Need: Stroke is the highest cause of adult disability. Seventeen million strokes occur every year worldwide - one stroke every two seconds. Half of all stroke survivors lose the ability to perform everyday tasks using their upper limbs, which affects their independence. The UK societal cost is nine billion pounds per year.

Solution: Intensive movement practice can restore upper limb function lost following stroke. However, stroke patients often have little or no movement, so are unable to practise. Functional electrical stimulation (FES) activates muscles artificially to facilitate task practice and improve patients’ movement.

Novelty: Current commercial FES devices use large electrodes which only stimulate a limited number of muscles, resulting in simple, imprecise, movements. Our work demonstrates the use of bespoke screen printable pastes to print electrode arrays directly on to everyday clothing fabrics. The resulting garments are integrated with cutting-edge sensor technologies and advanced control algorithms that adjust the stimulation based on past experience. Successful operation has been demonstrated by stimulating an optimised selection of electrodes in order to achieve different postures and assist performance of daily activities.

Competitive advantages: Comfortable to wear; Easy to use; Unobtrusive.

Fabrication and testing results

Fabrication process

E-textile FES array sample

Material biocompatibility test

<table>
<thead>
<tr>
<th>Material</th>
<th>Score</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encapsulation</td>
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<td>pass</td>
</tr>
<tr>
<td>Carbon/Rubber</td>
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<td>pass</td>
</tr>
</tbody>
</table>


Muscle stimulation results

E-textile assisting daily activities

Repositioning object

Closing drawer

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Summary

• The feasibility of manufacturing e-textile electrode arrays using printing technology has been demonstrated.
• The materials used have had biocompatibility confirmed using ISO 10993-5 cytotoxicity test results.
• Tests have shown that the electrode arrays can provide effective assistance of movement.
• Our MRC project will translate this technology from the feasibility stage to a functional prototype able to deliver a practical, comfortable, high performance solution for cost effective rehabilitation.