence taking changes in operating points into account when computing the DMC control action. Overall, Adaptive DMC (ADMC) is investigated as to whether ADMC is capable of improved quadrotor control given load variation. The quadrotor is modelled analytically based on the Newton Euler Formalisation then experimentally based on system identification from flight data. The experimental model is optimised before being adopted as the system model for ADMC design. The adaptive controller is implemented and simulations run to evaluate the controller against PID and also adaptive PID. The controller comparison is based on experimental graphical analysis, which is possible if data is well presented. Optimal controller tuning methods are also a common basis for controller evaluation, producing precise evaluation indices for controller comparison, although typically applied to theoretical cases. The controllers are also tested experimentally, on a quadrotor and evaluated, for different load disturbance magnitudes. The experiments reveal that ADMC provides the best control quality in terms of disturbance compensation. To achieve this though, requires careful tuning of the possible ADMC parameters and in this case, additional manipulation of control action by applying some signal smoothing algorithm to the control action. The comparison is made by analysing, how in each case, the quadrotor responds to an in-flight weight (load) drop-off. These experiments are also important in understanding how close to reality system simulation is, and if not close enough, then the reasons for this too. An important aspect that is kept in mind in the design process is that of minimising computation because the ADMC controller (which must solve an optimisation problem at each time sample) is computationally expensive as it is.