附件四、技術說明表

基於形狀記憶離子凝膠的微型雙穩態致動器

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市場及需求:

軟性致動器微型化的優點能夠在微創手術、藥物遞送、生物檢測等領域中廣泛應用。例如在微創手術中因減少剛硬接觸對人體的損害，可以更有效地將手術風險降低。此外，若軟性機器人能夠保持長時間穩定的抓握，將對微創手術或複雜手術之操作帶來很大幫助。因此，微型軟性機器人能夠同時具備雙穩態特性，將有望實現更大的進步。微型化軟性致動器不僅提供了更高的精密度與靈活性，若能夠在其中整合致動及自主感測功能，帶來更多實際應用層面上之可能性。

技術摘要(含成果):

開發出一具形狀記憶及自感測功能之液晶離子凝膠微型雙穩態元件。此微型雙穩態元件由三個部分構成，分別為具形狀記憶之液晶離子凝膠雙穩態結構、液晶彈性體致動器，以及薄膜加熱器。此元件中液晶彈性體於使用電熱致動導致彎曲，同時藉由液晶離子凝膠之形狀記憶特性，當液晶彈性體形變後可對液晶離子凝膠施以外力致使其同樣彎曲形變。待液晶離子凝膠完成形狀記憶行為後，即便沒有受到液晶彈性體之外力，仍能穩定維持其記憶之外形。若再度對液晶離子凝膠加熱，便能回復至初始形狀。該微型雙穩態元件只需通過固定電壓，即可驅動液晶彈性體和液晶離子凝膠實現雙穩態。此外，此元件已成功利用了雙穩態達成不需供電與外力介入仍能夠持續夾持物體之能力，也具備將持續夾持之物體放置之能力，更透過量測液晶離子凝膠之穩態電阻值可判斷元件所處狀態。

優勢:

利用微機電製程技術將軟性致動器微型化，可以實現更精密的應用，同時也減少對環境的損害以及影響。由於單向形狀記憶效應，離子凝膠夾爪具有大變形的雙穩態，能夠在不消耗能量的情況下停留在任一位置，因此能在不消耗任何電力的情況下抓取並長時間穩定地握住重金屬物體。此外，此微型離子凝膠夾爪也可用作感測材料，以無感測器方式檢測其所處狀態。

競爭產品:

各式微型夾爪。

專利現況:

(1)本技術已有相關專利（中華民國專利申請號:XXXX；美國專利證號: XXX)。
(2)本研究團隊具有數十年研究經驗…
(3)其他…

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Miniaturized Ionogel-based Bi-stable Actuator

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Experience:

Various soft gripping devices have been developed using soft actuators, with advantages such as grasping compliance, light weight, low cost, low motion noise, and suitable stiffness for mimicking biological movements. Assembling or embedding an external sensor into a soft actuator usually increases the complexity of the system, which is undesirable for miniaturized devices.

Market Needs:

The development of miniaturized soft actuators, primarily made of highly compliant, deformable materials, has expanded rapidly in recent years due to their enormous potential in various fields, such as soft robotics, flexible machines, medical devices, and other emerging fields. Gripping actions are the most essential robotic functions and are required for a wide range of applications, including part picking, device assembly, product packaging, and surgery.

Our Technology:

A miniaturized soft actuator with state-sensing and bi-stable capabilities was demonstrated. Two such actuators were assembled into a miniaturized bi-stable gripper, and various measurements were taken to characterize the gripper's behaviors. The actuator consisted of an LCE cantilever with a thin-film heater and an ionogel finger. The LCE cantilever served as the actuating material for deforming the ionogel finger, while the heater layer was used to induce deformation of the LCE cantilever. The LCE cantilever was actuated when heated by the heater layer, subsequently causing the ionogel finger's deformation. The ionogel finger exhibited bistability with large forces and functioned as a strain-sensing material to detect its states.

Strength:

Due to the one-way shape memory effect, the ionogel finger possesses bistability with large deformations, and is capable of staying in either position without consuming energy. The gripper could grasp and stably hold heavy metal objects without consuming any power because of its bistability. In addition, the ionogel finger also functions as a sensing material for detecting its state in a sensorless fashion.

Competing Products:

Various miniaturized gripper.

Intellectual Properties:

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