

Biomimetics Research on Flying Insects for Developing High Performance, Small-Sized Actuator

by

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Abstract

This paper describes the development of highperformance, small sized actuators based on the vibration mechanism of flying insects'wings. At first, the three-dimensional observation of flight muscles in some kinds of winged insects such as bees, dragonflies, and cicadae are presented. In the 3-D observation of flight muscles, sequential sections through thoraces are sliced at the thickness of 30 μ m by the rotating knife and taken photos by camera with three-dimensional internal structure microscope automatically and repeatedly. The 3-D images are reconstructed by a computer based on the digital data after recording. From the 3-D observation, it is confirmed that the winged insects can classified into three groups at least by the differences of morphology of flight muscles. Then, relation between morphology of flight muscles and function of wings are examined experimentally. In the indirect-flight-muscle type of insects, the deflections of thoracic exoskeleton are measured under the static load. The obtained load-deflection diagrams show linear relation between them. In the direct-flight-muscle type of insects, the ultra high speed video camera is used to record the wing motion under the free flight conditions by making use of their nature of high sensitivity to light. The frequencies of wing vibration are determined from the analyses of recorded data on videotapes. It is found that the vibration frequencies depend on the wing mass in the case of losing weight and independent on it in the case of gaining weight. Finally, the application of these knowledges based on the biological experiments to the development of driving circuit and mechanism for small-sized actuator is presented.

KeyWords:Biomimetics, Winged Insects, Vibration Mechanism, Flight Muscles, Morphology,
3-D Observation, Small - Sized Actuator

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