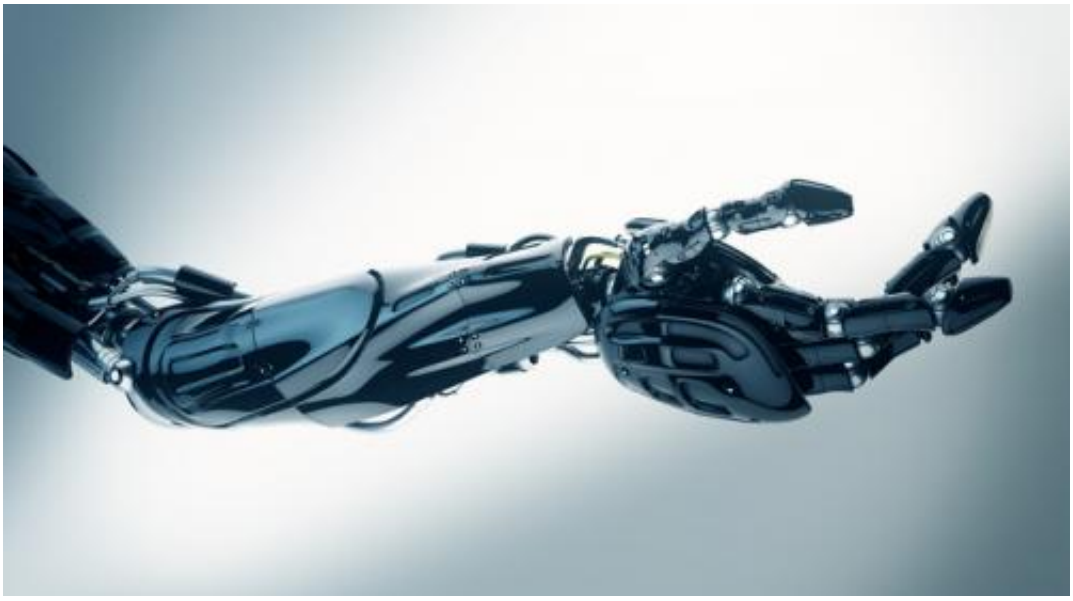
Bionic power trousers could be a more comfortable way to independent living

March 12 2015, by Jonathan Rossiter



Definitely the wrong trousers, too much chafe. Colin Hurst, CC BY Soft robotics will be more natural than conventional hard bionics. Credit: Ociacia

The word "bionic" conjures up images of science fiction fantasies. But in fact bionic systems – the joining of engineering and robotics with biology (the human body) – are becoming a reality here and now.

Getting older and less steady on your feet? You need a bionic exoskeleton. Having difficulty climbing those stairs? Try a pair of bionic power trousers. The biggest challenge for making these bionic systems ubiquitous is the huge range of situations we want to use them in, and the

great variation in human behaviours and human bodies. At the moment there is simply no one-size-fits-all solution.

So, the key to our bionic future is adaptability: we need to make bionic devices that adapt to our environments and to us. To do this we need to combine three important technologies: sensing, computation and actuation.

Sensing can be achieved by using sensors which directly record brain, nerve and muscle activity, and by using on-body devices such as accelerometers which indirectly measure the movement of our limbs. Computers then link this information with models of human behaviour – often tailored to personal information about how the user moves – and predict the movements that the user is about to initiate. In the final stage, the computer systems use these predictions to divert energy to a set of power actuators. This actuation step provides the needed assistance and support, continually adapting to our changing bodies and the changing environment.

At present, most bionic assist devices are made from rigid materials such as metals and plastics, and are driven by conventional motors and gearboxes. These technologies are well established but their hardness and rigidity can be a great disadvantage. In nature, soft materials such as muscles and skin predominate, and as humans we find comfort in soft materials, such as holding hands or sitting on a sofa.

Soft robotics for bionic bell-bottoms

New "soft robotic" technologies are emerging which have the potential to overcome the limitations of conventional rigid bionics. These systems, as their name suggests, employ soft and compliant materials that work more naturally with the human body. Instead of rigid metals and plastics, they use elastic materials, rubbers and gels. Instead of motors and

gearboxes, they're driven by smart materials that bend, twist and pull when stimulated, for example by electricity.

These smart materials can mimic the contractions of biological muscles, and are often termed "artificial muscles". With these advances we are now in a position to create radically new adaptive bionic devices for assistance and rehabilitation, including the smart bionic trousers.

The Engineering and Physical Sciences Research Council recently announced £5.3m investment into research targeted at the next generation of adaptive bionic devices. This includes funding for the development of soft robotic smart trousers that will help disabled and elderly people to maintain their mobility and independence.

The goal of the smart trousers project – a major collaboration between the Universities of Bristol, Leeds, Nottingham, Southampton, Strathclyde, Loughborough, and the West of England – is to demonstrate the feasibility of fully autonomous smart clothing. The smart trousers would be able to monitor the wearer's intentions and give automatic power assistance when needed, for example when getting up from a chair or when climbing stairs.

Of course, this is more than just a technology exercise. The soft robotic clothing will need to be comfortable, easy to put on, hygienic and stylish. These are important considerations that need the direct input of the end users and this project will consult closely, throughout its duration, with the target end users and clinical experts.

The future of smart trousers may lie in even tighter integration with the human body. By implanting sensors under the skin that monitor nerve signals directly, even more precise information about the user's intentions can be measured. This will enable future devices to have a much more natural relationship with the wearer.

The potential of this approach has been shown in the recent work by the Medical University of Vienna, where three patients with serious hand injuries volunteered to have their hands amputated and replaced with functional prosthetic hands controlled by their own nerve signals. They were then able to perform more sophisticated manipulations with everyday objects then they were before the transplants.

These exciting new technologies look to herald a new era of soft robotic wearable bionic devices for assistance and rehabilitation which work in harmony with, and adapt to, our frail human bodies.

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