

Fabricating the Future: AI in the World of Textiles

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ABSTRACT

Textile manufacturing industry is labour-intensive. This is characterized by high-fixed capital investment, a wide range of product designs and, hence, input materials, variable production volumes, high competitiveness, and often high demand on product quality. To cater these demands, the labour-intensive processes should be converted into automated processes accomplished by the use of computers, models, digital components, and artificial intelligence (AI). The textile industry, a cornerstone of global manufacturing, is undergoing a transformative shift driven by advancements in artificial intelligence (AI). AI is the field of study that deals with the synthesis and analysis of computational agents that act intelligently. Integrating AI into textile manufacturing is not only enhancing operational efficiency but also fostering sustainability, a critical need in an era of increasing environmental consciousness. Various applications of AI in textile and garment manufacturing industry include different types of AI such as expert systems, neural network, fuzzy logic, genetic algorithm, and other approaches.

Keywords: Artificial intelligence, Defect identification, Pattern inspection, Colour matching

INTRODUCTION

Artificial Intelligence (AI) is bringing in a new era of innovation and operational efficiency by rapidly transforming the textile business. As technology progresses, artificial intelligence (AI) is playing a pivotal role in revolutionizing all stages of textile production, including design, manufacturing, quality assurance, and customer service. This integration improves sustainability and inventiveness in the industry while streamlining operations. This investigation will reveal several significant ways artificial intelligence (AI) is influencing the textile sector. Artificial intelligence is becoming an important tool for the processors to enhance quality, increase production, lower operating costs and exercise inhouse control over production amounting to shorter lead times (Welamo, 2021). These examples demonstrate how AI is enhancing and transforming existing procedures and propelling the sector toward a future in which textiles and technology are completely integrated.

Generative Design:

AI aids designers in generating creative ideas, exploring new materials, and predicting fashion trends. This accelerates the design and innovation cycle, keeping textile companies competitive (Anonymous, 2024a). This helps designers to investigate a wider range of options while also quickening the design process.

AI can enable customization and personalization of unique designs on a large scale. Customers can now have garments tailored to their specific measurements and preferences, with AI algorithms ensuring that each piece is crafted to perfection. Resleeve, DALL-E and Autodesk fusion etc. are some AI tools used in this field.

Pattern Making and Sampling:

AI streamlines pattern-making in the textile industry, enabling computerized pattern generation through Computer-Aided Design (CAD) systems. This simplifies the design process and improves precision (Anonymous, 2024b). AI applications are revolutionizing fashion design

by enabling more intuitive and data-driven creation of patterns and fabrics. Tools such as Adobe's Textile Designer utilize AI to analyze vast amounts of trend data collected from fashion shows, online retail platforms, and consumer behavior studies. This analysis helps predict future trends in patterns, colors, and materials with high accuracy, empowering designers to craft collections that align closely with anticipated market demands. This predictive insight significantly shortens the time from design conception to market debut (10 ways AI is being used in the Textile Industry, 2024).

In fact, leading Computer Aided Design (CAD) software providers have developed advanced pattern making software that uses AI to optimize fabric utilization and generate precise patterns, resulting in reduced material waste and improved efficiency. A practical example of AI's impact is seen with companies like Stitch Fix, which employs AI to predict trends and tailor designs to individual customer preferences based on their previous selections and feedback. This personalization enhances customer satisfaction and loyalty by delivering uniquely customized shopping experiences that reflect users' tastes and preferences, showcasing AI's pivotal role in transforming traditional fashion design into a dynamic, customer-centric industry.

Digital Fashion Factories:

Smart manufacturing, enabled by AI, has the potential to revolutionize the entire production process. Smart factories that incorporate AI-driven technologies such as robotics, computer vision, and machine learning can allow manufacturers to optimize production workflows, enhance quality control, and minimize downtime.

In some places, AI-powered robots and machines have started to replace traditional labour-intensive tasks. These advanced systems can work around the clock, significantly enhancing productivity and reducing waste. With AI's ability to learn and improve over time, smart manufacturing is becoming more efficient and precise, resulting in higher quality products.

One interesting example which was possibly too ahead of its time was Adidas' Speedfactory, a (now defunct) pilot project that utilizes AI-powered robots and 3D printing technology to produce customized footwear in record time.

Quality Control:

Historically, spotting defects in textiles relied on the

human eye, often leading to inconsistencies. With AI, defects can be identified more accurately, and the reasons behind these defects can also be analyzed, leading to more effective preventive measures. Currently, the process is expensive, and even after multiple checks, there's a lack of accuracy because of human error (Anonymous, 2024a). AI enhances color management in textiles, ensuring precise tolerances by leveraging historical data from human operators' visual evaluations. This AI-driven approach saves time and enhances color consistency across products (Anonymous, 2024b). Real-time defect and inconsistency detection is possible with advanced inspection systems driven by computer vision and machine learning, guaranteeing that only superior items are delivered to final customers. Online monitoring and process management is being used by most big yarn production enterprises. AI detects defects, scientifically analyses failure rates and adjust control settings to maximize spinning (Sikka *et al.*, 2022).

AI algorithms can use sensor data and maintenance history to forecast when a machine will break down or need maintenance. By addressing any problems before they become serious, manufacturers may save downtime and boost productivity.

In order to do quality checks and inspections, the BMW Group, for instance, uses computerized picture recognition. This efficiently eliminates pseudo-defects, which are deviations from target specifications without any real flaws. They have been able to achieve remarkable levels of manufacturing precision because to their deployment.

Predictive Machine Maintenance:

AI and data analytics provide predictive maintenance, which enables manufacturers to plan maintenance in advance and foresee equipment faults. This method lowers total maintenance costs, increases equipment life, and minimizes downtime.

According to a Deloitte research, predictive maintenance can boost equipment uptime by 10% to 20% and lower maintenance expenses by 20% to 30%.

Optimum Resource Utilization:

AI is essential to the textile and apparel industry's enterprise resource management optimization. Demand forecasting solutions with AI capabilities can more accurately estimate future demand by analyzing market trends, past sales data, and outside variables.

Artificial intelligence (AI) algorithms can optimize energy use, minimize waste, and improve overall operational efficiency by examining production data and finding trends. For instance, Google used its DeepMind AI platform to optimize energy usage in its data centers, resulting in a 40% reduction in cooling costs.

Inventory Management:

Supply chain management can be completely transformed by AI-powered inventory management systems. Manufacturers may avoid stockouts, cut down on excess inventory, and improve their production schedules by using machine learning algorithms to evaluate past sales data and forecast future demand.

In the fashion sector, machine learning algorithms are used to evaluate past sales data, consumer preferences, and trends in order to forecast future demand and modify inventory levels appropriately. This is an example of AI-powered inventory management. AI is used by fast-fashion companies like Zara and H&M to improve inventory control and supply chains.

Fabric Inspection:

The textile industry's accuracy and efficiency are being significantly increased by advanced AI technologies that are transforming the fabric inspection process. Real-time textile analysis is possible with devices like the Uster Quantum 4.0, which are outfitted with high-resolution cameras and advanced AI software. By carefully checking for flaws like misweaves, odd patterns, and color variations, these technologies make sure that only the highest-quality fabrics proceed through the manufacturing process. This degree of accuracy improves product quality and drastically reduces waste. Furthermore, these AI-driven inspections can handle yards of cloth in a matter of minutes, surpassing the pace of human labor. If done by hand, this task would normally take hours. This improves the overall efficiency of industrial operations, lowers labor costs, and speeds up the production cycle.

Conventionally fabric comfort is measured by subjective measurement. However extensive research in Japan has shown that fabric handle can be objectively measured by Kawabata system of fabric evaluation. In this system, textile fabrics are analysed in very broad and wide-ranging groups without any real attempt to develop specific or definite fabric categories. By using ANN textile materials can be classified into recognisable definite clauses in terms of their measured fabric

mechanical and physical properties (Doke and Shanmugam, 2002).

Supply Chain Optimization:

AI is revolutionizing supply chain management, which is essential for managing demand swings and maximizing inventory levels. Artificial intelligence (AI) algorithms are able to estimate future product requests with amazing accuracy by utilizing economic indicators, weather forecasts, and past sales data. Robotic Process Automation (RPA), machine learning, and the Internet of Things (IoT) optimize warehouse management, product separation, and communication, ensuring a seamless flow of materials between merchants and manufacturers. AI also enhances merchandising by enabling data analysis, personalized customer experiences, behavior tracking, and trend prediction (Anonymous, 2024b). By minimizing holding costs, maintaining effective stock levels, and fine-tuning their production schedules, manufacturers may ensure a responsive and lean operation. For example, advanced supply chain analytics that estimate demand and model different market situations are provided by AI solutions such as Llamasoft. Artificial intelligence (AI) encourages improved decision-making and increases operational efficiency, assisting businesses in remaining competitive in quickly evolving markets by proactively (10 ways AI is being used in the Textile Industry, 2024).

Smart Textiles:

The development of smart textiles, which intelligently modify their functionality in response to environmental cues, depends heavily on AI. With the help of AI-driven algorithms, these cutting-edge textiles may change characteristics like color or temperature in reaction to changes in their environment since they are integrated with actuators and sensors. An example of how AI integration improves the interactivity and flexibility of wearable items is The Unseen's color-changing hair dye, which changes hues depending on temperature and humidity (10 ways AI is being used in the Textile Industry, 2024). In the same way, other textile materials can alter their brightness and color for safety in different light settings or their thermal characteristics for maximum comfort depending on the weather. This technology enhances user comfort and safety while opening the door for bold design statements and useful applications, such sun protection apparel that is sensitive to UV rays.

Predictive Maintenance:

In the textile industry, predictive AI maintenance is pivotal for enhancing machinery longevity and operational efficiency. By analyzing sensor data from textile machinery, AI algorithms can forecast potential equipment failures and recommend timely maintenance, preventing costly downtimes and extending the equipment's operational life. Companies like SKF lead in deploying AI-driven solutions that monitor machine health in real-time, analyzing vibrations, temperatures, and other critical parameters. This proactive approach prevents unforeseen production halts and optimizes maintenance schedules, reducing costs and resource use. Such strategies ensure uninterrupted production, higher efficiency, and lower operational costs, fundamentally transforming maintenance practices in the textile industry (10 ways AI is being used in the Textile Industry, 2024).

Personalized Marketing:

AI's ability to go through vast amounts of client data allows businesses to create highly customized marketing campaigns. AI algorithms enable textile manufacturers to cater to individual customer preferences. From design and color choices to sizing and fit, AI-driven customization allows for creating personalized textiles and fashion items, meeting the demands of today's discerning consumers (Anonymous, 2024a).

Companies like Tommy Hilfiger have effectively used this strategy, which used AI to create and distribute personalized ads. Their use of AI in marketing resulted in higher conversion rates and much greater customer engagement. This approach not only makes the shopping experience more relevant and personalized, but it also maximizes marketing resources by precisely targeting customers, which raises the total efficacy of marketing campaigns.

Robotic Automation:

The textile industry is being revolutionized by AI-driven robots like SoftWear Automation's Sewbot, which can cut and stitch cloth with remarkable accuracy and efficiency, among other repetitive and exact operations. These robots, which are outfitted with sophisticated vision systems and artificial intelligence, can handle and sew materials far more quickly than humans. For example, a Sewbot can sew a typical t-shirt in just 22 seconds (10 ways AI is being used in the Textile Industry, 2024). Fast production of in-demand fashion goods without sacrificing

quality is made possible by this notable speedup in production timelines. By reducing the need for expert human labor, these robots also optimize the workforce by freeing up skilled workers for more complicated and creative activities. These artificial intelligence-enhanced robots systems improve the overall sustainability and effectiveness of manufacturing operations by reducing human error and production irregularities.

Waste Reduction:

AI-driven systems are pivotal in reducing waste in the textile industry, a sector historically plagued by high levels of resource inefficiency. By optimizing production processes, minimizing defects, and reducing energy consumption, AI technologies help reduce environmental impact and lower resource usage (Anonymous, 2024a).

Technologies like Lectra's Vector utilize sophisticated algorithms to optimize fabric-cutting patterns. By meticulously analysing the most efficient layout for cutting fabric from patterns, these systems maximize material usage, minimizing offcuts and reducing waste significantly. This is not only economically beneficial but also crucial for environmental sustainability. For example, Lectra's Vector systems can increase fabric utilization by up to 10% compared to traditional cutting methods. This optimization substantially reduces fabric waste, contributing to less landfill waste and decreasing raw material consumption. Additionally, these AI solutions streamline assembly lines, ensuring operations are faster and more eco-friendly. By integrating such technologies, textile manufacturers can uphold more sustainable production practices, crucial in mitigating the industry's environmental footprint.

Enhanced Customer Experience:

AI-powered chatbots and virtual assistants, such as H&M's deployment on Kik and Levi's integration with Amazon Alexa, are revolutionizing the retail experience by giving highly tailored buying recommendations. These systems assess individual user interactions, tastes, and purchasing histories to create product recommendations uniquely for each customer. For instance, H&M's chatbot queries customers about their style preferences and then proposes clothing accordingly, learning from each encounter to better future choices. Similarly, Levi's Alexa skill assists buyers in locating the perfect pair of jeans by asking about fit preferences and past purchases. The technology underpinning these assistants utilizes advanced

machine learning algorithms that increase their accuracy and efficacy with each use. By offering a more personalized shopping experience, these AI innovations increase customer satisfaction and boost brand by creating a more personalized shopping experience, these AI enhancements increase customer satisfaction and boost brand loyalty and sales conversions, demonstrating the potent impact of AI in enhancing consumer engagement in the textile and apparel industry.

Sustainable Practices:

AI plays a crucial role in improving resource efficiency and reducing environmental effect in the textile industry, therefore promoting sustainability. For example, the traditionally resource-intensive dying process is being revolutionized by Alchemie Technology's Endeavour, which uses AI. Using computer fluid dynamics models, the technology optimizes the process to use 85% less chemicals and 95% less water than traditional methods by predicting and controlling the precise amount of water, fixative, and dye required for each type of fabric. This accuracy significantly lowers resource use and wastewater production, which is frequently contaminated with chemicals and dyes that have not been handled. Additionally, the Endeavour system is made to work with a variety of textiles and dyes, guaranteeing its broad industry use. This AI-powered strategy complements global initiatives to lessen industrial water pollution and encourage environmentally friendly production methods, as well as the sustainability objectives of the textile industry.

Conclusion:

In conclusion, artificial intelligence has a wide range of applications in the clothing and textile production sector. Textile industry in developed countries has already started exploiting these techniques to their advantage (Doke and

Shanmugam, 2002). The possibilities are genuinely limitless as we continue to investigate AI's full potential in this sector. AI has a huge and wide-ranging impact on the textile sector, leading to notable advancements in productivity, sustainability, and quality. Through the application of AI to various aspects of production and consumer interaction, the industry is evolving toward smarter manufacturing and more innovative design techniques. These ten AI applications show off textile technology's present capabilities while also suggesting the possibility of much more integration in the future. AI's impact on the textile sector is increasing as it develops, possibly leading to more ground-breaking discoveries and stretching the bounds of what is possible.

REFERENCES

- Anonymous (2024a). Power of Artificial Intelligence in the Textile Industry. Retrieved from <https://www.greyb.com/blog/artificial-intelligence-in-textile-industry/> on 1/08/2024
- Anonymous (2024b). How AI is Leading the Textile Industry to a New Lease on Life?. Retrieved from <https://amt-lab.org/blog/2024/1/how-ai-is-leading-the-textile-industry-to-a-new-lease-on-lifeon> 1/08/2024
- Doke, S.S. and Shanmugam, N. (2002). Artificial Intelligence and its Application in Textiles. *Asian Textile J.*, **11**(07) : 49-54
- Sikka, M.P., Sarkar, A. and Garg, S. (2022). Artificial intelligence (AI) in textile industry operational modernization. *Res. J. Textile & Appl.*, pp. 1560-6074
- 10 ways AI is being used in the Textile Industry [2024] retrieved from 10 ways AI is being used in the Textile Industry [2024] - DigitalDefynd on 05/08/2024
- Welamo, T. (2021). Application of Artificial Intelligence in Textile Industry. *J. Emerging Technologies & Innovative Res.*, **8**(10) : d49-d64.
