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Micro-robotics get a grip

As robotics get smaller, a new challenge emerges – how to design a 'gripper' in miniature and actuate it remotely.

The problem is particularly pronounced in medical robotics, such as eye surgery, where very small access ports are needed. In the eye, for instance, if the access trocar can be 23-gauge (0.65mm) or smaller there is no need for suturing and only topical anaesthesia is required.

A recent paper by a team at the Max-Planck Institute for Intelligent Systems describes the use of capillary forces to grip and manipulate objects in an aqueous environment. In their demonstration, a sub-millimetre robot is remotely manipulated using external magnetic fields. The device uses a protruding air bubble to grab hold of objects using capillary action. The bubble is actuated by controlling the pressure of the aqueous medium, lowering the pressure extends the bubble, whilst increasing it retracts it from the gripped object.

With the dimensions and materials used in the Max-Plank example, pressures of ~100 mbar are required. The gripper force is highest for hydrophobic surfaces, but also works for hydrophilic surfaces with a contact angle >30degrees. However at this low value other forces on the object may become comparable to the gripping force and cause the object to slip.

Whilst the Max-Planck example combined the capillary gripping technique with a untethered robot, it might also be combined with conventional tools to manipulate implanted sensors, drug delivery devices or structures in the eye. However, there would clearly be challenges to the technique such as whether it can grip at a lower pressure swing (intraocular pressure is typically around 20 mBar) and whether the vitreous humour provides appropriate capillary forces or whether the vitreous humour would first need to be removed by vitrectomy.

Sagentia Ltd ¬
T. +44 1223 875200

Sagentia Inc ¬
T. +1 617 896 0213

info@sagentia.com
www.sagentia.com