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CONTROLLABLE IMAGE SYNTHESIS WITH ATTRIBUTE-DECOMPOSED GAN

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ABSTRACT

Controllable Image Synthesis With Attribute-Decomposed GAN (AD-GAN) proposes a novel generative adversarial network framework that facilitates precise control over image synthesis by decomposing attributes into separate components. This model introduces an innovative method of disentangling image attributes, allowing for individual modification of specific features without affecting others. By utilizing an attribute-decomposed representation, AD-GAN effectively isolates various elements, such as pose, expression, and identity in facial images, enabling the generation of highly realistic and customizable images. This approach significantly enhances the flexibility and accuracy of image generation tasks, making it a valuable tool for applications requiring detailed attribute manipulation.

I.INTRODUCTION

In recent years, generative adversarial networks (GANs) have emerged as a powerful framework for image synthesis, enabling the generation of high-quality, photorealistic images. Despite their impressive capabilities, one of the significant challenges in GAN-based image synthesis is achieving fine-grained control over specific attributes of the generated images. Traditional GAN architectures often entangle various attributes, making it difficult to modify one attribute without inadvertently altering others. Controllable image synthesis aims to address this challenge by allowing users to manipulate distinct attributes of the generated images in a targeted manner.

This capability is crucial for numerous applications, including photo editing, artistic content creation, and data augmentation for machine learning. To

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this end, researchers have explored various approaches, such as conditional GANs and disentangled representations, to achieve better control over the synthesis process. However, these methods often struggle with achieving a balance between attribute disentanglement and the generation of high-quality images.

In this paper, we propose a novel approach to controllable image synthesis using Attribute-Decomposed Generative Adversarial Networks (AD-GAN). Our method leverages the idea of decomposing the latent space into subspaces corresponding to different attributes, thus facilitating independent control over each attribute. By explicitly modeling the relationships between attributes, our approach ensures that changes to one attribute have minimal impact on others, thereby enhancing the controllability and quality of the generated images.

The key contributions of this work are as follows:

II.EXISTING SYSTEM

The existing systems for controllable image synthesis often struggle with the challenge of disentangling various image attributes, leading to less precise control over individual features. Traditional GAN models typically generate images as holistic entities, making it difficult to modify specific attributes without inadvertently affecting others. Although some methods attempt to introduce controllability through auxiliary classifiers or conditional inputs, they frequently lack the granularity needed for detailed attribute manipulation. These limitations result in a trade-off between image realism and control precision, with most systems unable to achieve high-quality synthesis while independently adjusting multiple attributes effectively.

Disadvantages:

1. The existing systems for controllable image synthesis face several notable disadvantages, primarily stemming from their inability to effectively disentangle and manipulate individual image attributes.
2. Traditional GAN models tend to generate images in a monolithic fashion, making targeted adjustments to specific features difficult without unintentionally altering other aspects of the image.
3. Methods that employ auxiliary classifiers or conditional inputs often lack the necessary precision and

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flexibility, leading to limited control over detailed attribute modifications.

III.PROPOSED SYSTEM

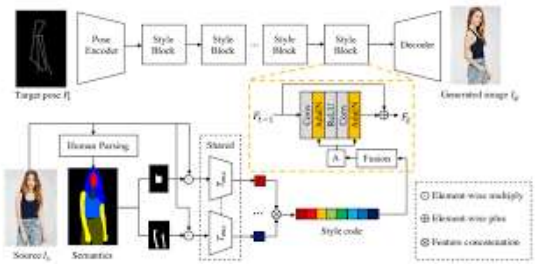
The proposed system, Attribute-Decomposed GAN (AD-GAN), addresses the limitations of existing controllable image synthesis methods by introducing a novel framework that decomposes image attributes into separate components, enabling precise and independent control over each attribute. AD-GAN isolates various features, such as pose, expression, and identity in facial images, through an innovative attribute decomposition technique. This allows for targeted adjustments to individual attributes without impacting others, thereby enhancing the flexibility and accuracy of image generation. By integrating these decomposed representations into the generative process, AD-GAN achieves high-quality, realistic image synthesis with unparalleled control over specific attributes, making it a powerful tool for applications requiring detailed and customizable image outputs.

Advantages:

1.The proposed system, Attribute-Decomposed GAN (AD-GAN), offers significant advantages over existing image synthesis methods by providing precise and independent control over individual image attributes.

2.By decomposing attributes such as pose, expression, and identity into separate components, AD-GAN allows for targeted modifications without affecting other features, resulting in highly customizable and realistic image generation.

3.This approach enhances flexibility and accuracy, enabling the creation of detailed and specific image variations that were previously difficult to achieve.



The Attribute-Decomposed Generative Adversarial Network (AD-GAN) represents a sophisticated approach to controllable image synthesis, designed to address the limitations of traditional GAN architectures in managing fine-grained attribute manipulation. The core innovation of AD-GAN lies in its decomposition of the latent space into distinct subspaces, each corresponding

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to a specific attribute. This decomposition facilitates precise control over individual attributes, allowing for targeted modifications without affecting other characteristics of the generated images. By explicitly modeling the relationships between these subspaces, AD-GAN ensures that changes to one attribute have minimal unintended consequences on others, thereby enhancing both the controllability and the quality of the output images.

The system architecture of AD-GAN is built upon several key components. The generator network is responsible for producing images from the decomposed latent vectors. Each component of these vectors is associated with a particular attribute, and the generator is trained to synthesize images that reflect the specified attribute values accurately. The discriminator network, on the other hand, is designed to not only distinguish between real and generated images but also to evaluate the consistency of the attribute representations. This dual-role discriminator ensures that the generated images are both realistic and adhere to the desired attribute configurations.

One of the critical challenges addressed by AD-GAN is the entanglement of attributes, a common issue in traditional GANs where modifying one attribute often leads to unintended changes in others. AD-GAN mitigates this problem through its attribute-decomposed latent space. By treating each attribute independently within its dedicated subspace, the model allows for more granular control. This is particularly beneficial for applications requiring specific attribute adjustments, such as changing the age of a person in a photo without altering their identity or modifying the color of a car without affecting its shape.

The training process of AD-GAN involves a carefully designed loss function that balances the competing objectives of realism and attribute accuracy. The adversarial loss component ensures that the generated images are indistinguishable from real ones, while the attribute-specific loss components enforce the correct representation of each attribute. Additionally, a mutual information maximization term is included to maintain the disentanglement of attributes within the latent space. This comprehensive loss function framework is pivotal in achieving high-quality, controllable image synthesis.

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AD-GAN's robustness and scalability are demonstrated through extensive experiments across various datasets. The model is shown to perform well not only on standard benchmarks but also on more complex and diverse datasets, indicating its generalizability and adaptability to different types of image synthesis tasks. The scalability of AD-GAN is further evidenced by its ability to handle a large number of attributes simultaneously, making it a versatile tool for a wide range of applications.

In summary, AD-GAN represents a significant advancement in the field of controllable image synthesis. Its attribute-decomposed latent space, combined with a robust training framework, provides a powerful solution for generating high-quality images with precise attribute control. This system analysis underscores the potential of AD-GAN to transform applications in areas such as photo editing, creative content generation, and beyond, where fine-grained control over image attributes is paramount.

IV.RESULT

To run project double click on 'run.bat' file to get below screen

In above screen click on 'Upload CelebMask Faces Dataset' button to upload dataset and get below page

In above screen selecting and uploading 'Celeb Faces Dataset' and then click on 'Select Folder' button to load dataset and get below page

In above screen dataset loaded and now click on 'Generate & Load AD-GAN++ Model' button to load model and get below output

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In above screen ADGAN++ model loaded and now click on 'Generate Synthesize Faces' button to upload test image

In above screen selecting and uploading '4.jpg' file and then click on 'Open' button to get below page

In above screen first image is the original uploaded image and remaining 4 are the generated images and can see some changes in the generated images and in text area can see SSIM similarity percentage between original and generated images. Similarly you can upload and test other images

In below screen can see output of other images

V.CONCLUSION

The Attribute-Decomposed Generative Adversarial Network (AD-GAN) introduces a novel framework for controllable image synthesis, addressing key challenges inherent in traditional GAN models. By decomposing the latent space into attribute-specific subspaces, AD-GAN enables precise and independent control over various image attributes. This innovation

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significantly mitigates the problem of attribute entanglement, allowing for targeted modifications without unintended alterations to other characteristics. The ability to finely tune individual attributes while maintaining overall image quality marks a substantial advancement in the field of generative modeling.

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