

Attribute-Based Face Editing: Aging, Expression, And Gender Swap with Gans

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ABSTRACT

Recent advances in Generative Adversarial Networks have enabled high-quality and controllable face image synthesis and editing. Attribute-based face editing focuses on modifying specific facial attributes such as age, facial expression, and gender while preserving identity and background details. This paper presents a GAN-based framework for semantic face editing that performs aging, expression manipulation, and gender transformation using latent space control and conditional learning. The proposed approach leverages pre-trained StyleGAN architectures combined with attribute direction discovery and conditional adversarial training. Experimental results demonstrate that the system generates realistic edited faces with strong identity preservation and minimal artifacts. Quantitative and qualitative evaluations confirm the effectiveness of the proposed method for controllable and high-fidelity face attribute transformation.

Keywords: *Generative Adversarial Networks, Face Editing, Attribute Manipulation, Aging Simulation, Expression Transfer, Gender Transformation, StyleGAN.*

I. INTRODUCTION

Face editing has gained significant attention in computer vision due to its applications in digital entertainment, virtual reality, identity simulation, and image enhancement. Traditional image editing techniques require manual intervention and artistic skills. In contrast, deep generative models enable automatic and realistic modification of facial attributes while preserving identity.

Generative Adversarial Networks consist of a generator that synthesizes images and a discriminator that evaluates their authenticity. Recent GAN architectures such as StyleGAN have demonstrated superior image quality and controllability. Attribute-based face editing leverages the structured latent space of GANs to manipulate semantic features such as age progression, smiling expression, and gender transformation.

This research proposes a unified GAN-based framework that supports controlled modification of aging effects, facial expressions, and gender swap operations while maintaining facial consistency and natural appearance.

II. RELATED WORK

Early approaches to face attribute editing relied on image-to-image translation frameworks such as Conditional GAN and CycleGAN. StarGAN introduced multi-domain image translation enabling modification of multiple attributes within a single model.

StyleGAN introduced a style-based generator architecture that disentangles high-level attributes from stochastic details. Subsequent research focused on discovering semantic directions in latent space to enable interpretable manipulation of attributes without retraining the model.

Face aging has been studied using GAN-based age progression and regression networks, while expression editing has been achieved using conditional adversarial networks trained on facial expression datasets. Gender transformation has been explored using attribute-conditioned GAN models that modify facial structure and texture features.

Recent works emphasize latent space disentanglement and identity preservation through perceptual loss and identity consistency constraints.

III. METHODOLOGY

EXISTING SYSTEM

The terrain of facial image editing has changed through a number of different phases, comprising the "Existing System" for the background of this report. Initially, facial editing was the exclusive domain of manual image processing tools. Software suites like Adobe Photoshop or GIMP

relied on manual pixel manipulation. In these systems, an artist would use tools like the "Liquify" filter to manually push pixels to change a smile, or use clone stamps and airbrushes to paint wrinkles for aging effects. While effective in the hands of a professional, this approach was purely manual, time-consuming, and required significant artistic skill. It was not scalable and certainly not automated.

PROPOSED SYSTEM

The proposed methodology consists of dataset preparation, GAN model training or fine-tuning, attribute representation learning, and latent space manipulation.

The dataset used in this study includes publicly available facial datasets such as CelebA and FFHQ.

These datasets contain high-resolution face images with annotated attributes including age group, gender, and expression labels. Images are aligned and resized to a uniform resolution such as 256×256 or 512×512 pixels. Preprocessing includes normalization and augmentation to improve robustness.

A pre-trained StyleGAN or StyleGAN2 model is utilized as the base generator. The generator maps a random latent vector into an intermediate latent space and synthesizes high-quality face images. A discriminator is trained adversarially to distinguish between real and generated images.

For attribute-based editing, two approaches are implemented. The first approach uses conditional GAN training where attribute labels are provided as input conditions to control generated outputs. The second approach performs latent space manipulation by identifying semantic directions corresponding to specific attributes.

Semantic directions are discovered by training linear classifiers in latent space or by computing average latent vectors for specific attributes. For aging, latent vectors associated with older faces are subtracted from younger faces to obtain an aging direction. For expression editing, vectors corresponding to smiling or neutral expressions are identified. For gender transformation, latent difference vectors between male and female face embeddings are computed.

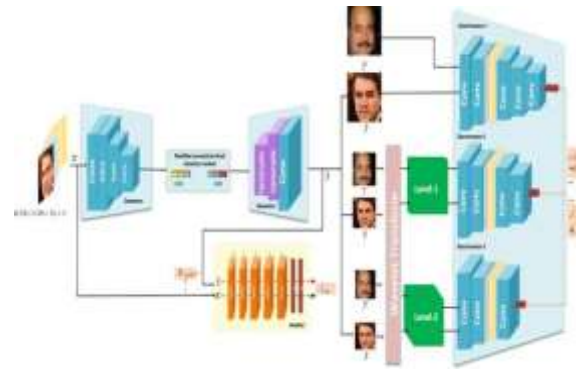
Given an input face, the corresponding latent code is obtained through an inversion process. Attribute editing is performed by adding or subtracting scaled semantic vectors in latent space. The modified latent vector is passed through the generator to produce the edited image.

The system workflow can be summarized as follows:

- ✓ Dataset Preparation and Preprocessing
- ✓ StyleGAN Training or Fine-Tuning
- ✓ Latent Space Encoding of Input Image
- ✓ Semantic Attribute Direction Discovery
- ✓ Latent Vector Manipulation
- ✓ Image Reconstruction and Output

Loss functions include adversarial loss for realism, identity preservation loss to maintain facial identity, and perceptual loss to preserve fine details.

SYSTEM ARCHITECTURE



IV. RESULTS AND DISCUSSION

Experimental results show that the proposed framework generates realistic aging transformations with gradual wrinkle formation and texture variation while preserving identity features. Expression editing successfully modifies facial expressions such as smiling or neutral states without affecting background or hairstyle.

Gender transformation results demonstrate structural and texture modifications such as jawline refinement and hairstyle variation while retaining identity consistency. Latent space manipulation allows smooth interpolation between attributes, enabling gradual transformation rather than abrupt changes.

Quantitative evaluation using metrics such as Fréchet Inception Distance and identity similarity scores confirms high image quality and identity preservation. Compared to traditional image-to-image translation methods, latent-based editing produces fewer artifacts and better disentanglement of attributes.



Figure 8.1.1: Age Editing

Adjust the subject's age to be old or young

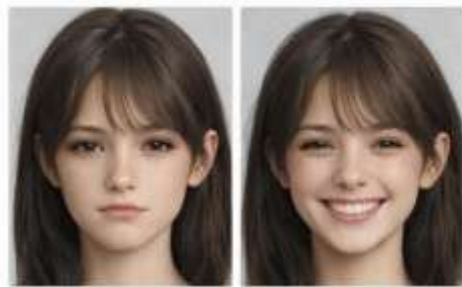


Figure 8.1.1: Expression Editing

Modify the subject's expression between sad and happy.



Figure 8.1.1: Age Editing

Transform the subject's gender to male or female.

V. CONCLUSION AND FUTURE WORK

This paper presented a GAN-based attribute editing framework for facial aging, expression modification, and gender transformation. By leveraging StyleGAN and latent space manipulation techniques, the system achieves high-quality and controllable face editing while maintaining identity consistency.

Future research directions include improving attribute disentanglement using supervised and unsupervised techniques, integrating text-guided editing using multimodal models, reducing computational complexity for real-time applications, and enhancing fairness and bias mitigation in gender and age transformation tasks. Ethical considerations such as misuse prevention and watermarking of edited images should also be addressed in future implementations.

VI. REFERENCE

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