Use of Generative Artificial Intelligence tools for Image Processing for Facial Recognition Systems

1. Introduction

1.1 Generative artificial intelligence (GEN AI) is a subset of artificial intelligence that uses generative models to produce text, images, videos, or other forms of data. These models learn the underlying patterns and structures of their training data and use them to produce new data based on the input, which can come in the form of natural language prompts.

1.2 Some GEN AI tools can add 'artificial pixel information' to imagery, thus enhancing the apparent quality of images by increasing their resolution.

1.1 Currently there is no known research on the extent of GEN AI tools in the use of Facial Recognition Systems in an investigative context. However, given the compelling nature of the output and the availability of such tools, the purpose of this document is to raise awareness of the risks of using such tools in conjunction with Facial Recognition Systems.

> Note: GEN AI tools, such as ones that offer 'Increased Resolution' during image processing create visually appealing output images, but current OSAC and Facial Identification Scientific Working Group (FISWG) standards state to always use the original image as the basis for a final opinion.

2. Referenced Documents

2.1 *ASTM Standards*:

E2916 Terminology for Digital and Multimedia Evidence Examination[1]

E2825 Standard Guide for Forensic Digital Image Processing

E3445-24 Standard practice for Image Processing to improve automated facial recognition search performance

2.2 Other Standards:

FISWG Image Processing Techniques for Facial Image Comparison[2]

FISWG Standard Practice/Guide for Image Processing to Improve Facial Recognition Search Performance[3]

3. Terminology

3.1 *Definitions:* See ASTM E2916 Terminology for digital and multimedia evidence examination terms.

4. Document Summary

4.1 The document provides an awareness of potential use of GEN AI tools with imagery used in Facial Recognition systems. It summarizes the risks of applying GEN AI Tools to facial images for use in facial recognition systems.

4.2 This document is not intended to provide detailed information on the different forms of GEN AI tools.

4.3 The intended audience of this document is system users, facial examiners, and facial reviewers.

4.4 All facial images used in this document are from the following Internet sources:

- Labeled Faces in the Wild (LFW): http://vis-www.cs.umass.edu/lfw/
- GFPGAN that makes a face photo very beautiful | by MLBoy

5. Background

5.1 There are many different types of GEN AI that can be applied to images. These include but are not limited to; Generative Adversarial Networks (GANs), Super-Resolution GANs, Diffusion models, Variational autoencoders and Wavelet based generative models.

5.2 These have been shown to improve the apparent quality of low-resolution imagery. There are many different versions of GEN AI, all working on trained models. The following is an example of one of these models.

Generative Facial Prior-GAN[4]

Introduced by the author researchers for their paper "Towards Real-World Blind Face Restoration with Generative Facial Prior" by Xintao Wang, Yu Li, Honglun Zhang, and Ying Shan, GFP-GAN is a new GAN architecture designed to upscale the quality of human faces in damaged, aged, and otherwise low resolution photos. In practice, this has an apparently restorative and upscaling effect on the quality of the images and can be used in conjunction with other models to further raise the quality of images.

[1] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@asstm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

[2] https://fiswg.org/fiswg_imag_procssng_tchnqs_for_fac_img_comparison_v1.0_20220617.pdf

[3] https://fiswg.org/fiswg_image_proc_to_improve_fr_search_v2.0_2020.07.17.pdf

[4] https://blog.paperspace.com/restoring-old-photos-using-gfp-gan/

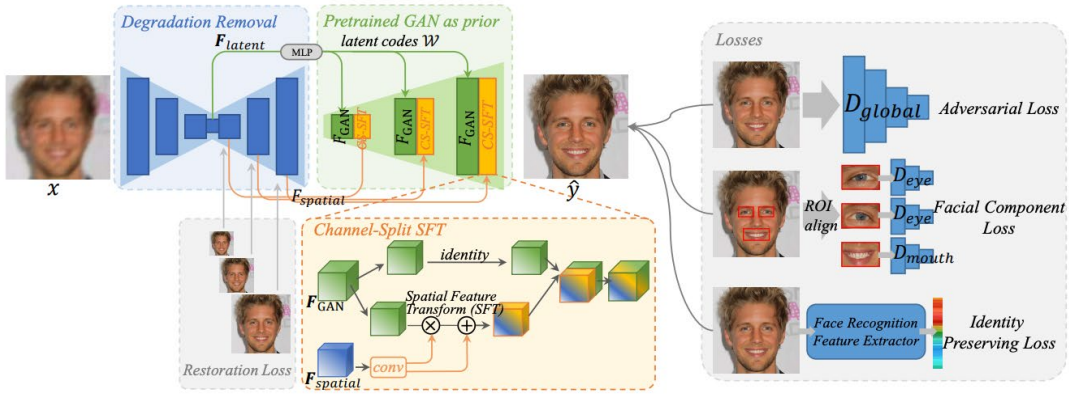


Figure 1: GFP-GAN Architecture

It is critical to realize that the statement of "raising the quality of images" does not imply that the biometric usability of the enhanced images has been improved. While the enhanced image may appear visually appealing to the human eye, its forensic value may be diminished.

5.3 Applying GEN AI tools to 'poor quality' images may result in an output image without artifacts that may appear to be visually better. These can be searched in a facial recognition system. This may result in a true mate appearing in the candidate list, but there are risks, such as returning a false match, associated with such processing.

6. Risks

6.1 GEN AI tools may introduce artifacts; As shown in Fig. 2 a - c, when the degradation of real images is severe, the restored facial details by GFP-GAN are twisted with artifacts[5]. These methods may also produce unnatural results for very large pose deviations. This is because the synthetic degradation and training data distribution differ from those in the real-world.

[5] From reference paper: https://arxiv.org/pdf/2101.04061.pdf

6.2 However, some GEN AI may produce visually appealing results by converting lower quality facial imagery to high quality photo-realistic facial imagery. These may introduce apparent detail that is not reflective of the subject's facial features (Figure 2d). Although visually appealing the resultant image might not correctly reflect the features of the face.

6.3 On low quality imagery the application of Generative AI may in fact reduce the chance of returning a true mate in the candidate list. In Figure 2e, the original CCTV 'input' image was returned against its true mate mugshot image with a low score. However, the upsampled and unblurred output image did not return the true mate in the candidate list. It is clear that the shape of the mouth appears different through over sharpening and both detail and color have been introduced in the area around the eyes and mouth in the output image compared to the input image.

6.4 The application of GEN AI may result in high scoring imposters in the facial recognition search results: The goal of any image processing should be to optimize the image for searching by the FRS, not to create an aesthetically pleasing image. An image that visually appears "good" is not necessarily the same as one that is optimized for use by an FRS due to image processing within the vendor-specific algorithms.

6.5 GEN AI tools will give varying results which are impacted by their training data and therefore may not be representative of, for example, the racial features or age of the subject in the image.

6.6 GEN AI artefacts can be extreme and easily recognized (Figure 2a - 2c) to the subtle and compelling (Figure 2d) and everything in between (Figure 2e). Therefore, even if the image looks 'good' the risk mitigation measures as outlined in section 7 should be applied.

7. Risk Mitigation

7.1 If GEN AI image processing techniques are used, they should be done so with extreme caution because of the risks as outlined in section 6 above.

7.2 If such techniques are used, any decision regarding whether a candidate returned from an FRS search is a possible match must be made based on a comparison with the original (unedited) image and NOT the image produced by the GEN AI.

Input Image

GFPGAN Output

Figure 2a

Input Image GFPGAN Output

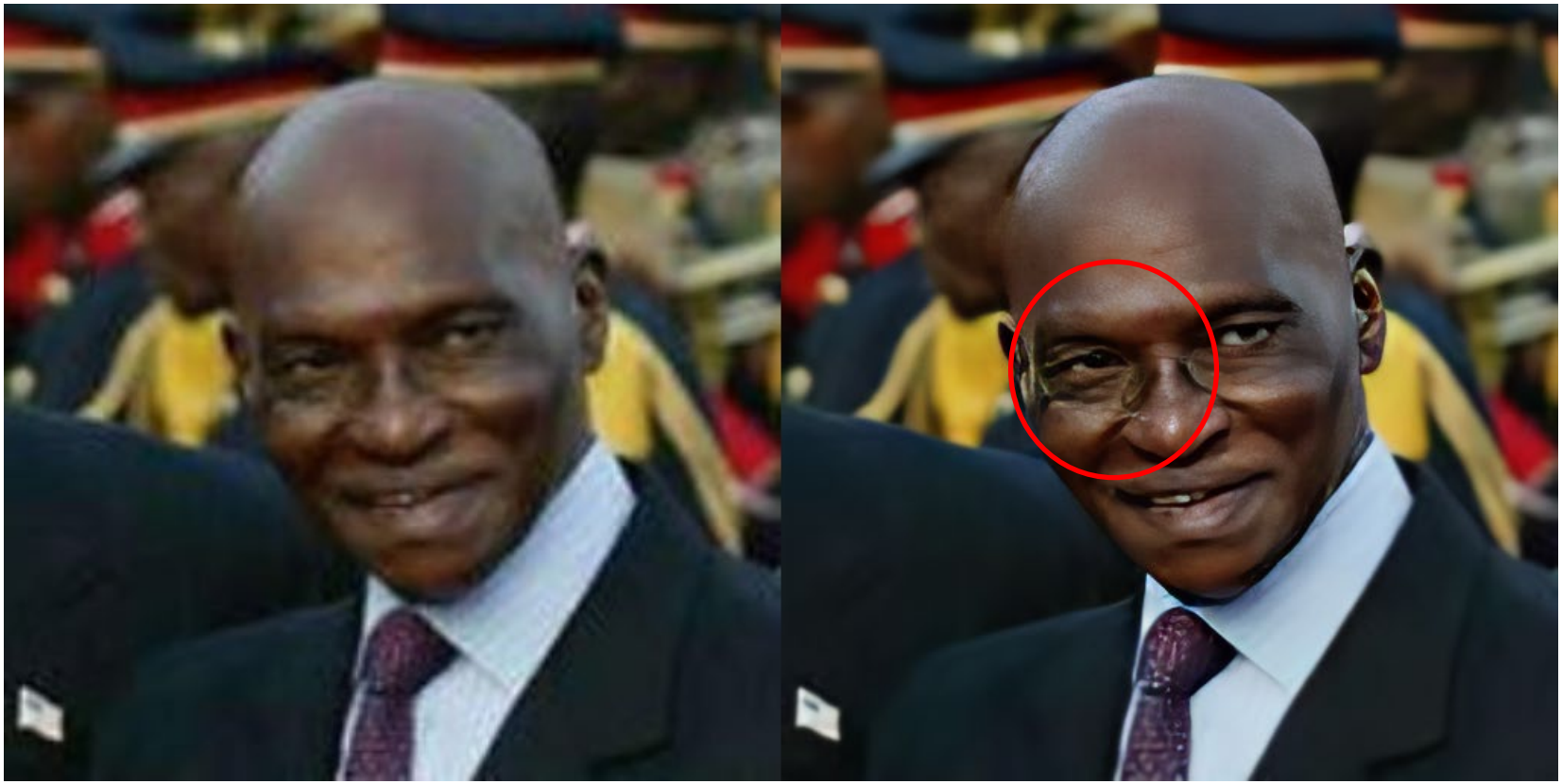


Figure 2b

Input Image

GFPGAN Output

Figure 2c

Figure 2d

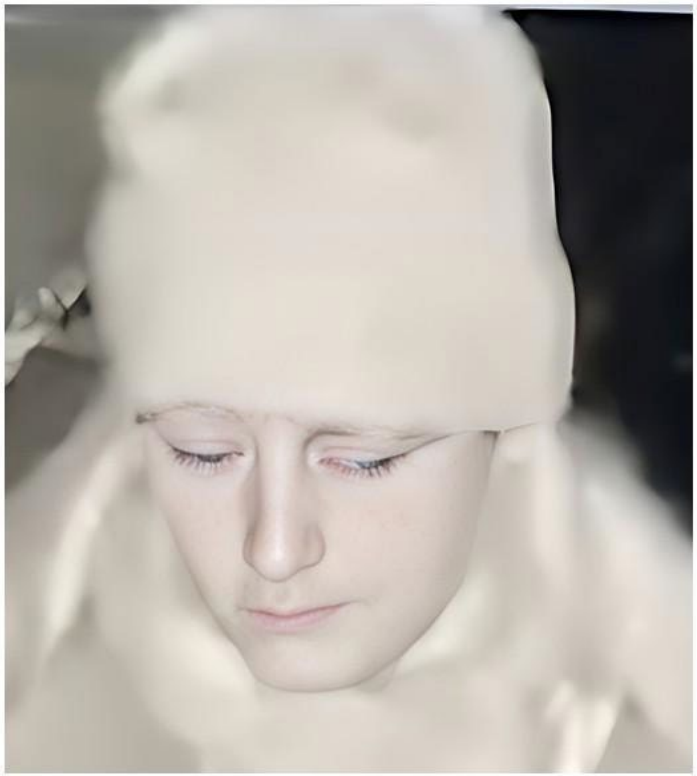
Figures 2e

Input Image

Output GEN AI processed Image

Input Image - detailed

Output GEN AI processed Image - detailed



Mugshot of subject depicted in the CCTV image

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