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"Butterfly Flight is Characterized by Unsteady Flow arpund Flapping Wings with Large Vortical Structures"

Chang-kwon Kang
University of Alabama in Huntsville

Faculty or Research Mentor

Chang-kwon Kang, Assistant Professor
Department of Mechanical and Aerospace Engineering, College of Engineering
Technology Hall N266
Huntsville, AL, 35899
tel: 256-824-6612
email: ck0025@uah.edu
website: kanglab.uah.edu

Summary

Butterfly flight is characterized by unsteady flow around flapping wings with large vortical structures. Moreover, wings deform in dynamic balance with surrounding flow. Wings are inherently anisotropic. Furthermore, the body and wing motions are closely coupled. A numerical butterfly model is being developed at the MAE department of UAH. This butterfly model accounts for the coupling between unsteady aerodynamics, wing motion, and a flight dynamics model accounting for the mass and inertia of the wings.

Wing kinematics and body trajectory of freely flying Monarch butterflies will be measured using a high resolution motion tracking system. Based on the measured morphological data and butterfly motion, we will validate and analyze the numerical butterfly model. Using the numerical butterfly model, we will analyze the interplay between wing kinematics, wing structural response, resulting aerodynamic forces, and body motion.

Female and minority students are encouraged to apply.

Student Prerequisites

Dynamics (e.g. MAE271) with a final grade of an A.

Student duties

The student will be expected to work closely with a graduate student to perform following duties:

- Measuring the morphological parameters of Monarch butterflies
- Measuring the wing kinematics and body trajectory of freely flying Monarch butterflies in the UAH ATOM motion tracking lab
- Simulation of the numerical butterfly model based on the measured butterfly data
- Postprocessing and analyzing the measured and simulated butterfly flight

Main benefits to the students are

- Unique opportunity to use state-of-the-art experimental and numerical tools:
    - motion tracking system in the UAH ATOM lab
    - simulation tool to model and analyze a numerical butterfly
- Opportunity to contribute to a journal or conference paper, depending on the progress

Butterfly measurements are expected at the beginning of the Summer semester. Simulations including a validation study will be performed mid-Summer. Data will be analyzed towards the end of the Summer.

Mentor Supervision and Interaction

A graduate (PhD) student will provide a daily supervision to the student. In addition, the student is expected to update the mentor with a weekly progress update report and during a bi-weekly update meetings. The followings are the specifics.

- Weekly progress update report
    - Written together with the graduate student
    - To discuss the results, any issues, and plans for the following week
    - Evaluation: the mentor will provide feedback to all reports. The mentor will assess the writing, scientific progress, and quality of the analysis. Suggestions will be provided
- Bi-weekly progress update meetings
    - Together with the graduate student.
    - To discuss the results and any issues in person.
    - Frequency of the meeting will increased as needed.
    - Evaluation: the mentor will provide detailed instruction for the on-going work and offer suggestions for improvement.