Precision control of movement in robots

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A research team from the Department of Electricity and Electronics at the University of the Basque Country's Faculty of Science and Technology in Leioa, Spain, led by Victor Etxebarria, is investigating the characteristics of various types of materials for their use in the generation and measurement of precise movements.

When the arms of a robot move to pick up an egg or an electric lamp, the greatest precision possible is essential. To this end, advances in the science and technology of materials have provided the design and control of systems equipped with sensors and actuators built with new materials.

The Automation Group at the Department of Electricity and Electronics of the Faculty of Science and Technology at the Leioa campus of the University of the Basque Country (UPV-EHU) is studying the stimulus-response characteristics of various kinds of materials to be used in the generation and measurement of precise movements in electromechanical systems in miniature and in robotics.

The studies focused on two types of materials in concrete, and which had promising characteristics for micropositionng applications: shape-memory alloys (SMA) and magnetic shape memory (MSM) alloys or ferromagnetic shape memory alloys (FSMA). All these smart alloys are new materials, catalogued as intelligent for their ability to memorise shape and other novel properties.

Shape-memory alloys are capable of remembering their original size and shape despite having undergone a deformation process. The most

common alloy amongst these is that generically known as nitinol, given that it is made of almost 50% nickel and almost 50% titanium. It is on the market and is sold in the form of wire.

Magnetic shape memory alloys are ferromagnetic materials capable of withstanding large transformations that are reversible both in shape and size when a magnetic field is applied to them. They do not exist as yet commercially and are currently only made in research laboratories.

The team built a number of potentially useful devices for robotics, using these shape memory materials, and investigated new applications fundamentally aimed at light or miniaturised electromechanical systems.

Laboratory prototypes

The use of SMA as actuators in low-precision applications is not something particularly novel. However, the researchers at the UPV/EHU have developed some experimental devices that radically improve the control of positioning of these actuators. Thanks to this, they have built a prototype of a lightweight gripping claw device for a flexible robot of small dimensions, capable of handling small objects. To achieve this, they placed nitinol wire between two elastic metal sheets in such a way that, when an electric current is applied to the wire, the sheets contract and the “claw” completely closes, gripping small objects around it. With the current switched off, the claws open completely. Nevertheless, the UPV/EHU team has managed to enhance the opening-closing movement, to the point of precision of within a micron. This level of precision is sufficient for many applications, for example in machine tooling.

As regards magnetic and ferromagnetic shape memory alloys, the UPV/EHU researchers designed a device which had a precision of positioning objects to within 20 nanometres. Being a handmade device

with a simple control, the researchers do not doubt that it can be improved. Moreover, it could be a serious candidate to substitute current high precision devices, given that positioning devices manufactured with ferromagnetic shape memory alloys have the great advantage that, once suitably positioned, they do not consume energy. The use of FSMA actuators could become highly important in certain applications, for example, in large-dimension telescopes that have a great number of mirrors that have to move with great precision in order to focus correctly.

All these devices, currently at a laboratory stage, are useful for testing the basic characteristics of the materials, but perhaps in the future they could be end-product commercial prototypes for robotic devices and in micro and nanopositioning.

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