

Chapter 86

Applications of Mechatronics in Textiles and Clothing Industries

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ABSTRACT

This article focuses on the transformative potential of mechatronics in up-to-date textiles and clothing industries, with a special focus on its implications for automation, efficiency in production, and product quality. Supported in the mechatronic systems by the sensors and control elements, precise textile production with almost no defects and an improved uniformity property is achieved. To adapt to it, mechatronics makes design changes easily and quickly, to quickly satisfy consumers' spending. Furthermore, mechatronics reduces costs and waste while saving resources in hand with enhancing fabric inspection with new sensor technology. The chapter underscores four key applications—intelligent textile systems, automated manufacturing, smart clothing and wearables, testing and analysis of textiles and clothing—supported by relevant examples from authors' studies.

INTRODUCTION

The modern textile and clothing sectors operate based on technical progress, sustainability, and individualisation along with ethically oriented transparent production. These characteristics reflect the need to adjust emerging consumer preferences, environmental awareness and the mutable character of backdrop fashion and textile markets.

Mechatronics is one of the most employable technologies in the sector. It provides relevancy to the textile and clothing industry for several compelling reasons. To begin with, mechatronics enables the automation of several processes in textile production like spinning, weaving, knitting, cutting, and sewing (Jindal & Kaur 2021; Elnashar 2022). Automation reduces manual operations, increases the speed of production, and guarantees quality (Laužikas et al., 2021). This results in improved efficiency and cost-effectiveness.

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The mechatronic systems include sensors and control elements that guarantee high accuracy in textile production (Nguyen et al., 2023). This leads to better quality assurance, lower defect rates and improved product uniformity important in the textile and clothing industries where high-quality product is required (Alonso-Muñoz et al. 2022).

Customization and quick design adaptations are also quite common in the sector. Mechatronics provides the freedom to adapt according to different product specifications (Laužikas et al., 2021). Thus, it is possible for textile and apparel producers to easily meet consumer/customer needs in a timely manner.

Mechatronic systems help create smart textiles and novel fabrics embedding electronics, sensing elements, and functional materials (Younes 2023). These advanced products exhibit unique characteristics like self-heating (Abedi et al., 2023), moisture management (Lao et al., 2020), and interactive abilities, which help new applications and even markets to develop.

It is important to mention that mechatronics helps reduce production costs in the textile and clothing industries because it allows for optimizing different processes (Laužikas et al., 2021). At the same time, it decreases waste (Venditti & Ramasubramanian, 2007), and improves resource utilisation (Younes, 2023). Mechatronics is also a tool for maintaining high quality in textile production (Stylios et al., 1995). The fabric inspection systems provided with sensors and computer vision technology can detect defects like stains and irregularities in woven or knitted fabrics that cannot be detected by human inspectors (Rasheed et al., 2020). Therefore, cost reduction is paired with the overall product quality increase, which plays a vital role in today's competitive market.

Using mechatronics, textile companies can also optimize energy consumption (Martikkala et al., 2023): those with smart control systems can adjust processes to limit energy loss and reduce environmental damage. This may result in more sustainable and green production procedures.

With mechatronics, textile manufacturers would be able to stay relevant and overtake their competitors regarding the latest trends. It enables them to provide cutting-edge solutions and keep the production quality at a high level (Isermann, 2008; Schmidt et al., 2021). As mechatronics may play a role in specialized textiles and clothing (Shang et al., 2018), it could enable the use of high-end or personalised products, that would meet niche market needs (Schmidt, Schitter & Rankers, 2020).

This chapter presents the key uses of mechatronics in the textile and clothing sectors. The role of mechatronics is introduced in four key areas of textile and clothing industries, namely Intelligent textile systems, Automated manufacturing, Smart clothing and wearables and Testing and analysis of textiles and clothing. Carefully selected examples, built mainly on the authors' original studies, are also presented.

INTELLIGENT TEXTILE SYSTEMS

General Overview

Intelligent textile systems (ITS) are a clever mix of classical types of woven, knitted and non-woven fabrics with up-to-date technology. It leads to the rise of groundbreaking items that help achieve modern smart life. Textiles which include innovative technologies are recognised as ITS, smart textiles or intelligent textiles. In any case, the outcome is textile products and wearables offering disruptive engagement with the surroundings (Libanori et al., 2022). They react to various stimuli; this makes them

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