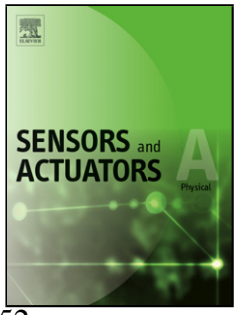

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Fuzzy-Controlled Living Insect Legged Actuator

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Highlights

- Developed a micro actuator based on living insect leg.
- Found the muscle reaction was proportional to the electrical stimulation frequency with a hypothesis property.
- Designed a fuzzy feedback control for manipulating the beetle's leg motion by actively changing the stimulation frequency.
- The fuzzy control demonstrated better performances including small overshoot, short response time, and less deviation compared with a conventional proportional controller.

ABSTRACT

Steering motor units (e.g. legs) of a living organism by controlled stimulation protocols is a key performance toward living machines, biohybrid robots, or cyborg animals — a fusion of living organisms and man-made devices. To achieve fundamental locomotion pattern generation (e.g. walking gait), a closed-loop (feedback) control system to steer motor units to be set at or to move along a predetermined position and motion path is essential. This study demonstrated the capability to build a precise closed-loop control system manipulating the angular displacement of a coleopteran's leg with electrical stimulation applied directly to the corresponding muscles. We confirmed the correspondence between the angular displacement of the beetle's leg and the electrical stimulation frequency was proportional, nonlinear, and time-variant. A fuzzy control system with multiple membership functions using a proportional controller with adjustable parameters was then proposed and adopted for motion control, and we successfully steered a living leg along a predetermined motion path.

Keywords: Fuzzy Control, Biohybrid Robots, Insect Motion Control, Insect Muscle Control