The Art of Machine Learning as Fashion Stylish for Designing Clothes

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***Abstract*—Over the years, designers have come to the fore with their originality and personal styles and have shaped the fashion industry with their designs. However, due to the progress of time, designers have become unable to meet the demands of all consumers. Since it takes a lot of time to produce an original design, the production process progresses slowly, and customers are uncomfortable with this situation. As in many other industries, designers are trying to solve this problem with the help of artificial intelligence, which is indispensable in the fields of commerce, art, and security. It first entered the fashion sector with drawing programs in the 1950s and has started to change the fashion sector since the 2000s. In the 1950s, artificial intelligence was used only to create a virtual drawing environment. When the designer makes a mistake, he can simply erase the mistake and continue working on the design without having to start the whole design from scratch. These programs have greatly facilitated the work of designers. Designers are now able to draw their designs in a much shorter time. But even this shortened period is not enough for the whole fashion industry. Designers could still not keep up with the demands of all customers. Thanks to researchers who added different perspectives to artificial intelligence in the early 2000s with its usage not only for drawing but also for designing, Therefore, in this paper, it is aimed at producing some original designs by preserving the designer's style with the use of AI techniques. With the proposed model, it has become able to produce ready-made designs by using features such as object detection and visual processing. The experimental results showed that AI techniques are very successful for combining different patterns for producing an original fashion style.**

***Index Terms*—Artificial intelligence, Art, Pattern, Design, Technology.**

I. Introduction

In recent years, artificial intelligence (AI) has become an indispensable part of our lives , since it has entered our lives to such a degree, scientists have aimed to use it every application fields. One of these fields is the fashion design sector, which is one of the most important sectors in our lives. In this area, designers and artists are slow and insufficient to meet the demands of consumers. They spend a long time and work hard to produce original designs and works of art.

The decrease in the creativity of the artists and the long duration of inspiration negatively affected the fashion industry. At this point, the artists developed themselves by adapting to the technology and started to use AI to shorten the production times, but the drawing programs they used were not enough. They need programs that produce designs.

The aim of this paper is to develop an AI program that produces new images by combining two different images that will help artists and designers. One of the two different images is called the basic image and the other is called the style image. The base image is considered the main layer and is the layer on which the style image is rendered. Almost lifelike content can be produced with Generative Adversarial Networks (GANs), meaning that the designer does not even spend time drawing sketches. With the help of this program, artists and designers will be able to produce new and original content in a much shorter time with less effort. This situation will affect both artists and designers positively, as well as the fashion design industry and consumers.

A trained model, the VGG-19 model, was used in this project. One of the most important reasons for choosing the VGG-19 model in this project is that it can examine two different images at the same time by processing two different images separately with the layers it has. This shortens the processing time considerably. Generative Adversarial Networks (GAN) algorithm was used for production. After the data is presented to the model, our images are converted into matrices using pixel values. Transformed matrices are processed. Values such as the lengths and widths of the images are calculated. While these processes are taking place, our images lose value. The basic logic of our project starts with finding out at which point the lost values are in the image, when it detects those two different images have lost value at the same point, it overwrites the pixel of the style image at that point on the basic image. This process is repeated for all points, thus combining the two images to form a new image. Google Colab was chosen as the working environment. The reason why Colab is preferred

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is the virtual Graphical Process Unit (GPU) it provides, it significantly increases the overall working speed of the project and saves time. Another important reason for choosing Colab is that since it can easily connect with Google Drive, the data is kept in the drive and not included in the project, thus reducing the project. Since the data used is related to fashion and art, the product will be a new work related to fashion and art.

The success of the project is determined by the quality of the visual it produces. The quality mentioned here is not the quality of the image, but the lines of the image, the compatibility in the merger ratio, the proper fit of the pictures on each other, the correct matching of the value losses found as a result of the calculations. If the visual created by combining two images by the program does not need to be edited by a designer, this project is considered successful, if the created visual needs to be edited by a designer, the project is considered unsuccessful.

The rest of the paper is organized as follows. In Section 2 the background works on this area is detailed, Then, the methodology of the the proposed work is detailed and Experimental Works are depicted in Section 3 and Section 4 respectively.Finally the paper is concluded by showing the future works.

II. Background

In the last few decades, machine learning emerged as a hot topic research area, that can fit any kind of application areas such as computer security, IoT Devices, malware detection, fashion design and etc. [6]–[8]. For the content of fashion, there have been many studies on the merging of AI and fashion design. However, most of them failed or started to produce different results by deviating from their purpose. The reason for this is that visual processing is suitable for use in many different areas. As a result of the researches, similar studies were reached with the project discussed.

A. Existing Systems

Many studies have been done on creating a new image by combining two new images with AI. As shown as in Fig.1 Yuan and Moghaddam tried to use attribute GAN for designing. One of them was tried to produce a new design for chair production [3]. But the chair designs produced were unsuccessful. Another similar study was carried out by Kato and colleagues in 2019. Their project is to try to produce clothes with a new design with AI.

Fig. 1: Garment Design [3]

Another of the studies related to visual processing is the project of repairing damaged walls with the GAN algorithm [20]. In the study, the model is trained with many wall images and it is based on estimating the real state of damaged walls. By detecting the solid parts of the model wall, the model gets information about the type, color and shape of the brick. Then, using this information, it tries to produce the real state of the wall by engraving on the damaged part. Another similar study was conducted by Jun-Yan Zhu and colleagues in 2017 [15]. It aimed to produce a new visual by bringing together the matched pictures. In 2019, Utkarsh Mall, Noah Snavely and their colleagues used the GAN algorithm in a mass production project connected to the supply chain [18]. The program aimed to produce designs suitable for their environment by perceiving their environment from the photos shared by people. Thus, the designs will be started to be produced according to the wishes of the consumer without the need for them.

A project has been developed that aims to produce rapid design by giving up original design in 2020 [9]. By detecting similar clothes, it produces a new outfit by taking certain parts from the two. However, clothes that lost their originality were not demanded much in the fashion industry. This project, which was considered for mass production, did not change anything for consumers. In 2021, a project on fashion design was made using the VGG-19 model [4]. The project performs image processing with the help of GAN algorithm and various formulas. First, it calculates the pixel values of the images, and then transforms these calculated values into a matrix. Then it takes the transpose of these matrices and changes the places of the values. It creates groups by matching the changed values with the values of the other picture. It starts to process on the first image according to the groups formed. Another study on this subject was carried out in 2021 on the combination of art design and AI [22]. Artists have come to the fore with their originality and their own styles over the years. However, in cases where the inspiration period is long or they lose their inspiration, the art industry loses these artists. Both art fans are left with high expectations. At this point, it is aimed to produce new works of art thanks to AI. Trained with the pictures drawn by the artist, the model thoroughly adopts the artist's style. Later, she reshapes two different images given to her in accordance with the style she learned. Thus, the artist has created a work of art that is both suitable for his own style and unique.

In 2021, Zhang Han explained the importance and working logic of the combination of AI and art design [23]. As a result of the combination of AI used in information gathering and art design, new works of art can be created. A painting or photograph is combined with a work of art to produce a new result. This application paves the way for art design. In traditional art design, the inspiration of the designer is limited, but the design combined with AI has an unlimited production capacity. In this way, the designer can produce unique designs without forcing himself too much. While the components such as inspiration, tools to be used, preferred techniques, and design design are all determined by the designer in traditional

art design, situational semantic understanding, data collection by the artist, modeling, processing and design design are done by the computer in art design with AI. It generates random designs using the data collected by the designer.

Ibrahim et.al. explained the GAN algorithm's working principle with an Wall restoration application in 2021 [21]. This application's aim is straighten out the painted walls with predicting the wall's original form. Application contain three learning process. These are brick, mortar and occluded regions respectively. Application's first step GAN algorithm predict the brick's and mortar's type. When it predict the their type firstly perceive the RGB colors after that perceive the shape of bricks. The predict process Works like this: firstly perceive the unpainted brick's shape ,size and color then perceive the mortar's color and type. Then try to give similar output that fit to painted part. If Wall contain more than one painted part the algorithm try to straighten out at the same time. In this situation application Works slowly, because GAN try to predict too many information.

In 2022, Valizadeh and Wolff clarified the convolutional neural network(CNN) [16]. Masha and Sarah use convolution neural network for additive manufacturing. They explain what is additive manufacturing(AM), what is machine learning and what is convolutional neural network and its architecture. Additive manufacturing or 3D printing is designing a n layer data and print it. CNN using deep learning techniques. In application model have shape,color,sıze and extra details. In CNN every neural networks works on different information.Every neural network pooling the data. This situation provide a true prediction ratio. When application try to print a model CNN predict the model's size,color and shape before the user enter information. In this way AM process completed in a short time. According to the literature study, producing different patterns for designers facilitated the designer as it was created in a short time and with low capital thanks to the AI used.

Yan et. al. explained the shortcomings of AI currently used for the traditional fashion industry, and the development of new models to eliminate these shortcomings, and what exactly these models do in 2022 [12]. Traditional models are used to assist designers, but they do not speed up the process as much as they should. While the model is expected to produce a preliminary sketch and determine the texture and yarn dimensions suitable for the produced sketch, the models can only produce a sample sketch. For this reason, the designer has to make the necessary classifications. The new models developed work separately. The first model produces only the sketch, the second model determines the texture suitable for the sketch obtained. The designer, on the other hand, only makes the final checks and drawings. Thus, the design and production process is significantly accelerated. Figure2 shows the overall operation of the GAN-based AI design model.

B. Overall Problems of Existing Systems

The common problem of these previous studies is the wrong algorithm and wrong model selection. Since the models are trained very extensively, the models cannot make detailed

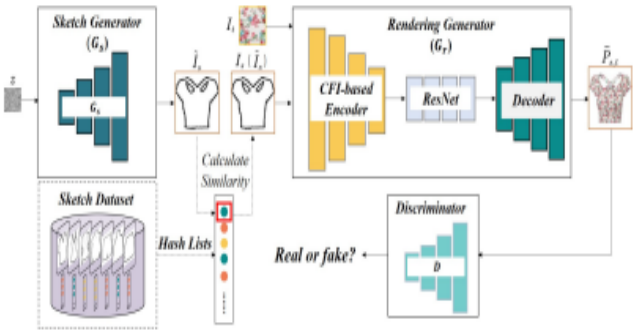


Fig. 2: GAN-based AI design model. [12]

analyzes. For this reason, they make mistakes in many places while processing. The model, which is trained with thousands of murals, tries to predict the intact state of the damaged wall, while trying to make predictions over thousands of options. This causes inaccuracies in the color tone of the brick type. While the developed projects should work with the AttGAN algorithm in general, GAN algorithm is preferred. For this reason, they were insufficient to perceive environmental behaviors.

In the project we have done, visuals in the same style are used for the model to use. This allows the designer to maintain his style and to produce a new design with much less error rate without deviating from the determined style. The outputs created by the projects that have been realized are not at the level to be considered a new design on their own. Outputs that require a designer to go over them again.

III. Proposed System

The project uses two images, a base image and a style image. The process aims to produce a new image by printing the style image on the base image. Pixel losses are experienced in the process, and the loss value method is used to capture these pixels.

A. Overview of the Dataset/Model

The VGG19 model was used in the software we developed. The reason for using this model is that it is successful in extracting the features of the images clearly. Feature selection is a very important problem in data science and not only in static feature vectors [13] but also for image type data it needs to be worked hard [14]. The Vgg-19 model was created in 2015 by the visual geometry group at the University of Oxford and the description of the name is an acronym for their own name. It is a pre-trained model thanks to ImageNet. To explain what ImageNet is, it is a multi-category image database developed for visual object recognition research of hundreds of images. It is open source, available for free to users. Today, it is seen that it comes in Tensorflow and keras frameworks and 80% success is achieved as a result of the competition, and it has a 7.0% classification error rate. As shown in Figure 3, the VGG19 model is a neural network with

a depth of 16 convolution layers, 3 Fully connected layers, 5 MaxPool layers, and 1 SoftMax layer. There are other variants of VGG such as VGG11, VGG16 and others [18].

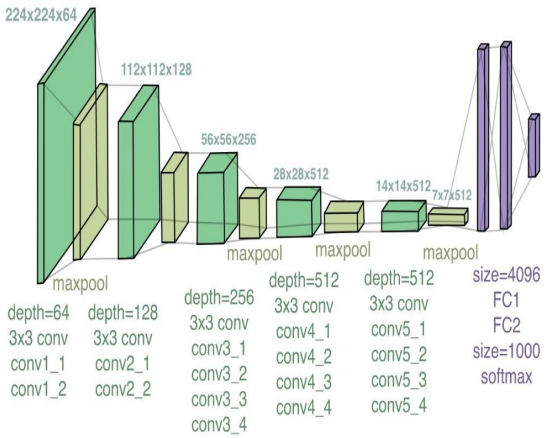


Fig. 3: VGG Architecture

B. Tools and Technology

Tools and technologies used in the software of the project,

- Operating System-Windows: While developing this program, windows were used because it is simple to use and more user-friendly and user-friendly than other systems.
- Programming languages-Python: AI programming languages need to be powerful, scalable and easy to read. Python code meets the mentioned requirements. There are other technology stacks in AI-based projects, but Python has proven to be the best programming language for AI. It provides excellent libraries and frameworks for AI and machine learning (ML).
- Development Environment-Google Colab: Thanks to Google Colab, it allows writing, running and sharing python code without configuration through the browser. It is particularly well suited for machine learning, data analysis, and education.
- Libraries-Numpy: NumPy (Numeric Python) can be used as a math library that allows performing various multidimensional arithmetic operations on arrays. It adds powerful data structures to Python that enable efficient arithmetic using arrays and matrices. Added sequences should be homogeneous.
- PyPlot: Pyplot is a submodule of the matplotlib library for Python and functions for plotting 2D graphs. Creating a shape, creating a drawing area, some lines in a drawing area, etc.
- Seaborn: Seaborn is an open source Python library built on matplotlib. It is used for data visualization and exploratory data analysis.
- Tensorflow: TensorFlow Deep Learning library is used for fast numerical computation developed and published by Google. It is a basic library that can be used to build deep learning models directly or to use wrapper libraries that simplify the process built on top of TensorFlow.
- Pandas: Pandas provides easy handling of lost data. It is a Python package that provides fast, flexible and meaningful data structures by making it easy to work with ”relational” or ”tagged” data in processing and analysis.

In the researches carried out in the approach of the project, it was concluded that ”style” can change according to the environment in which people live and their personal thoughts. The individual differences of the designers are limited in producing new patterns, so the effect of deep learning networks in this area has increased significantly, which has helped in this regard. The fact that style can change independently of people as a result of different trials in new areas has opened new avenues. Since the technologies used in the development phase of the project are open source, it is free for developers and researchers. Legally, there is no copyright issue. The first priority in the requirements of the software is to try on the images of the items used in daily life, the critical point here is to realize that the design on the products we use and see in our lives can be used in more creative and different areas. In this way, anyone who uses the software can make changes according to their own field and use it easily.

If we talk about how to produce an artistic look, it comes up with a smart style algorithm. Style transfer is the practice of recreating the style image as a result of the combination of the base image and the style image. The given base image defines the outlines and the style image will give texture to the final image to be created. The final image is an image that includes the content of the base image and the texture of the style image.

In this section, the working logic of the Neural style transfer will be explained as the basis of the project. It consists of a combination of deep learning methods. It gives output by adjusting according to random input and output in the training of neural networks. Python stores incoming images as RGB, but since the VGG architecture expects 4-dimensional input, the expand_dim function was used to add a virtual dimension to prevent this. Content and style images given as input have been converted to 224x224x3 size as they require VGG architecture.

The converted image will be input to the VGG network via base image and style image. Two loss values will be stored for images given as input. The stored values will be fed into the VGG model. In the multi-layer sensor section of the software, the structure of the network, the number of layers and neurons in the layers, the normalization method of the data, the activation function used in the layers, the learning rate, the momentum coefficient, the number of iterations, the selection of the initial weights were adjusted to give a result picture with the least loss.

The work whose selected style will be used is called the style image, and the image to be converted is called the base image. The picture that is created by transferring the style

picture to the content picture is called the final image created. It was concluded that the backgrounds in Fig.4 were also processed, resulting in an unsuccessful result.

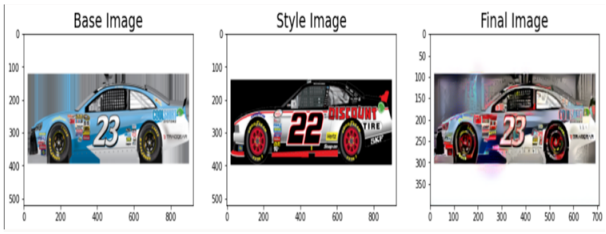


Fig. 4: Designing of Car

The Figure 5, images were chosen because by including edges, points, and every part of the object, changes were seen more clearly in sharp-edged images and for both low and high layer levels. As the importance of the background of the selected Base and Style pictures was noticed in Figure 4, a more successful result was obtained by paying attention to the pictures selected in Fig.5. As a result of the software,

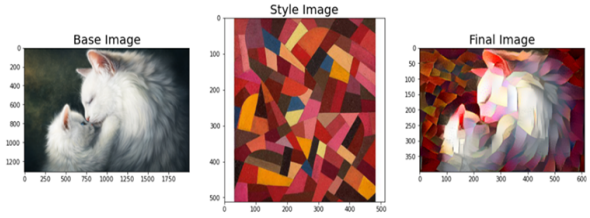
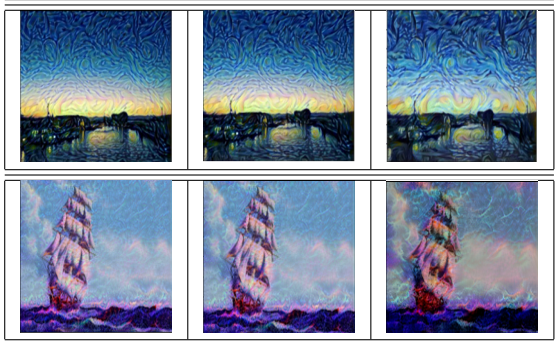


Fig. 5: The Red Cubic Cat

it was concluded that the operations performed when suitable datasets and patterned images of the same size were selected, yielded successful results. Table I shows the importance and success of the number of iterations.

TABLE I: Change of Iteration Numbers.

ITERATION NUMBER		
50	150	350
		

IV. Experimental Results

Our project aims to produce a new image by combining two different images. Thanks to this process, it reduces the burden of designers in the fashion design industry and shortens the production time. The joining process is done with the VGG-19 model. One of the two combined images is called a ”base image” and the second is called a ”still image”. The merging process starts by transforming the pixels of the images into a matrix and taking their transposes. Data loss is experienced while taking Trans poses, this is called loss value. The loss data in the still image and the base image are matched, and the pixels with the same two loss values are replaced so that the visual processing operation is performed. This process is a single iteration. Many iterations are required to obtain a correct result. The number of iterations required varies depending on the content and design of the base image and still image. In order to determine the ideal iteration number, a general iteration number was determined by making multiple trials. When using cubic style images as still images, as shown in Fig.6, 50 iterations were observed to be sufficient. With the increase in the number of iterations and the increase in the processing time, there is no visible change in the ”final image”.

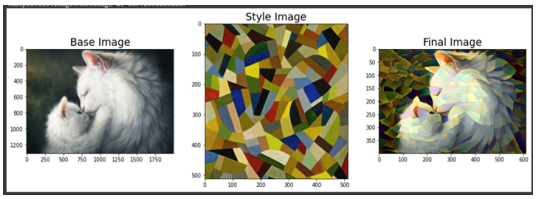


Fig. 6: 50 iterations of the cubic.

The stability of the result created by 50 iterations was confirmed by making other combination examples with the images in the cubic style. As shown in Fig.7, after 50 iterations the style image merges with the base image appropriately.

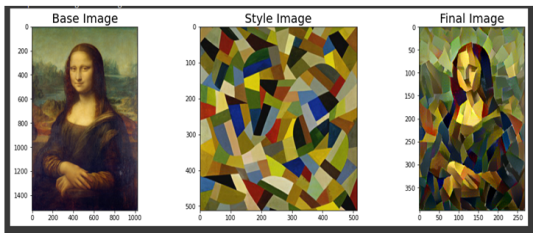


Fig. 7: 50 iterations cubic 2.

The number of iterations has been increased to 100, as higher iterations will result in a higher join rate. If 50 iterations are preferred, the processing time is 6.30 minutes, while if 100 iterations are preferred,the processing time increases to 13 minutes. In cases where the still image is cubic images, the ideal number of iterations has been determined as 50, depending on the variables such as the final image does not change and the processing time is shorter.

It was thought that if an image with more oval lines was chosen as the base image, a different result would be obtained in 100 iterations. As shown in Fig.8, it has been observed that the base image’s sharp or oval lines will not affect the result,

and the cubic style is dominant.

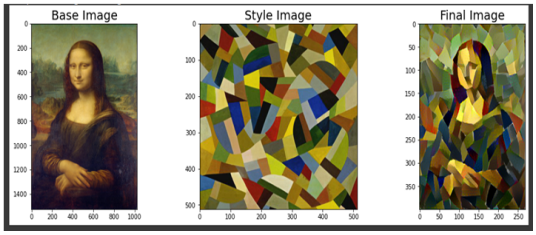


Fig. 8: 100 iterations cubic.

It was observed that 50 iterations were insufficient in the images designed to be printed on t-shirts and similar clothes. The images preferred by the consumers were analyzed and a base image and a style image were selected according to the patterns they liked on their clothes. Depending on the results of the experiments, these two different images were first processed with 50 iterations. However, consumers were not satisfied with the new image. This is because As shown in Fig.9, base image and style image merge rate is very low. For this reason, the number of iterations is increased and reprocessed.

In the second experiment, 150 iterations were tried as the number of iterations. It was thought that a more visual artifact would be obtained by processing the Style image more, but the resulting image was hardly different from the result of the 1st experiment. Very little color difference was observed. For this reason, it was decided that 150 iterations were insufficient and a third experiment was performed.

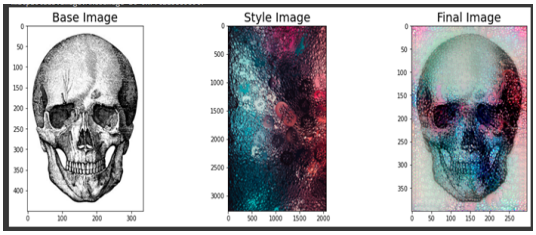


Fig. 9: Skull 150

As shown in Fig.10, 350 iterations were tried as the number of iterations in the third experiment. It could be seen that the resulting image was much more successful than the results of previous experiments. It has been observed that the tones and texture of the colors of the Style image combine very successfully with the base image. In the next step of our project, besides producing new patterns to reduce the time of production and supply chain, it was tested whether it could combine two different clothes. Two t-shirts with high sales rates liked by the people were selected and it was observed how the combination of these two t-shirts would be. The fact that t-shirts have their own printing patterns shortens the production process as follows. The new patterns produced are printed on the t-shirt in a virtual environment and it is checked whether it is suitable for production and production starts depending on the situation. This eliminates virtual assembly and shortens production time. The experiment was initially started with 50 iterations.

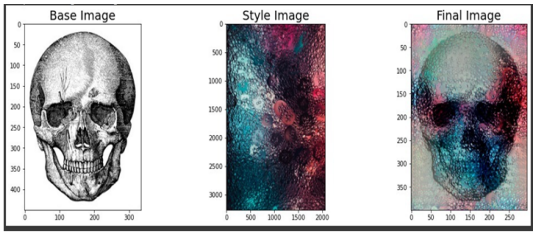


Fig. 10: Skull 350.

As shown in Fig.11, as a result of the first experiment, it was observed that 50 iterations did not have much effect on joining the t-shirts. It is seen that the color of the style image is rendered to the base image to a small degree. However, it is impossible to say a new design for the final image. The print pattern on it is the same as the print pattern of the t-shirt in the base image. It has not been affected by the merging process. The number of iterations has been increased to get more positive results. For the second experiment, 350 iterations were preferred.

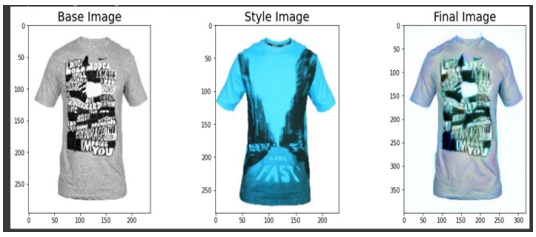


Fig. 11: T-shirt 50.

As shown in Fig.12, As a result of the second experiment, the t-shirt has the color of the style image, although it is different from the base image, but it has a different pattern from the style image in the base image. This proved that 350 iterations were sufficient when combining two different t-shirts.

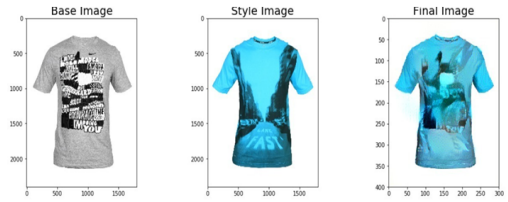


Fig. 12: T-shirt 350.

As a result of the experiments, it was decided that the ideal iteration number of the project was 350 iterations. It was observed that 50 iterations were sufficient in the merging process where the Style image was in cubic style, while 50 iterations were insufficient when using other style images, this result was supported by several different experiments. In general, 350 iterations providing a high success rate were accepted as the ideal iteration.

V. Conclusions

The problem to be solved in this project is that it takes too long for fashion designers and artists to produce a product. Artists and fashion designers need a source of inspiration to produce a product. For this reason, it takes a long time to start production. As a solution, a project has been developed that aims to produce a new product by using the original products of the person by using a model that adopts the style of the artist and the designer. The most common mistake in the project is the processing of some mergers into disproportionate areas. This is because the images are not at the same angle. When combining two products in the same style, for example, the car must be at the same angle in the two car images. Thus, the model automatically ignores the background of the images. If one of the vehicles is at another angle, the model detects it in the background and adds it to the process. The successful operation of the project has a positive impact on the fashion design industry. It increases the production speed and shortens the supply chain time.

The fact that style can change independently of people as a result of different trials in new areas has opened new avenues. It has been concluded that the concept of "style" can change according to what people observe in their environment and can change according to their personal thoughts. Since designers are limited in time and creative new patterns are limited from time to time, the style generation tool that has been opened with the development of technology has become a great need. In the developed system, it is aimed to get more creative outputs apart from the "personal thoughts" of the concept of style. The patterns and shapes output by AI are intended to be a tool to present preliminary ideas to the designer. The priority of our project is to try on items used in daily life and to offer solutions to the designer with different patterns. Users who use the software in different sectors can select, change and easily use their unique base image and texture image.

To increase the quality of the new model, and to increase its originality, some optimization algorithms such as genetic algorithms or similar evolutionary models can be used [24]. With this huge range of the searching capability it is believed to reach very stylish models.

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