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Parametric Study on Bundled Shape Memory Alloy Coils for Application in Active Compression Garment
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Abstract
Compression garments have numerous applications from clinical interventions, cosmetic, to aeronautics. Traditional compression garments, though beneficial, often lack dynamic control and therefore efforts have been made to make it active and controllable. Integrating smart materials like shape memory alloy (SMA) coil as actuators is advantageous due to its high force-to-weight ratio, and ease of control. For this, the behavior of the bundled SMA coil actuator needs to be well-understood for optimal design of the active compression garment (ACG). This work focused on parametric investigation of bundled SMA coils by evaluating the amount of counter-pressure developed in single-layer parallel configuration. Mathematical modelling conducted shows that SMA coil with lower spring index and larger wire-diameter is more favorable for higher pressure generation. In this study, 9 different configurations are studied using coils with wire diameter of 0.381mm (C = 5.7) and 0.75mm (C=7.7), and with different lengths. Experimentally, the trend shows that higher quantity of actuators will generate more pressure, which means generation of force is more dominant i.e. the amount of tension increases as number of actuators increases, and this tension is distributed over the same surface area covered by the garment. It is also found that the setup with 0.75 mm-wire-diameter, 6 cm-length, and five coils in parallel showed the most significant counter-pressure produced, peaking at 86 mmHg from a baseline of 52 mmHg. This net gain of 34 mmHg falls within the recommended therapeutic range of 30-60 mmHg for limb compression in medical application. Further improvement requires friction reduction for enhanced responsiveness. Results from this study provide valuable insight into optimizing the design of SMA-based ACG, potentially leading to improved therapeutic applications. © 2024 IEEE.

Author Keywords
active compression garment; actuator; pressure; shape memory alloy

Index Keywords
Compaction, Friction, Hosiery manufacture, Mercury amalgams; Active compression garment, Clinical interventions, Counter pressure, Dynamic controls, Memory alloy, Optimal design, Parametric study, Shape-memory, Weight ratios, Wire diameter; Shape-memory alloy

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