AUTEX 2022 Conference Proceedings 978-83-66741-75-1

DOI: 10.34658/9788366741751.98

USE OF ARTIFICIAL INTELLIGENCE FOR CREATIVE TEXTILE DESIGNS

Arzu Vuruskan[1] (*), Ozer Can Devecioglu[2], Ender Bulgun[3], Gokhan Mura[4], Turker Ince[5]

[1] Izmir University of Economics, Department of Textile and Fashion Design, Izmir, Turkey
[2] Tampere University, Department of Computing Science, Tampere, Finland
[3] Izmir University of Economics, Department of Textile and Fashion Design, Izmir, Turkey
[4] Izmir University of Economics, Department of Visual Communication Design, Izmir, Turkey
[5] Izmir University of Economics, Department of Electrical and Electronics Engineering, Izmir, Turkey
(*) *Email:* arzuvuruskan@gmail.com

ABSTRACT

Creativity in the design process is not only based on the problem solving ability or the utility of the outcome of the process, but it is also based on producing novel outcomes satisfying aesthetic expectations. Due to the creative aspect of the design process depending on defining and referring to evolving human defined aesthetic values and taste, applying artificial intelligence to textile and apparel design is one of the major challenges. This research aims to explore a new system for creating textile print designs by artificial intelligence methods. A dataset including various patterns such as geometrical shapes, animal figures, flowers and abstract print designs were collected from a textile printing company to be assessed and used to generate new patterns by AI. As a result, original textile print designs were generated by integrating machine learning systems. It is suggested that AI based generative design algorithms have immense potential to create novel textile design samples.

KEYWORDS

Textile design, Artificial intelligence, Textile supply chain, Creativity, Generative adversarial networks.

INTRODUCTION

The application of Artificial Intelligence (AI) has been recognized in the fashion and textile industry at various stages. By considering the operational processes of the apparel industry from concept to consumer, Guo et al. (2011) describes the complete supply chain network with the phases of: (1) apparel design, (2) manufacturing, (3) retailing and (4) supply chain management [1]. As defined by Nayak and Padhye (2018), “AI is the field of study that deals with the synthesis and analysis of computational agents that act intelligently” [2]. Recently, numerous AI techniques have gained more importance by researchers in the apparel industry within all phases of apparel supply chain. However, AI technology in the textile and apparel industry is still in its early stages, with few applications, and the industry still lacks a widespread adoption of AI technologies [3,4]. Amongst all phases in the supply chain, adopting the machine intelligence to textile and apparel design has been one of the major challenges due to the creative nature of design process where human taste is a major concern.

With the support of digital textile technologies, endless opportunities can be created for textile designers. Digital technologies assist designers to transform and edit designs relatively in a simple way. However, the creative perspective still remains as a challenge. Textile patterns can be inspired by a variety of sources, including historical patterns, art works, and visual abstractions of natural forms. Such inspirations provide valuable input for integrating machine intelligence for creative textile designs.

Considering the gap in the literature about the use of AI technologies for textile design, this research aims to investigate the creative perspective of a new method for generating novel textile patterns with the use of a dataset including various textile print designs.

MATERIALS AND METHODS

Generative adversarial networks (GANs) can assist creating new textile designs based on the structure and parameters of the neural network and based on the strategy used in selecting unpaired sets of visual libraries to train the network. The first library set from which the system analyses and learns from the previously existing designs is then transformed into new designs from the styles extracted, analyzed and learned from the second visual library set. Besides, the code content of the GAN algorithm, enabling it to learn generation of novel design decisions based on the previously generated designs, the selection of the unpaired set of training images, visual design samples and the visual styles employed also weigh in producing creative textile designs.

In this research, a dataset consisting of approximately 500 textile designs were collected from a textile printing company. The dataset included various patterns such as geometrical shapes, animal figures, flowers, arty and abstract print designs.

A novel creative textile design methodology, which is based on recently proposed Operational Cycle-GANs is employed in this research. Cycle-Consistent Adversarial Networks (Cycle-GANs) [5] are powerful unsupervised generative models that are used for image-to-image translation/synthesis. Self-Organized Operational Neural Networks (Self-ONNs) [6] were recently shown superiority over well-known Convolutional Networks, on many regression and classification tasks with their non-linear generalized neuron models. To reflect this superiority over generating various creative textile patterns, the convolutional layers of the native GANs are replaced by operational layers of the Self-ONNs.

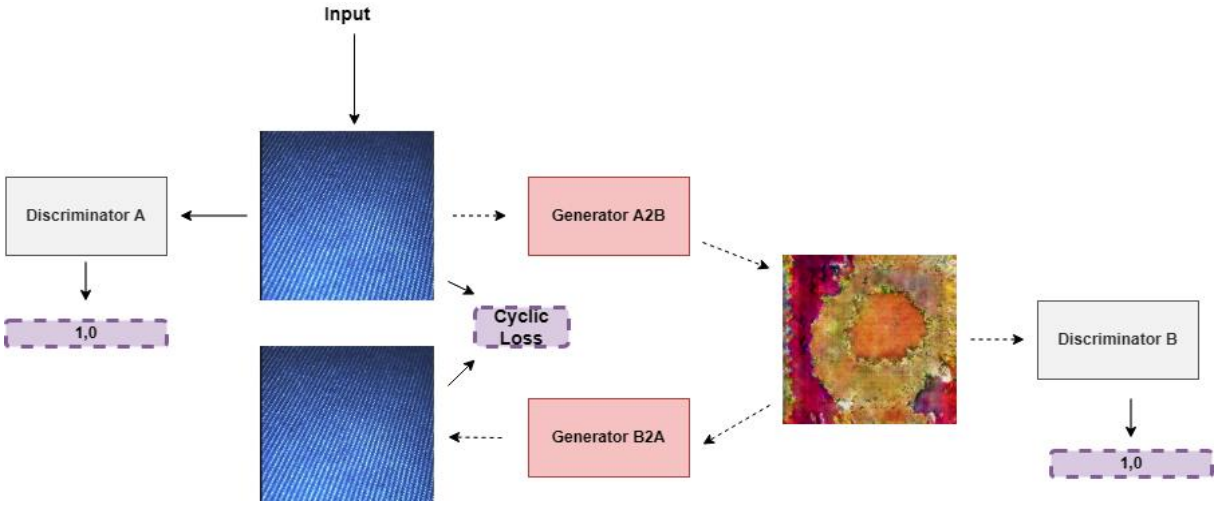

Figure 1. The general framework of the proposed creative textile design scheme.

The general framework of our proposed creative textile design scheme is shown in Figure 1, where operational Cycle-GANs analyze with images of size 256×256. Each color channel (RGB) of the input image is resampled to 256×256 and normalized by linear scaling to the range of [-1,1].

We have selected 432 random texture images and 480 textile pattern images from the Medeiros' clothing pattern dataset [7] to establish the training dataset. Sample images from the training dataset are shown in Figure 2.

The proposed approach consists of two sets of generators and discriminators. While Generator A2B, learns to add textile patterns to the textures, Generator B2A will learn the opposite and will be used to calculate cycle-consistency loss for the preservation of the texture characteristics. Both corresponding discriminators aim to maximize the adversarial loss functions to generate more realistic transformations.

For both generators GA2B and GB2A of Operational GANs, a 10-layer U-Net configuration is used with 5 operational layers and 5 transposed operational with residual connections.

Figure 2. Sample random texture images (bottom) and textile pattern images (top).

The kernel sizes are set as 4 and the stride is set as 2 for both operational and transposed operational layers. Both discriminators consist of 5 operational layers with a kernel size of 4. The stride for layers is set as 2, 2, 2, 1, and 1 respectively. The architectures for the generators and discriminators are shown in Figure 1. For all experiments, we employ a training scheme with a maximum of 1000 BP iterations with batch size 8. The Adam optimizer with the learning rate 10-4 is used for both generators and discriminators. We implemented the proposed architectures using the FastONN library [8] based on Python and PyTorch [9].

The Generator in ML network is supposed to work as an artist in this approach. Consequently, the Discriminator in ML network acts as the person being responsible for the design decisions of generated items. Human intervention is involved in training of ML network (by choosing input image samples, ML network model and training parameters). Therefore, the human defined design and aesthetic values are transferred into this design model at the beginning as the creative source to be learned from. During training, the Generator learns to make the Discriminator think its output image samples belong to the human provided target input patterns (class). This approach assures keeping the initial human defined design identity (from the input patterns) reinterpreted and applied into the newly generated print designs.

RESULTS AND DISCUSSION

The sample results of the proposed creative textile design method (Figure 1) after training with 1000 epochs are given in Figure 3. From the visual (qualitative) evaluation of the results, the capacity of Operational GANs for textile design creativity is judged to be promising, yet to be improved based on the training set and with iterative approaches. Even though the current outcomes lack exact realistic forms, such as the shape of a flower, the uniqueness and the aesthetic specifications prove useful for the purpose of generating print designs in the desired style, especially being appropriate for digital textile printing applications.

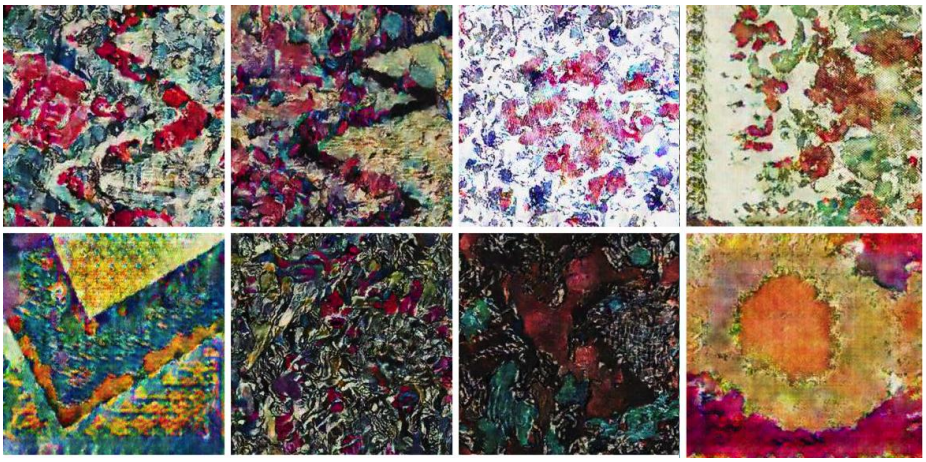

Figure 3. Sample output images generated by the proposed creative textile design method.

CONCLUSION

Considering the increasing use of digital textile design technologies in many fields including fashion, interiors, home textiles, wallpaper and accessories, ingenuity in digital textile technologies has gained importance. Beyond the possibility of the direct contribution of generative adversarial networks in producing high quantities of fashionable patterns for the industry, the ability of AI based generative design algorithms we have covered in this paper have immense potential to create novel design samples. As the newness of the generated design samples are based on deep and continuous learning from the visual datasets and from the desired styles selected by the firm, curating the content of these datasets, the relatedness and the continuity yet the novelty of the design decisions produced in the brand's visual styles create a sustainable creative strategy for the textile company.

ACKNOWLEDGMENT

The authors would like to express appreciation to designers Ebru Saltık and Sümeyye Yıldız from Batı Basma Sanayi A.S. (Izmir, Turkey) and Serhat Karakaya, the head of Research and Development Center of Batı Basma Sanayi A.S. (Izmir, Turkey), for providing the dataset of approximately 500 digital print designs.

REFERENCES

[1] Guo Z.X., Wong W.K., Leung S.Y.S., Li, M., *Applications of artificial intelligence in the apparel industry: A review*, Textile Research Journal 2011, vol. 81, no 18, pp.1871–1892. https://doi.org/10.1177/0040517511411968

[2] Nayak R., Padhye, R., *Artificial intelligence and its application in the apparel industry* [in:] Nayak R., Padhye R. (Eds), *Automation in garment manufacturing* Elsevier, Woodhead, Cambridge 2018, pp.109-138.

[3] Sikka M.P., Sarkar A., Garg S., *Artificial intelligence (AI) in textile industry operational modernization*, Research Journal of Textile and Apparel, 2022), https://doi.org/10.1108/RJTA-04-2021-0046

[4] Giri C., Jain S. Zeng X., Bruniaux P., *A detailed review of artificial intelligence applied in the fashion and apparel Industry*, IEEE Access 2019, vol. 7, 95376-95396, doi: 10.1109/ACCESS.2019.2928979.

[5] Zhu J.Y., Park T., Isola P., Efros A., *Unpaired image-to-image translation using cycle- consistent adversarial networks* [in:] *Proceedings of the IEEE international conference on computer vision* 2017, pp. 2223–2232.

[6] Kiranyaz S., Malik J., Abdallah H. B., Ince T., Iosifidis A., Gabbouj M., *Self-organized operational neural networks with generative neurons*, Neural Networks 2021, vol. 140, pp. 294-308. https://doi.org/10.1016/j.neunet.2021.02.028

[7] Medeiros A.J., Stearns L., Findlater L., Chen C., Froehlich, J. E., *Recognizing clothing colors and visual textures using a finger-mounted camera: An initial investigation* [in:] Association for Computing Machinery, *Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '17)*, New York 2017, pp. 393–394. https://doi.org/10.1145/3132525.3134805

[8] Malik J., Kiranyaz S., Gabbouj M., *FastONN—Python-based opensource GPU implementation for operational neural networks*, online, http://arxiv.org/abs/2006.02267 [access: 4.11.2022]

[9] Paszke A., Gross S., Massa F., Lerer A., Bradbury J., Chanan G., Killeen T., Lin Z., Gimelshein N., Antiga L., Desmaison A., Kopf A., Yang E., DeVito Z., Raison M., Tejani A., Chilamkurthy S., Steiner B., Fang L., Bai J., Chintala S., *PyTorch: An Imperative Style, High-Performance Deep Learning Library* [in:] Curran Associates, Inc., *Advances in Neural Information Processing Systems* 2019, vol. 32, pp. 8024–8035, http://papers.neurips.cc/paper/9015-pytorch-an-imperative-style-high-performance-deep-learning-library.pdf [access: 4.11.2022]