Editorial: Focus on research from China in Bioinspiration & Biomimetics

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Editorial: Focus on research from China in Bioinspiration & Biomimetics

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Chinese people started to seek nature for inspiration ever since the ancient history. Ever since the Spring and Autumn and Warring States Period (from approximately 771 to 476 BCE), Ban Lu invented the saw inspired by the plant alpine yarrow. While in the Three Kingdoms period (from 220 to 280 AD), the Wooden ox, a single-wheeled cart with two handles, was invented by Geliang Zhu for transporting grains and grass. Chinese biomimetics research started to boost in the past two decades after a long period of stagnation. Inspired from nature, China has made several important progresses regarding aspects of biomimetic robots, biomimetic materials, and biomechanics. In particular, the biomimetic soft robotic fish reached the deepest part of the ocean- the Mariana Trench [1], while the Yutu lunar rover took its first step on the backside of the moon for scientific discovery [2].

This special issue "*Focus on research from China in Bioinspiration & Biomimetics*" aims to show the recent research progress from several representative labs from China. This issue contains 12 papers divided into three sub-fields: biomimetic terrestrial robots, biomimetic aerial robotics, and biomimetic underwater robotics (figure 1).

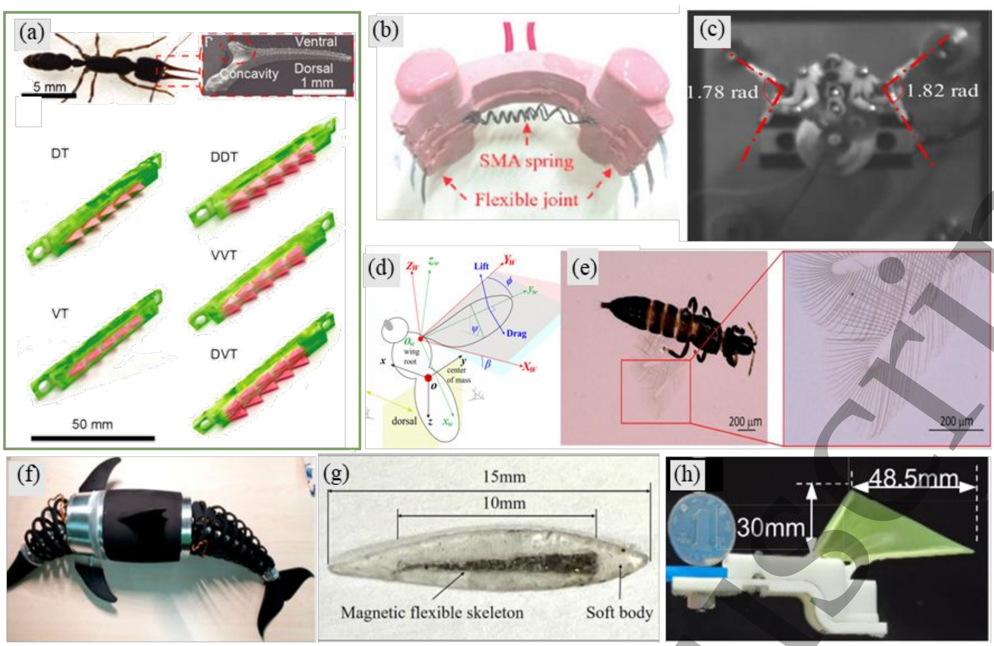

Figure 1. Selected biomimetic robots from the special issue. (a) Mandibles with tooth-like structures of an ant (H. Venator) [3]. (b) The prototype of passively adaptive soft gripper [4]. (c) An elastodynamic model for flapping-wing micro air vehicle (FMAV) [7]. (d) The hovering model of a fruit fly [9]. (e) Morphology of a thrip's bristled wing configuration [10]. (f) The biomimetic robot features dual tendon driving continuum mechanisms [11]. (g) A magnetic actuated fish-like microrobot [12]. (h) A biomimetic tuna finlet for underwater sensing [14].

1. Biomimetic terrestrial robots

Wei Zhang et al. [3] conducted a morphological and kinematic analysis of ant's mandibles and quantitatively investigated the tribological performance of the ant's mandibles. Due to the biaxial rotation, the friction coefficient shows an opposite change pattern between dorsal teeth (DT) and ventral teeth (VT).

Inchworms are highly adaptable to the shape and roughness of their climbing surfaces. Inspired by inchworm's foreleg, Manjia Su et al. [4] implemented a passively adaptive soft gripper. This soft gripper utilizes the passive adaptability of structure and material and can be well adapted to grasping various objects.

By imitating the dog tongue's large expansion and large bending characteristics, Ning Gong et al. [5] designed a biomimetic soft tongue capable of grasping particles and liquid objects by adopting a hybrid actuating method of pneumatic and shape memory alloy.

Dong Zhou et al. [6] proposed a self-sensing control method for the Twisted artificial muscles

(TAMs) by monitoring the heating wire's real-time resistance, and realized controlling of the TAM's temperature accurately. Furthermore, a bionic soft hexapod robot with multi-motion and load capacity is implemented.

2. Bioinspired aerial robotics

Flying creatures generally adopt the flapping-wing flight mode, which has small size, flexible movement, high efficiency, and low consumption. Therefore, the biomimetic research of flapping-wing flight mode is critical.

Xin Fang et al. [7] built an elastodynamic model of the transmission mechanism based on kineto-elastostatic analysis and reveals the effect of elastic deformation of the transmission mechanism on the flapping motion. The research found that the inertial force of the transmission mechanism for the flapping-wing micro air vehicle is notably smaller than the force transmitted.

Xueguang Meng et al. [8] investigated the ground effect of the insect fly at a low Reynolds number (Re = 10) and found that the forces enhance as the insect approaches the surface at a near distance. In addition, the ground effect might help insects enhance their lift during hovering.

Jinjing Hao et al. [9] found that passive wing pitching significantly affects the flight control of hovering model insects and gliding vehicles. This provides a compelling theoretical basis and guidance for the design and development of future flapping-wing micro air vehicles. The accurate perception of the surrounding flow field is the premise of stable flight control.

Inspired by the bristled wing structure of tiny insects, Peng Zhao et al. [10] proposed a novel differential pressure (DP) sensor. The sensor can retain a high sensitivity under low differential pressures as well as achieve a higher theoretical upper detection limit.

3. Biomimetic underwater robotics

The underwater environment of aquatic creatures is complex, especially in the oceans facing extreme environments such as high pressure, unsteady flow, etc.

Jincun Liu et al. [11] designed a biomimetic robotic dolphin with dual tendon driving continuum mechanisms according to the twisting and bending motions of the dolphin's caudal vertebrae and thoracic vertebrae. Utilizing a central pattern generator (CPG) controller, the multi-modal swimming of the bionic dolphin is realized.

By simulating fish swimming, bioinspired microrobots have broad application prospects in biology and medicine. Chenyang Huang et al. [12] proposed an untethered miniature robotic fish composed of a flexible magnetic skeleton and a soft body. The robotic fish can swim under the water through the control of an external magnetic field and can easily pass through narrow spaces.

Lin Su et al. [13] designed an untethered magnetic adhesive pad inspired by the octopus sucker. The adhesive pad can be activated from a low-adhesion state to a high-adhesion state by near-infrared laser, allowing to fulfill the task of retrieving and releasing objects.

Inspired by fish fin perception, Wenguang Sun et al. [14] realized a biomimetic fin prototype with motion perception and environment perception. The sensing mechanism of finlets shape for multi-directional flow field is revealed through experiments.

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