公益財団法人 セコム科学技術振興財団
研究成果報告書

研究課題名

羽音をたてずに自在に飛翔する超小型飛行機の実現のための蝶の羽ばたき飛翔の解明

Unraveling butterfly flapping flight to realize micro air vehicles that fly freely without hum sounds

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Abstract

The objectives of this research are to study the flapping flight of butterflies, to understand how they achieve high maneuverability, and to clarify why they can flap their wings without making a sound so that the research results can contribute to realizing the following micro air vehicles (MAVs). Suppose MAVs with high maneuverability like butterflies can be realized. In that case, they will be able to fly freely and inspect the inside of the decommissioned reactor building at the Fukushima Daiichi Nuclear Power Plant, which is an intricate environment where conventional drones cannot fly. If the MAV can fly without making wing noises, it will be suitable for inspections for crime prevention purposes.

Butterflies are composed of three systems, i.e., control (cranial nervous system), body (wings/musculoskeletal system), and environment (flow field). The butterfly uses the interaction among these three systems and the interaction among subsystems composing the three systems to achieve a form of locomotion, i.e., flapping flight. The flapping flight has motor intelligence, e.g., high maneuverability and adaptive ability. In addition, multiple functions are superimposed, such as maneuvering while generating lift to support body weight. Therefore, we are studying the analysis and design methods for dynamic motion intelligence, in which multiple functions can be superimposed and adaptively changed through the interaction of subsystems.

For this purpose, we have developed a high-resolution and measurement-accuracy wind tunnel test method, acquired measurement data, and constructed a highly accurate mathematical model. We are also studying dynamic motion intelligence using the obtained high-precision models.

This report describes the results obtained for each of these items.