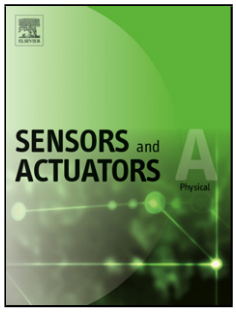

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A speedy, amphibian, robotic cube:

Resonance actuation by a dielectric elastomer

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Highlights

1. The out-of-plane vibration characteristics of a dielectric elastomer resonator were identified and analyzed.
2. A high-speedy robotic cube was designed, driven by the first-order resonance of a dielectric elastomer resonator.
3. The robot can locomotion either on the land or on the surface of water.

Dielectric elastomers (DEs), as a stimuli-responsive material, have been widely used in soft robots with the advantages of high deformability and adaptability. Since most research on DE has been focus on its quasi-static actuation, its dynamics is under-explored. In this paper, a robotic cube actuated by the resonance of DE is proposed, according to the characterization of the out-of-plane vibration in DE. A model is established to study the motion performance of the robot which agrees with the experimental result. The robot has three superior motion performances: 1) a high speed (2.8 body length per second) that is much faster than previously reported application using soft, responsive materials; 2) a weight-carrying ability (exceeding its own weight); 3) locomotion either on the land or on the surface of water.

Keywords: dielectric elastomer; electromechanical resonance; locomotion dynamics; robot

1. Introduction

Dielectric elastomer is a soft active material, showing large mechanical strain under voltage. Proposal on dielectric elastomer actuated robot is of great potential as it represents a novel category in robotic science [1]. A number of dielectric elastomer actuator (DEA) in different configurations have been developed which is then integrated in micro locomotion robot of diverse motion type, including planar [2, 3], rolled [4], bender [5], folded [6], minimum-energy structured [7, 8], and et al. Due to the