Numerical Simulation and Analysis of the Small Bird Flapping Wing

Niramol Hutacharern, Artit Ridluan
Research and Develop, Defense Technology Institute (Public Organization)
Changwattana Road, Nonthaburi, Thailand
E-mail: niramol.h@dti.or.th, artit.r@dti.or.th

ABSTRACT

Recently, there has been an attention to develop a vehicle that can mimic behavior of an animal. One of the most interesting studies is regarding the replication of a small bird flight behavior. The key to replicate and develop small-bird flight lies on its complex flight mechanics, described by flapping wing pattern. It is simple, yet very effective. This paper investigates the aerodynamics performance of a small bird flight through the simulation of House sparrow's wings which possess efficient aerodynamic performance and maneuverability. The investigation includes lift force, drag force, and wing aspect ratio which are numerically computed. The computational results were compared with biological experiment data to determine the marginal difference. The analysis has revealed that lift force changed quadratically when the flapping frequency and flapping angle increased. The vertex was observed in the vicinity of the wingtip during the wings fluttering down.

Keyword: Flapping wing, Aerodynamics, House sparrow, Lift and drag ratio

1. Introduction

Small bird flight has been under attention of many aerodynamicists due to its aerodynamic performance and manoeuvrability. Its flight can be described by a flapping mechanism. Many studies have been done to develop the fascinating technique. For instance, many Ornithopters have studied and built flapping wings aircraft which replicates the flight of birds, bats, and insects (1).

Pennycuick (2) observed and measured airspeed and wing beat frequency of sixteen birds. Miller and Peskin (3) applied the immersed method to solve two-dimension Nervier-Stokes equations. The results shown that at Re = 64 or higher, lift is increased during the rotation of two wings while at Re=32 or lower, lift coefficient per wing is greatly enhances.

Due to its excellent manoeuvrability, the house sparrow flapping behaviours is interested. In this paper, numerical simulation and analysis of House Sparrow flight has been there established by simplifying the rotational circulation flight into