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Soft Robotic Fish with Multiple Swimming Models based on Variable Stiffness Control

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As a product of natural evolution through millions of years, fish possesses excellent swimming performance. The development of bionic robotic fish plays an important role in underwater rescue, resource exploration and so on. Compared with traditional rigid robots, soft robots driven by intelligent materials have preferable kinematic dexterity and environmental adaptability. However, the simplicity of propel mode has limited the application of the current soft robotic fish. In addition, the lack of modeling methods and control strategies for soft robots also has hindered further development. To improve the adaptive capacity to complex environment, this work has proposed a soft robotic fish with multiple swimming modes actuated by dielectric elastomer actuators (DEAs) with variable stiffness control. This fish can perform three different swimming modes according to the various application scenarios by regulating the stiffness distribution. What's more, the soft robotic fish prototype was designed by CAD software SolidWorks, and was fabricated by 3D printing technology. To optimize the actuation and control parameters for different swimming modes, the swimming performance has been simulated by commercial software ANSYS. This work not only provides a novel idea for the development of robotic fish, but is also useful for other soft devices.

Keywords—robotic fish; soft robots; dielectric elastomer actuator; variable stiffness; bionic robots