<table>
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<tr>
<th><strong>Title</strong></th>
<th>Wing flapping mechanism without gear: a realisation of MAV</th>
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<tr>
<td><strong>Author(s)</strong></td>
<td>Astrini</td>
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<td>Astrini. (2010, March). Wing flapping mechanism without gear: a realisation of MAV. Presented at Discover URECA @ NTU poster exhibition and competition, Nanyang Technological University, Singapore.</td>
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Inspired by biological flying mechanisms, MAVs are able to navigate in places that are impossible reached by normal flying vehicles. Real applications include military spying, geological surveillance of geographically challenging environments, and mapping applications.

How to Realise?
A flapping wing insect model MAV will be created. Vibration motor is used as the driving mechanism of the MAV. The concept applied is vibration excited at the natural frequency of the thorax due to rotating unbalance. Precision Microdrives 307-002 motor is selected for this project.

The Specifications
Polyimide is used to mimic the joints connecting the wing and the body. It provides flexural stiffness and elasticity to the wing, transmitting motion from the vibration motor to the wing.

Carbon is used as the thorax substance of the MAV, constructing the wing, wing root, and tergum. The characteristics of high strength and low weight per unit volume make carbon a good choice to model the insect thorax.

<table>
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<tr>
<th>Material</th>
<th>Young’s Modulus</th>
<th>Poisson’s Ratio</th>
<th>Density</th>
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<tr>
<td>Polyimide</td>
<td>2.5 GPa</td>
<td>0.34</td>
<td>1420 kg/m³</td>
</tr>
<tr>
<td>Carbon</td>
<td>220 GPa</td>
<td>0.34</td>
<td>2000 kg/m³</td>
</tr>
<tr>
<td>Motor</td>
<td>200 GPa</td>
<td>0.28</td>
<td>1341.7 kg/m³</td>
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1st Model
Modal analysis using Block Lanczos is done with ANSYS. A basic model of wing-roots connected to tergum by polyimide joints. Flapping motion of the wing roots will be achieved in the 2nd natural frequency.

2nd Model
Wing and motor are incorporated in the thorax model. Additional feature of discontinuous polyimide joints provide a chance of twisting motion of the wings. Reduce in natural frequency due to addition of motor and wing that contributes to inertia.

3rd Model
Changes in joint structure, from horizontal to vertical joints positions to promote more efficient force transmission from motor to wings. Increase in natural frequency of flapping motion mode shape due to direct transmission of motor vibration such that frequency of the flapping wing is not reduced along the path of transmission.

Mode Shape
1 2nd Flapping (50Hz)
2 2nd Flapping (22Hz)
3 4th Flapping + Twisting (230Hz)
4 4th Flapping (46Hz)

Modelling Results
Flapping Motion of 3rd Thorax Model at 45.9 Hz

A Realisation of MAV
WING FLAPPING MECHANISM WITHOUT GEAR

Project Title: Wing Flapping Mechanism without Gear
Supervisor: Asst Prof Lau Gih Keong

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