Novel empirical models for estimating aerodynamic coefficients of small UAV propellers

Kedarisetty, S. & Manathara, J.G.

Motivation

No simple model that captures thrust and power coefficient variation with advance ratio for small propellers

Such a model is essential for small UAV design

Methodology

Analysis of 170 propeller data revealed that thrust and power coefficients and efficiency depends mainly on the pitch ratio — ratio of linear pitch to radius (for a 8x4 propeller, the pitch ratio is 1)

Propeller Modeling

Thrust and power coefficients as polynomials in advance ratio

Coefficients are rational functions of pitch ratio

Results

Thrust coefficient model

$$\hat{C}_T(J) = b_{T_2} J^2 + b_{T_1} J + b_{T_0},$$

with

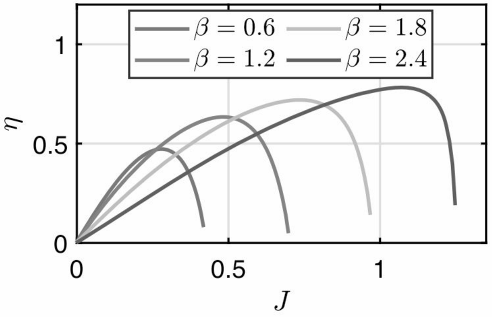
$$b_{T_2} = -\frac{\Delta C_{T_{\max}}}{J_{mT}^2}, \quad b_{T_1} = \frac{\Delta C_{T_{\max}}}{J_{mT}} - \frac{C_{T_0}}{J_{0T}}, \quad b_{T_0} = C_{T_0}.$$

$$\hat{J}_{0T} = 0.4559\beta + 0.1574, \quad \Delta\hat{C}_{T_{\max}} = 0.0205\beta - 0.0073, \quad \hat{J}_{mT} = 0.2275\beta + 0.0792.$$

A third degree model for power coefficient

Efficiency curves for UAV design

Efficiency variation with advance ratio: prediction from our model



Link to the paper