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Article

Intellectualization Of Sewing Machinery Management Processes Taking Into Account Technological Similarities

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Abstract: In the garment manufacturing sector, effective control of sewing machines plays a crucial role in achieving higher productivity, enhancing product quality, and maintaining overall operational efficiency. This study also examines the working principles of sewing equipment, approaches to optimizing technological processes, improving workforce productivity, and promoting energy-saving practices. In addition, modern hardware and software solutions for machine control, their real-world implementation, and their significance within production systems are explored. The discussion emphasizes the benefits of digitalizing technological operations and adopting management approaches aligned with the Industry 4.0 paradigm. Furthermore, the research offers scientific, theoretical, and practical recommendations focused on advancing production processes in the sewing industry, upgrading management frameworks, and supporting the manufacture of competitive products.

Keywords: Sewing machines, control process, intelligent control system, technological similarity, automation, production efficiency, product quality and digital transformation.

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Introduction

Sewing refers to the process of joining fabric or other flexible materials using a needle and thread. It is considered one of the earliest techniques associated with textiles. Even before humans mastered the skill of fabric production, they had already developed sewing practices. The survival of early human societies largely depended on sewing, as it allowed people to create clothing and protect themselves from harsh environmental conditions. The needle - whether made from bone, silver, bronze, steel, or other materials - has maintained a similar basic structure throughout history: a slender shaft with a pointed tip on one end and an eye on the other for holding the thread. This straightforward yet effective design represented a significant advancement over earlier sharp tools, such as bones or sticks, which were used to puncture holes through which thread or laces were later passed[1-5].

The precise origin of sewing as a technique for joining materials is difficult to determine. Nevertheless, historical findings from different civilizations indicate the use of sewing tools for producing garments from natural materials like leather. The needle played a central role in the early development of sewing. Evidence dating back to the Palaeolithic era shows that early needles were crafted from bone, while threads were made from plant fibres, such as tree bark, or from animal sinew. This combination of basic sewing components was used to connect materials, and its fundamental concept continues to be reflected in modern sewing machines today[5-9].

In the course of human civilization's progress, ancient Egyptians developed the technique of producing yarn with the help of spinning wheels approximately 5,000 years ago. Archaeological findings from ancient Egypt also reveal that garments were decorated with embroidery. Sewing techniques continued to advance during the middle Ages, and in the Renaissance period, sewing became a highly valued skill, while finely stitched clothing was regarded as a sign of wealth and social status[10-12].

Metodology.

The modern era of sewing machines began during the Industrial Revolution. Prior to this period, sewing was a labour-intensive and time-consuming activity, with garment production often taking several days. Creating or repairing clothing required considerable effort and was mainly carried out by women. Producing a single piece of clothing could take a long time, and purchasing ready-made fabric from shops was considered a luxury that most people could not afford[13-14].

Result.

The history of the sewing machine's invention is intertwined with controversy. During the Industrial Revolution, numerous inventors sought to ease the labour of sewing by developing mechanical sewing devices. Translating centuries of accumulated sewing knowledge into a mechanical apparatus was a breakthrough that fundamentally changed economies and the societal role of women, while also exerting a profound influence on the global clothing industry, which today exceeds 1.5 trillion USD in value[15].

Picture.1. History of sewing machine.

The intellectualization of sewing machinery management processes taking into account technological similarities represents a modern and highly relevant direction in the development of industrial automation. In contemporary textile and garment manufacturing, the increasing complexity of production systems requires more adaptive, efficient, and intelligent control mechanisms. Traditional control approaches, which rely heavily on fixed algorithms and manual adjustments, are no longer sufficient to meet the demands of flexible

production, customization, and high productivity. Therefore, integrating intelligent systems into sewing machinery management has become a critical necessity.

Technological similarities play a crucial role in optimizing and unifying control processes across different types of sewing machines and operations. Despite the diversity of sewing equipment—such as lockstitch machines, overlock machines, and embroidery systems—many of their operational principles, mechanical structures, and control parameters exhibit significant similarities. These include stitch formation mechanisms, thread tension regulation, fabric feeding systems, and motor control strategies. By identifying and formalizing these similarities, it becomes possible to develop generalized control models that can be applied across multiple machine types, reducing the need for highly specialized configurations. The intellectualization process involves the application of advanced technologies such as artificial intelligence, machine learning, sensor systems, and data analytics. Intelligent control systems can monitor key performance indicators in real time, including stitch quality, thread consumption, machine speed, and vibration levels. Based on this data, the system can automatically adjust parameters to maintain optimal performance and prevent defects. For example, machine learning algorithms can learn from historical data to predict potential faults or inefficiencies, enabling predictive maintenance and reducing downtime.

Picture.2. Intellectualization of sewing machinery management processes taking into account technological similarities.

Another important aspect is the use of similarity-based clustering and classification techniques. By grouping sewing operations and machine states according to their technological similarities, intelligent systems can quickly identify patterns and apply appropriate control strategies. This approach significantly enhances decision-making speed and accuracy, especially in complex production environments where multiple machines operate simultaneously under varying conditions. It also facilitates the development of modular and scalable control architectures, where new machines or processes can be integrated with minimal effort.

Discussion.

Moreover, the implementation of digital twins and simulation models further enhances the intellectualization of sewing machinery management. A digital twin is a virtual

representation of a physical machine or process, which allows engineers to simulate different scenarios, test control strategies, and optimize performance without interrupting actual production. When combined with similarity-based models, digital twins can provide deeper insights into system behaviour and support continuous improvement.

Conclusion.

Human-machine interaction is also improved through intelligent interfaces and decision support systems. Operators are provided with real-time recommendations, visual analytics, and automated alerts, which reduce the cognitive load and minimize human error. This is particularly important in sewing production, where precision and consistency are essential for product quality. In addition, the intellectualization of sewing machinery contributes to energy efficiency and sustainability. Intelligent systems can optimize energy consumption by adjusting machine operation based on workload and production requirements. They can also reduce material waste by ensuring consistent stitch quality and minimizing defects. The intellectualization of sewing machinery management processes based on technological similarities offers significant advantages in terms of efficiency, flexibility, quality, and sustainability. By leveraging artificial intelligence, data-driven methods, and unified control models, manufacturers can transform traditional sewing operations into smart, adaptive systems capable of meeting the challenges of modern industry. This approach not only enhances production performance but also lays the foundation for the development of fully integrated smart factories in the textile sector.

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