Engineering and Physical Sciences Research Council

Expanding the Frontiers of Physical Intervention: Case Study

‘Soft’ robotics set to offer robust solutions to patients’ needs

Less rigid and uncomfortable, more in harmony with the human body: a brand new breed of wearable and implantable medical devices aims to redefine the way we aid mobility and function.

Meeting the Grand Challenge:

Linked to a suite of specific EPSRC-funded projects, an EPSRC Fellowship at the University of Bristol focusing on soft robotic technologies[1] has provided the platform to broaden the boundaries of medical devices which interface with living tissue. Setting new standards in flexibility, biocompatibility and customisability, devices incorporating soft rather than conventional ‘hard’ robotics are helping to rewrite the rulebook on physical interventions in healthcare.

Vision and Value:

Robotics technologies offer extraordinary scope to transform lives by replacing or supplementing people’s own capabilities. But many patients recuperating from illness, injury, or surgery, or dealing with ageing or disability, are deterred from using exoskeletons and other devices designed to assist movement, function and balance. Unwelcome side-effects, such as sores caused by the way devices put pressure on the skin, are a big barrier to uptake and regular use.

What if such devices – whether worn outside the body or incorporated into it – could be made of less hard, less harsh materials? What if, inspired by and working with the body’s biology, they could bend, twist, shrink or stretch safely and easily when stimulated electrically or chemically? This is the enthralling vision underpinning the work at Bristol.

Key Components:

Supported by £1 million of EPSRC funding and due to end in 2021, the six-year Fellowship has enabled fundamental work in this pioneering field, plus development of components that can become the building blocks for bigger devices; it has also been a springboard for a range of complementary EPSRC-funded projects led by Bristol. With partners including seven other UK universities and the Royal National Throat, Nose and Ear Hospital, this overall portfolio is combining the expertise of engineers, clinicians, physiotherapists and designers, augmented by consultation with end-users, to open up this new front in healthcare.

Covering both wearable and implantable technologies, the focus is not simply on aiding mobility. Boosting blood circulation to avoid deep-vein thrombosis and tackling breathing and eating problems caused by disfunction of the larynx are just two of the many other areas where devices incorporating soft robotics could make a key contribution. With development of new soft, smart, reactive materials to the fore, and working down to the nanoscale, the goal is to produce solutions that combine efficacy, practicality, and comfort.

Image credit: University of Bristol

[1] Soft Robotic Technologies for Next-generation Bio-integrative Medical Devices. Grant number: EP/M020460/1

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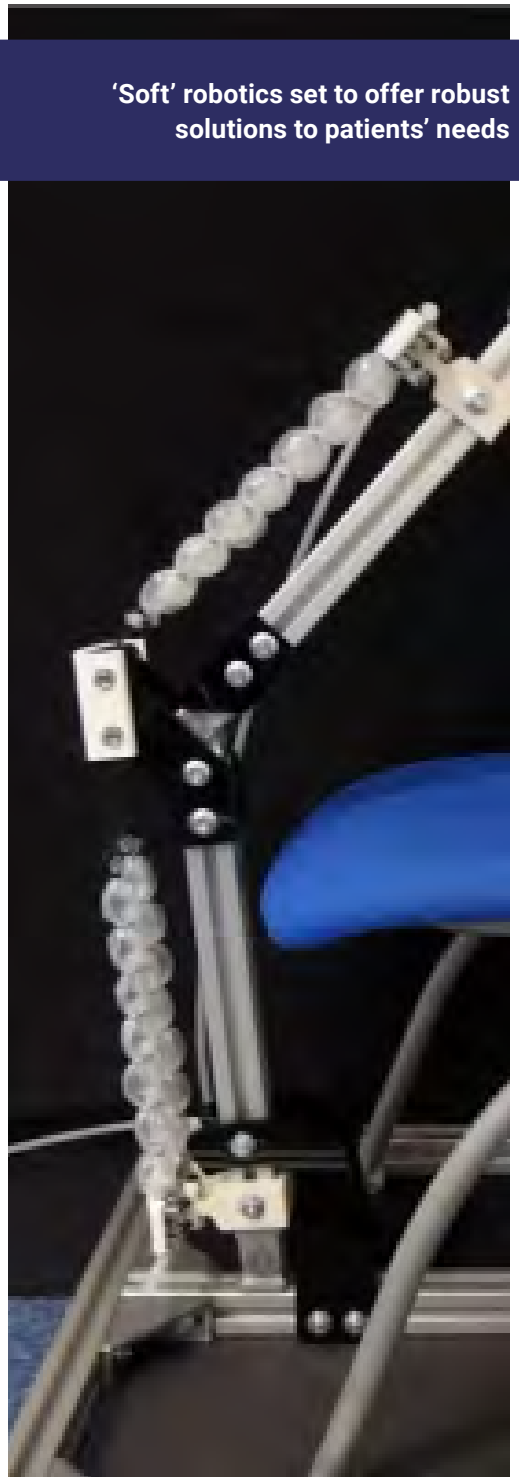

Image credit: University of Bristol

Outputs and Outcomes:

- A range of soft robotic technologies specifically designed for use in wearable and implantable medical devices have been developed successfully.
- For example, the ‘Right Trousers’ project has produced ‘power trousers’ incorporating artificial muscles in their soft fabrics to help the wearer walk for longer, avoid falls and get out of a chair, with the core technology patented and licensing agreements being explored.
- The foundations of understanding are now in place on how the engineering components contained in implantable soft robotic devices can interface with human biology.
- The Bristol team estimates that its wearable and implantable technologies have the potential to achieve real-world application in 5-10 years and 15-20 years, respectively.
- The work of the university and its partners has secured considerable media coverage from outlets including the BBC, the Financial Times and the CBS network in the US.

Impacts and Benefits:

- **Lives transformed: physical health.** By restoring mobility and functionality, soft robotic devices can help prevent the need for hospital treatment and enable people to live in their own homes for longer.
- **Lives transformed: mental health.** By increasing independence, boosting confidence and enabling people to stay active, the devices will have a positive effect on stress, anxiety and depression, while wearables could also potentially incorporate communications capabilities that help reduce loneliness.
- **Less pressure on healthcare services.** Reduced need for hospital treatment and home visits will help cut healthcare costs and demands on staff.
- **Growth and jobs.** This field offers a big opportunity for the UK to build on its world-leadership in off-the-shelf consumer devices, while the potential benefits of soft robotic medical devices also extend to avoidance of and recovery from work-related injuries – cutting levels of sick leave and helping people remain productive for longer.

Next Steps:

The coming years will see the first of the wearable devices advance to the pre-clinical stage, and demonstration of the fundamental practicality of implantable soft robotic devices. Ongoing EPSRC-funded projects based at Bristol include FREEHAB (developing soft, wearable rehabilitation devices) and emPOWER (developing implantable artificial muscular assistance)[2]. The Wellcome Trust’s Robovox project is taking forward research carried out under the Fellowship on using soft robotics to restore the voice, breathing and swallowing.

Behind the Project:

Professor Jonathan Rossiter received the EPSRC Fellowship award. Key colleagues in his work on medical devices include Dr Ailie Turton of the University of the West of England and Professor Martin Birchall of UCL.

“By underpinning the development of core technologies and providing the flexibility to explore the bigger picture, the Fellowship has provided the foundation for a hugely exciting portfolio of research,” Jonathan says.

“Effective physical interventions will always be at the heart of healthcare. The emphasis must now be on developing innovative devices that offer increasing capabilities and that people actually want to use.”

£6.4Bn:

the size of the UK medical device market (2015 figure)

Relevant EPSRC Research Areas:

- Robotics
- Biomaterials and Tissue Engineering
- Assistive Technologies, Rehabilitation and Musculoskeletal Biomechanics

[2] Grant numbers: EP/S026096/1 (FREEHAB) and EP/T020792/1 (emPOWER)