Bionic high-performance perception theory and technology

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Abstract
Sensors, which serve as crucial instruments for gathering external information, have drawn substantial attention in domains such as electronic skin, human-computer interaction, and precision instrumentation. Among these, mechanical sensors represent a major area of research focus. However, the performance of existing mechanical sensors in terms of weak vibration detection, target signal identification, and vibration source localization is difficult to meet the practical requirements. Therefore, it is important to find innovative methods to design high-performance mechanical sensors. Over billions of years of evolution, the fusion of organisms and nature has become perfect. This report takes the scorpion as its biological prototype. Through systematic bionic studies, a range of intrinsic mechanisms underlying the scorpion's remarkable perceptual functions have been revealed. These principles enable scorpions to detect faint stimuli, accurately discriminate signals, and quickly locate vibration sources even in complex settings, which is conducive to avoiding enemies and hunting for food in harsh conditions to maintain survival. Drawing inspiration from such ingenious biological strategies, corresponding designs and fabrication methods for biomimetic sensors have been developed and widely applied in fields such as automotive industry manufacturing, micro-vibration monitoring of bridges, and fault monitoring of precision equipment.

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