Sensitivity analysis on the model input parameters of flapping wing kinematics for optimum level flight via particle swarming optimization

ABSTRACT

A systematic reviewing process to assess the sensitivity of the input parameters of flapping wing kinematics for optimum level flight is presented. This is done prior to the development of a stroke optimization model to predict the aerodynamic performance of an insect (hawk moth) during flight. A systematic iterative process-population-based stochastic algorithm, known as particle swarming optimization, is used. In the search for an optimal realistic wing kinematic motion, several constraints for stable flight are defined following the observational wing kinematics data from experiments on real insects. This is to avoid any physically-unrealistic solutions of the wing motion. Two stages of sensitivity analyses are conducted via partial sensitivity analysis, or one-at–a-time. First, sensitivity screening analyses are performed to gauge the dependability of the solution output, i.e. total force and total power, on each model input parameter; a total of 9 model input parameters. Then, the second stage of sensitivity analysis to measure on how the most sensitive model input parameters will affect the optimized kinematics are conducted. The results have shown that the wing length and the wing translational lift coefficient are the most sensitive aerodynamic model input parameters among other inputs.

Keyword: Flapping wing; Kinematic; PSO; Optimal flapping motion; Level flight