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## Digital Interventions in Textile Art -The New Era of Revival

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### ABSTRACT

The digitization of textile art has been one of the most radical changes in creativity and preservation. Textile traditions are being challenged by mass production and a shrinking number of artisanal practices; digital interventions open new paths for artistic innovation and cultural revival. This paper explores how novel technologies such as algorithmic design, blockchain-based authentication, AI-enhanced pattern-making, and interaction with textiles, in the realms of digital media and communication, add new dimensions and challenges to textile art. In more than one aspect, they strengthen artistic expression through sustainability, authentication, and ownership protection. Digital platforms have also opened up access to textile education, and artists and designers can experiment with virtual simulations and digital embroidery. By bridging the gap between traditional craftsmanship and contemporary digital aesthetics, these technologies are redefining how textiles are designed, produced, and experienced in both physical and virtual spaces. This research explores the studies on contemporary textile artists, fashion designers, and cultural institutions using digital interventions to revisit heritage in innovative, boundary-pushing ways. In this manner, it reflects changing relationships between tradition and

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technology and positions digital innovation as a leading agenda-setter for the future of textile art.

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## 1. Introduction-

Textile art has been an important part of cultural identity, the preservation of craftsmanship, and a medium of artistic expression. Throughout civilizations, textiles have not only been functional but also symbolic, religious, and historical.

From the intricate handwoven fabrics of India and the Middle East to the elaborate embroidery traditions of East Asia and Europe, textile artistry reflects regional aesthetics, techniques, and narratives. However, industrialization and globalization have dramatically changed the landscape of textile production and artistry. The shift toward mechanized manufacturing and mass production has led to a decline in traditional handcrafting techniques and put the survival of artisanal communities at risk, making handcrafted textiles less unique. Fast fashion and synthetic material production also bring environmental concerns that further complicate the sustainability of these textile traditions. (Sawant et al., 2023)<sup>i</sup>

These challenges have birthed digital interventions in textile art as a transformational force in preserving, reimagining, and advancing textile traditions. Artificial intelligence, algorithmic design, blockchain authentication, and interactive textiles are some of the technologies transforming the way textiles are designed, produced, and experienced. AI-driven generative design allows for the creation of intricate patterns that blend traditional motifs with contemporary aesthetics, while algorithmic weaving techniques enable precision and complexity beyond human capability. (Ranpura, 2024)<sup>ii</sup> Blockchain technology has been introduced to authenticate handmade textiles, ensuring their originality and protecting artisanal craftsmanship from counterfeiting. Furthermore, the integration of interactive and smart textiles—such as fabrics embedded with sensors, responsive fibers, and digital embroidery—has expanded the artistic and functional possibilities of textile art. (Ornaghi Júnior et al., 2022)<sup>iii</sup>

These technological advancements not only provide tools for innovation but also contribute significantly to sustainability, cultural revival, and new artistic expressions. By optimizing material usage and reducing waste, digital fabrication techniques promote more environmentally responsible textile production. Additionally, digital platforms allow for the documentation, restoration, and global dissemination of endangered textile traditions, fostering cultural appreciation and economic opportunities for artisans. Moreover, contemporary artists and designers are utilizing digital media to push the



boundaries of textile art, creating hybrid forms that merge tradition with modernity. (*Emerging AI Technologies Inspiring the Next Generation of E-Textiles*, 2023)<sup>iv</sup>

## 2. Objectives of this study:

1. To Analyze the impact of digital technologies on traditional textile art.
2. To Examine AI's role in pattern generation, restoration, and customization.
3. To Evaluate blockchain's role in ensuring textile authenticity and ownership.
4. To Explore the sustainability benefits of digital textile interventions.

## 3. Literature review:

1. The article "**Indian Northern Region Old Heritage Hand Embroidery Manufacturing Techniques**" offers a detailed overview of the vibrant embroidery heritage in Northern India, stressing their profound cultural importance and historical background. It discusses methods such as Kashidakari, Chambal Rumal, Phulkari, and Chikankari, underlining their origins, motifs, and artistic styles, which tend to be inspired by nature and sacred texts. These complex handicrafts are not only works of art but also hold a significant economic position, offering jobs to skilled artisans in rural and semi-urban regions. The paper highlights the labor-intensive process of embroidery, where the artistry of work increases the market value of such handicrafts. In addition, it talks about how the traditional method of embroidery has developed with modern trends, making them relevant for the times while retaining cultural identity. This research finally presents the interconnected trinity of embroidery, history, and economy, highlighting the importance of preserving these crafts for future use. (Sawant et al., 2023)<sup>v</sup>

2. The Book Chapter "**Technological Transformation in textile Design**" Discuss the convergence of new technologies like physical computing, 3D fabrication, artificial intelligence and digitization, which have transformed textile design with innovations such as e-textile and customized materials. The COVID - 19 pandemic has sped up digital adoption, substituting virtual simulations for conventional prototyping, with fears of losing of losing hand crafted processes. As Technology improves efficiency, it also undermines the cultural and emotional value of conventional efficiency; it also undermines the cultural and emotional value of conventional textiles, creating questions about identity maintenance. "Collective Intelligence" as a concept proposes a future in which human, technolocal and ecological knowledge are in partnership in designing textiles. Development in bio- fabrication, based on microbiology and nanotechnology, emphasizes a movement towards sustainability, with an environmental focus. Nevertheless, with all the advantages of digitalization, there is no replacing the sensory & tactile nature



of physical textiles, which underscores the perpetual equilibrium between digital & old-fashioned craftsmanship. (Ranpura, 2024)<sup>vi</sup>

3. The article presents a detailed review of developments in e-textiles and smart textile with a focus on the integration of neuromorphic computing and artificial intelligence. The article presents a three-generation path of development for smart textiles from limited electronic integration fully integrated electronic sensing capability. AI, especially spiking neural networks (SNNs) and neuromorphic computing, is leading the way through the imitation of human brain processing, allowing for more intelligent and adaptive textile. In medicine, e-textiles enable real-time monitoring of patients, using predictive analytics for the early identification of anomalies. The paper also delves into the effects of AI on textile production, such as computerized defect inspection and machine learning-based quality inspection. Further, improvements in memristor technology and smart textiles. (*Emerging AI Technologies Inspiring the Next Generation of E-Textiles*, 2023)<sup>vii</sup>

#### 4. Study Progress: The Role of Digital Technologies in Textile Art

Digital interventions in textile art involve several key technological advancements that contribute to innovation and preservation. These include:

##### 3.1 Algorithmic Design

Algorithmic design in textile art makes use of mathematical patterns and computational models to produce intricate and precise textile patterns. With the help of fractals, parametric design, and generative algorithms, designers can produce highly detailed structures that cannot be achieved with handcrafting techniques. The process allows for quick customization, which ensures efficiency and consistency but at the same time provides for unique design variations. It also bridges digital aesthetics with traditional motifs, preserving cultural textile heritage and incorporating contemporary computational elements. (Pagán et al., 2020)<sup>viii</sup>

The sustainability which algorithmic design renders is further enhanced beyond innovation: material use and waste in the generation of textiles are optimized. According to research, digital fabrication techniques combine with sustainability, taking eco-friendly practices toward sustainable fashion and responsible manufacturing. Incorporation of AI-driven generative systems, as well as interactive textiles, pushes the boundaries of artistic and functional possibilities of textiles. The emergence of algorithmic techniques continues to redefine the creative, practical applications of textile design from traditional craftsmanship into a digitalized form, going hand in hand with the age. (Dumitrescu & Motta, 2024)<sup>ix</sup>



### 3.2 AI-Enhanced Pattern-Making

It has revolutionized textile design by providing high-tech tools for the analysis of patterns, trend prediction, and creative exploration. AI-powered systems can process vast datasets of historical textile patterns, which may identify recurring motifs and stylistic elements to generate new designs that maintain cultural authenticity. Through deep learning and neural networks, these tools can recognize intricate details, reconstruct damaged or lost patterns, and seamlessly integrate traditional artistry with modern aesthetics. Such platforms also allow designers to experiment with patterns endlessly as they generate countless variations automatically. They can compose complex patterns that may be unattainable manually, develop complex color schemes, and elaborate textures. It allows for high precision and flexibility in artistic expression as well as efficiency in production.(Liang et al., 2020)<sup>x</sup>

Apart from the design generation, AI contributes towards textile innovation through smart customization and real-time modifications. Machine learning algorithms help in predicting consumer preferences and emerging fashion trends, thus adding a personal touch to textures. AI can also be used to optimize the weaving and printing processes, reduce waste material, and increase the sustainability quotient in production. Furthermore, AI-based digital restoration tools can revive ancient textile patterns by reconstructing faded or damaged designs to ensure their preservation for future generations. Blending tradition with technology, AI is not only transforming the art of textile artistry but also opening up possibilities in sustainable and culturally enriched textile design.(Casini & Rocchetti, 2020)<sup>xi</sup>

### 3.3 Blockchain for Authentication and Ownership Protection

One of the powerful tools that blockchain technology has risen to become is to ensure authenticity and provenance in textile art. Digital records may be embedded onto decentralized blockchain networks to create immutable proof of ownership and originality for textile artists in order to safeguard their intellectual rights. Each textile piece can then be given a unique digital signature or cryptographic token that cannot be counterfeited or replicated. This technology is particularly useful for traditional craftsmanship, which is easily replicated and produced in mass quantity. With the use of blockchain authentication, artists can record the origin, materials, and craftsmanship of their work, giving them a verified lineage that increases its value within the international market.(Luo, 2022)<sup>xii</sup>

Beyond authentication, blockchain facilitates transparency and trust in the textile industry, especially in digital-first marketplaces where buyers and collectors seek assurance of authenticity. Smart contracts self-executing agreements stored on the blockchain enable secure transactions by ensuring that artists receive proper compensation and royalties when their work is sold or resold. Additionally, blockchain-powered supply chain tracking helps verify ethical sourcing, ensuring that textile materials originate from



sustainable and fair-trade sources. This means that, through the implementation of blockchain technology, textile artists and artisans will not only secure their works but also contribute to a more secure, transparent, and ethical marketplace for textile art.(Fallucchi et al., 2021)<sup>xiii</sup>

### **3.4 Interactive and Smart Textiles**

Interactive textiles combine digital interfaces, LED fibers, and sensory-responsive materials to create dynamic and responsive textile artworks. These textiles respond to environmental stimuli such as light, touch, or temperature variations, transforming fabric into an interactive medium for artistic expression. Embedding smart technologies in interactive textiles redefines traditional textile practices by allowing real-time adaptability and immersive experiences. Their applications span from art into fashion, interior decoration, performance art where fabrics change colors and fabrics change patterns as one moves and even perform interactions between stages and actors. The union of digital innovation and textile traditions offers new aesthetics along with broadened functionality for today's designer in contemporary design.(Sowbhagyam, 2024)<sup>xiv</sup>

## **4. Sustainability and Digital Textile Art**

Sustainability is a prime aspect in the development of textile art, with digital interventions providing creative, innovative solutions to diminish the environmental impact. One of the most significant contributions is minimization by avoiding material wastage as digital simulations and AI-driven tools allow designers and artists to visualize or explore pattern combinations, colors' and compositions without having to be implemented physically and allowing for low fabrication and prototype rejection. (Aralova, 2024)<sup>xv</sup>

Another important advantage is the improvement of recycling processes through digital embroidery and fabric printing techniques, which can upcycle old textiles into new artistic and functional pieces, promoting a circular design approach. In addition, eco-friendly production methods such as 3D weaving and automated digital looms are contributing to sustainability by optimizing fabric usage, reducing excess materials, and streamlining manufacturing processes with lower energy and water consumption. The digital advancements integrated into the designers' and artists' workflow will enable them to produce novel textile works while emphasizing environmental responsibility and reducing the ecological footprint of textile production.("The Possibility of Modeling on Mannequin Using Liquid Fabric to Develop Fashion Design and Displaying It Using Digital Programs (3D)," 2024)<sup>xvi</sup>



## 5. Discussions

This brings together old-world craftsmanship with contemporary aesthetics; hence, the scope of intervention that digital platforms afford artists and designers to rethink heritage textiles. Through AI-generated patterns, algorithmic weaving, and digital looms, the best contemporary textile artists are integrating the historical heritage of textile art into modern computational design, creating an amalgamation that preserves the narrative of cultures and introduces novel possibilities in artistic practice.

This would see designers like Alexander McQueen push boundaries on digital embroidery, 3D-printed fabrics, blockchain-certified couture, to keep it authentic and sustainable while redrafting the relationship between craftsmanship and technology. Cultural institutions like museums and galleries will come close to embracing digital storytelling, virtual exhibitions, and augmented reality for engagement as they look to make textile heritage more accessible and interactive to audiences who can engage with traditional textiles in an immersive manner. Through these technological developments, textile traditions continue to be developed. Artistic and design practices therefore involve a dynamic dialogue between past and present.

## 6. Conclusion

The adoption of digital technology had transformed textile art in that sense, promoting countless creative endeavors into sustainable actions of artistic proprietorship. Advances were made integrating intelligent tools from high-tech gadgets- AI-driven enhanced pattern making algorithmic designing-blockchain authenticated-to interactive fabrics bringing together heritage arts and latest scientific innovations among skilled artists-designers. The AI-driven technologies develop complex patterns and designs that would have been hard to get through handwork or time-consuming. Algorithmic design introduces a new way of exploration in geometric and organic forms as concerned with textiles. Through blockchain technology, digital textile works are ascertained for authenticity, thus giving a way to protect ownership and prove the provenance of an increasingly digital artifact.

Interactive textiles can respond to environment stimuli such as touch, light, or temperature, which creates a whole other level of expressive potential by adding the tactility of fabric and the dynamism of digital interfaces. This doesn't only retain and celebrate this rich heritage but also lets these traditions evolve with contemporary contexts. The evolution of these digital tools will continue to shape the future of textile art, allowing artists to push boundaries while staying rooted in tradition. This fusion of technology and craftsmanship marks a turning point, where digital interventions do not replace traditional techniques



but rather enhance and expand upon them, providing fresh ways to reinterpret textile heritage for the modern world. Ultimately, this blend of innovation and tradition will lead to a renewed appreciation of textile art, driving its reinvention and ensuring its continued relevance in the future.

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