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Feature Extraction From Human Image

A Feature-Based CNN Approach

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Abstract:

The rapid evolution of Generative Adversarial Networks (GANs), particularly models such as StyleGAN2, has resulted in the generation of highly realistic synthetic facial images, commonly referred to as deepfakes. These images pose serious threats to digital media authenticity, identity security, and public trust. Traditional deepfake detection techniques primarily depend on visible artifacts and pixel-level inconsistencies, which are increasingly minimized by advanced generative models. This paper presents a passive deepfake detection system that relies on facial biometric and texture-based cues without using physiological signals. The proposed framework analyzes facial landmark consistency, eye-region characteristics, and Local Binary Pattern (LBP) texture features, combined with a deep learning-based visual classifier. A VGG19 Convolutional Neural Network (CNN) is employed to learn discriminative spatial features from facial images and accurately classify them as real or fake. Experimental evaluation on CelebA-HQ and StyleGAN2 datasets demonstrates that the integration of handcrafted facial features with VGG19 significantly improves robustness against visually convincing deepfakes. A Flask-based web interface enables image upload and instant prediction, making the system suitable for res.earch and educational applications.

1.INTRODUCTION

Deepfake technology has witnessed rapid growth with advancements in deep learning and GAN architectures, enabling the synthesis of facial images that closely resemble real human faces. While such technology has beneficial applications in entertainment, animation, and digital media, its misuse has led to serious concerns including identity fraud, impersonation, misinformation, and cybercrime.

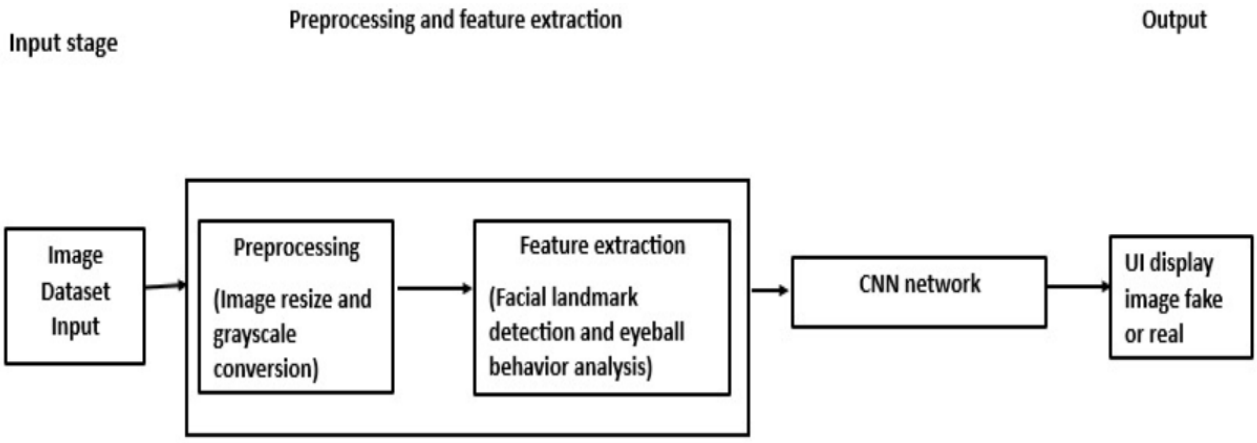
Early deepfake detection methods focused on identifying visual artifacts such as unnatural lighting, blending errors, and distortions around facial boundaries. However, modern GAN-based generators such as StyleGAN2 significantly reduce these artifacts, rendering traditional visual-only detection techniques less effective. As a result, there is an increasing demand for robust detection systems that examine deeper biometric and structural inconsistencies within facial images.

This work proposes a passive deepfake detection approach that focuses on facial geometry, eye-region behavior, and texture-level inconsistencies. By combining handcrafted features such as facial landmarks and Local Binary Patterns with a deep learning-based VGG19 classifier, the proposed system enhances detection accuracy and generalization against high-quality synthetic faces.

2.METHODOLOGY

2.1 SYSTEM ARCHITECTURE

The proposed system follows a structured pipeline consisting of image acquisition, preprocessing, facial feature extraction, VGG19-based classification, and result visualization. The framework operates passively, requiring only a single facial image as input without any user interaction. Both real and fake images undergo identical processing stages to ensure unbiased classification.



2.2 DATASET AND IMAGE PREPROCESSING

The system uses high-resolution datasets such as CelebA-HQ for real facial images and StyleGAN2-generated images for synthetic samples. All images are resized to a fixed resolution of 224×224 pixels to match VGG19 input requirements. Images are converted to grayscale where required for texture extraction, and pixel values are normalized to improve training stability and consistency across samples.

2.3 FACIAL LANDMARK AND EYE-REGION ANALYSIS

Facial landmarks including the eyes, nose, mouth, and jawline are extracted using standard landmark detection algorithms. These landmarks are analyzed to identify geometric inconsistencies, unnatural facial proportions, and asymmetries commonly observed in deepfake images. Eye-region analysis focuses on pupil shape, reflections, and eye symmetry, which are often imperfectly synthesized by GAN-based models.

2.4 LBP TEXTURE FEATURE EXTRACTION

Local Binary Pattern (LBP) texture analysis is applied to grayscale facial images to capture fine-grained texture information. LBP histograms are generated to detect smoothing effects, loss of skin detail, and blending artifacts introduced during image synthesis. These texture descriptors provide important cues for distinguishing real skin patterns from artificially generated textures.

2.5 VGG19-BASED CNN CLASSIFICATION

A pretrained VGG19 Convolutional Neural Network is employed as the core classifier. The network is fine-tuned on the prepared dataset to learn discriminative spatial features related to facial structure and texture inconsistencies. The dataset is divided into training and testing subsets to evaluate generalization performance. The VGG19 model outputs a probability score indicating whether an input facial image is real or fake.

3. PROBLEM STATEMENT

The rapid evolution of Generative Adversarial Networks (GANs), particularly advanced models such as StyleGAN2, has enabled the creation of highly realistic synthetic facial images that are extremely difficult to

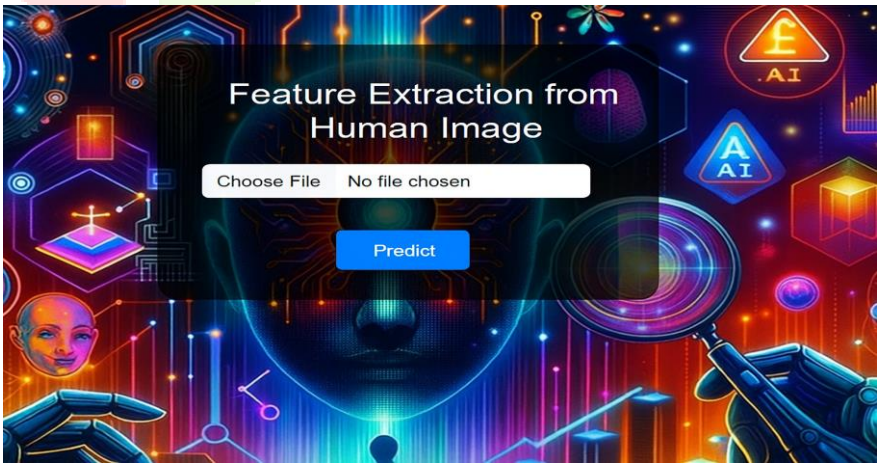
distinguish from genuine images. Traditional deepfake detection techniques rely primarily on visible artifacts, pixel inconsistencies, or shallow visual cues. However, modern generative models are capable of producing images with minimal artifacts, high resolution, and realistic textures, significantly reducing the effectiveness of conventional visual-only detection methods.

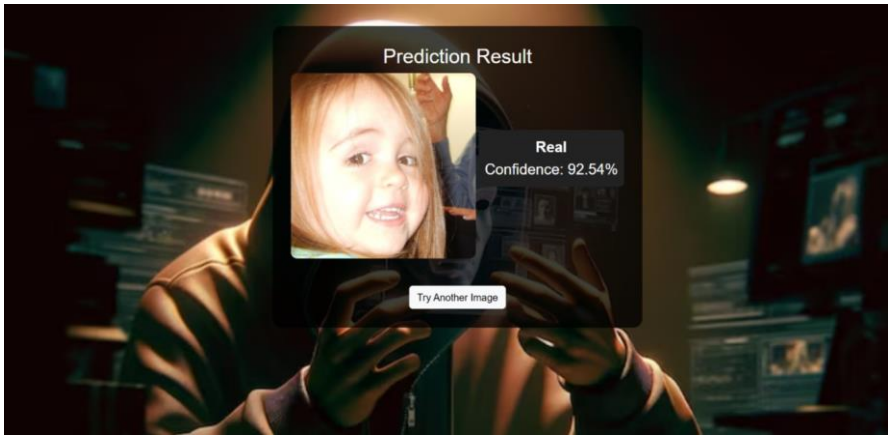
Most existing deepfake detection systems adopt single-modality approaches, such as CNN-based classification alone, which often suffer from poor generalization and vulnerability to unseen fake generation techniques. These systems lack robustness when handling high-quality synthetic faces that closely mimic real facial structure and texture. Therefore, there is a strong need for a passive and reliable deepfake detection framework that integrates facial geometry, eye-region analysis, and texture-based features with a powerful CNN architecture like VGG19 to accurately identify subtle biometric inconsistencies in synthetic facial images.

4. RESULTS AND DISCUSSION

The proposed deepfake detection system was evaluated using real facial images from the CelebA-HQ dataset and synthetic images generated by StyleGAN2. Experimental results demonstrate that combining facial landmark analysis, eye-region features, and Local Binary Pattern (LBP) texture descriptors with a VGG19 Convolutional Neural Network significantly improves classification accuracy compared to approaches relying solely on visual features. The VGG19 model effectively captured high-level spatial patterns, while handcrafted features contributed additional discriminatory information by highlighting subtle inconsistencies in facial structure and texture.

LBP texture analysis proved particularly effective in identifying smoothing effects and loss of fine-grained skin details commonly present in synthetic images. Eye-region analysis further enhanced detection by capturing unnatural pupil shapes and reflection irregularities. The system exhibited strong generalization performance on unseen test samples, demonstrating robustness against visually convincing deepfakes. Overall, the integration of handcrafted features with deep learning resulted in more stable and reliable predictions .





5. CONCLUSION

This study presented a passive deepfake detection framework that combines facial landmark analysis, eye-region characteristics, Local Binary Pattern texture features, and a VGG19-based Convolutional Neural Network to accurately classify real and synthetic facial images. By moving beyond reliance on visible artifacts, the proposed approach focuses on deeper biometric and structural inconsistencies that are difficult for advanced GAN models to replicate.

Experimental results indicate that the integration of handcrafted features with VGG19 significantly enhances detection accuracy and robustness compared to traditional visual-only methods. The proposed system provides a practical and scalable solution for deepfake detection in digital media forensics and educational applications. With future enhancements such as real-time video analysis and multimodal feature integration, the framework can be further extended to address emerging deepfake threats.

6. FUTURE ENHANCEMENTS

Future enhancements of this work will focus on extending the current image-based framework to support real-time video-based deepfake detection. Integrating behavioral and temporal cues such as eye-blink dynamics, frame-level consistency analysis, and liveness indicators can significantly improve detection robustness in live webcam scenarios. Incorporating multimodal inputs will allow the system to better handle advanced deepfake videos that exhibit minimal spatial artifacts but contain temporal inconsistencies.

Additionally, the system can be enhanced by adopting multimodal fusion strategies that combine texture-based features, eye-behavior analysis, and deep learning-based visual classification into a unified decision-making framework. Optimizing the model for real-time performance and deploying lightweight CNN architectures alongside VGG19 can further enable practical applications in identity verification, access control, and anti-spoofing systems. Expanding evaluation to larger and more diverse datasets will also improve generalization and real-world reliability.

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