Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

A mechanism of thrust enhancement on a heaving plate due to flexibility at moderately low Reynolds numbers[1] YUNG-SHENG LIN, YAU-TING TZENG, CHIEN-CHENG CHANG, CHIN-CHOU CHU, Institute of Applied Mechanics, National Taiwan University, Taipei, TAIWAN — A numerical study is conducted to investigate the force mechanisms for a 3D heaving flexible plate from the perspective of a diagnostic force element analysis (Chang 1992). The problem is relevant to a simplified flapping fish-tail with the front edge held fixed in space. The flow is assumed to be laminar with the Reynolds numbers fixed at Re=200 or 500, and the Strouhal number St ranging from 0.1 to 0.6, and the flexure amplitude of the plate a0 for 0.1 to 0.25 (dimensionless). It is shown that heaving, whilst increasing thrust generation, also reduces the frictional drag, yet the flexibility promotes thrust generation at the expense of accruing more frictional drag. In the literature, the thrust exerted on the tail-mimicking plate is largely credited to the vortices in the wake. However, this study performs a regional force analysis to show that the vorticity in the wake region supplies approximately 20-30% of the total thrust, especially in the cases of strong thrust generation. Comparable contributions come also from the regions direct above and below the heaving plate (mainly including the attached vortices) as well as from the two side regions (mainly including the tip vortices) next to the flapping plate. In addition, the potential motion associated with the unsteady flapping and the contribution from the surface vorticity are non-negligible constituent force components.

[1]MOST, TAIWAN under contacts NO. 105-2221-E-002-097-MY3 and NO. 105-2221-E-002 -105 -MY3

Chin-Chou Chu
Institute of Applied Mechanics, National Taiwan University, Taipei, TAIWAN

Date submitted: 01 Aug 2017 Electronic form version 1.4