# WEAVING MOVEMENTS

*Textile Actuators based on Electromechanically Active Conducting Polymers*

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The defence will take place in M506 at The University of Borås, Sweden and on Zoom.

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# Abstract

Textile actuators are an exciting new area of smart textiles in which otherwise stationary fabrics can be made to move and interact with their surroundings. Being novel, the fundamental knowledge of what factors affect fabric actuation behaviour is sparse. This thesis explores the concept of woven actuators. This includes experimental studies of fabric assembly and creating an electric connectivity infrastructure through the inclusion of conductive yarns. Furthermore, the ideas of fabrics exhibiting multiple areas of actuation and dual actuating-sensing functionalities, implications for long-term use, and the application of woven actuators in a haptic context were explored.

Woven actuators were made by integrating three-layered tape yarns (TYs) containing conducting polymers, either PEDOT:PSS or polypyrrole which were paired with ionic liquids for actuation in air. TYs and woven actuators were characterised through their displacement and blocking force behaviour and relevant weaving parameters were investigated. The experimental work showed that woven actuators can transfer the displacement of TYs into fabric movement and displayed additive, linear, correlation between blocking force and the number of integrated TYs. However, the relationship between weaving parameters, especially warp density, and actuation behaviour is more complex and needs to be further explored. The integration of TYs in multiple woven areas yield fabrics that exhibit an interconnected actuation displacement profile, which is important and exciting for the future development of complex movement patterns as well as using textile processes as a new way of manufacturing soft robotics. Yet, more extensive investigations into the long-term use of CP-based textile actuators are necessary for reliable systems in the future.

This thesis shows that textile actuators, with their inherent softness, exhibit potential for the creation of soft robotic, haptic, and wearable applications. It also makes a significant contribution by consolidating the current state-of-the-art in yarn-based fabric actuation, identifying and clarifying key terminology. The culmination of the thesis was the development of a theoretical framework for woven actuation and influential factors. This framework highlights the complexities involved in predicting woven actuator behaviour and not only supports understanding of woven actuators as a concept but also serves as a foundational reference to guide future research and stimulate new paths in the exploration of textile-based actuation.



Keywords

Textile actuators, woven actuators, weaving, conducting polymers, electromechanically active polymers, soft actuators, soft robotics, haptic wearables.