1-1-2016

# "Insect Flight has Garnered a lot of Attention from both the Engineering and Biology Communities in the recent Decades, Often Driven by and Interest in Bioinspired or Bio-Mimicked Design of a Small Unmanned Ariel Vehicles, Called Micro Air Vehicles (MAVs)"

Chanh-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

Insect flight has garnered a lot of attention from both the engineering and biology communities in the recent decades, often driven by an interest in bioinspired or bio-mimicked design of small unmanned aerial vehicles, called Micro-air vehicles (MAVs). MAVs are classified as miniature aerial vehicles with wingspans less than 15cm. Given their smaller size than conventional drones, MAVs have even more potential to revolutionize our sensing and information gathering capabilities in areas such as environmental monitoring and homeland security. However, state-of-the-art MAVs, e.g. the Nano Hummingbird, DelFly, or Harvard's robotic fly have limited onboard power sources due to their small sizes. Even larger commercially available drones can only fly 10 to 25 minutes on the onboard battery. Therefore, the key challenge in MAV development is their power efficiency and stability in an unsteady flight environment.

Biological flyers showcase desirable flight characteristics and performance in rapid maneuvers that can guide the design of MAVs. These flapping flyers utilize wing kinematics, deformable wing shapes, and large scale vortical structures to enhance lift and thrust. Among these flapping flyers, the Monarch butterfly *Danaus plexippus* stands out with the longest migration distance among insects. Their long migration suggests that they are extremely efficient flyers. Moreover, they flap, glide, and perform agile maneuvers while climbing and descending with ease. Furthermore, these butterfly flight mechanisms appear universal across a wide range of wing lengths - from just 2 cm long to 25 cm. This suggests that the butterfly flight strategy can be applied to a wide range of MAV sizes.

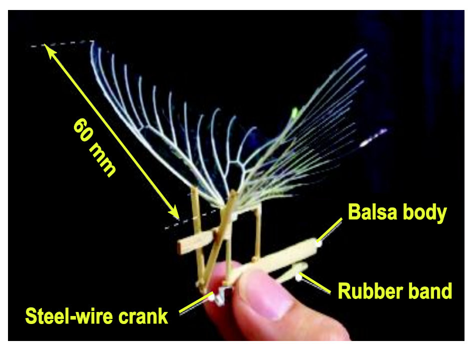

Figure 1 Artificial butterfly by Tanaka et al., which we will take as the starting point by adding hindwings.

In this project, we will develop an artificial butterfly. The initial artificial butterfly will be built based on a published model by Tanaka et al., see also Fig. 1, which incorporates a simple flapping motion with a rubber band-driven crank mechanism that made the wings flap vertically relative to the body. Although simple, this artificial butterfly was passively stable. The design of the vein structures of the wings will be mimicked from the Monarch butterfly wings. Resulting wing kinematics and trajectory will be measured in the UAH motion-tracking lab.

Female and minority students are encouraged to apply.

**Student Prerequisites**

None.

**Student duties**

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

- Literature study of existing MAVs including the method of fabrication, motion actuation, etc.
- Design and development of the artificial butterfly
- Documentation of the artificial butterfly development

Main benefits to the students are

- Unique opportunity to operate a state-of-the-art motion tracking system
- Development of a bio-inspired MAV
- Opportunity to contribute to a journal or conference paper, depending on the progress

Working prototype and a final report including a literature study and measurements of the wing kinematics and motion trajectory of the prototype will be expected at the end of the summer semester.

**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.