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Detection of Automated Facial Beautification by a Camera Application by Comparing a Face to a Rearranged Face

Clemenz Portmann

Yuriy Romanenko

Vinit Modi

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Abstract:

This publication describes systems and techniques to detect if a camera application is applying an automated mechanism to beautify a human face present in a photograph. Some camera applications may automatically adjust characteristics of a face to "beautify" them, such as by changing a skin tone. Although provided as a feature, this "beautification" potentially can be interpreted as cultural insensitivity or can result in mental health concerns. Accordingly, enabling a user to at least have knowledge of automated beautification can be beneficial. Detecting beautification is accomplished by determining if a camera application adjusts pixels corresponding to a face but not pixels corresponding to a rearranged face. Facial recognition software recognizes the face but fails to recognize the rearranged face. A tile from the face is compared to a corresponding tile from the rearranged face. If the two tiles are sufficiently dissimilar, then the system infers that the camera application has adjusted the pixels of the tile corresponding to the original facial image responsive to recognizing those pixels as part of a face. In this manner, the automated facial beautification can be detected.

Keywords:

smartphone, camera, camera application, photograph, image, face, facial features, consented beautification, retouching, automated enhancement, detection, tile, patch, rearrangement, scramble, jumbled, adjustment, skin tone, complexion, smoothness, symmetry, degree, level, extent, flaw, camera effect, filter

Background:

Most smartphones include a camera configured to take a photograph, which can include human faces. These smartphones provide camera functions using a camera application, which can be a dedicated image application or a portion of another application, such as one for a social media platform. These camera applications can adjust an image obtained by a camera sensor to change the appearance of the final photograph. Many adjustments are generally considered improvements, such as reducing blurriness, moderating noise, and compensating for low lighting. Certain adjustments, however, are not universally considered to be improvements and might cause harm to mental health.

Some camera applications, in conjunction with facial recognition, automatically adjust facial characteristics in an attempt to “beautify” each human face. Typical adjustments pertain to color (e.g., skin tone changes), texture (e.g., face smoothing), and geometry (e.g., eye size and jawline changes) that are often deemed “better” by a developer of the camera application. Facial beauty is, however, subjective and can vary by culture, over time, and even from region-to-region. Automated facial beautification therefore risks being culturally insensitive. Beautification, especially secretive beautification, can also lead to unreasonable social expectations, a warped self-image, or poor self-esteem. Unfortunately, camera applications do not necessarily disclose that an automated beautification process is being performed on images. Therefore, it is desirable to provide end-users with knowledge that automated beautification is being performed and/or provide an ability for end-users to selectively prevent the automated beautification from being performed.

Description:

To prevent unknown or involuntary facial beautification by a camera application, an operating system feature can include disclosing the beautification to an end-user and/or enabling the end-user to control usage of the beautification process. To implement such an operating system feature, an automated beautification by a camera application is first detected. The systems and techniques described herein enable detection of an automated beautification that is performed by a camera application.

The detection techniques involve a test of the camera application using a scene that is created to have a face and a "control" element. The facial recognition capability of an electronic device, such as a smartphone, is expected to recognize the face but not the control element. The control element is sufficiently similar to the face to enable a comparison of a patch of the face, which may have been beautified as part of a recognized face, and a patch of the control element, which should not be beautified. To enable this comparison, a rearranged face is used as the control element because individual pixels between the face and the control element are at least similar. Advantageously, the described system can operate on a single image, which eliminates shot-to-shot and scene variations. Further, the described techniques avoid engaging in comparisons involving "absolute" beauty standards. In other words, the described techniques are agnostic relative to any particular beautification preferences.

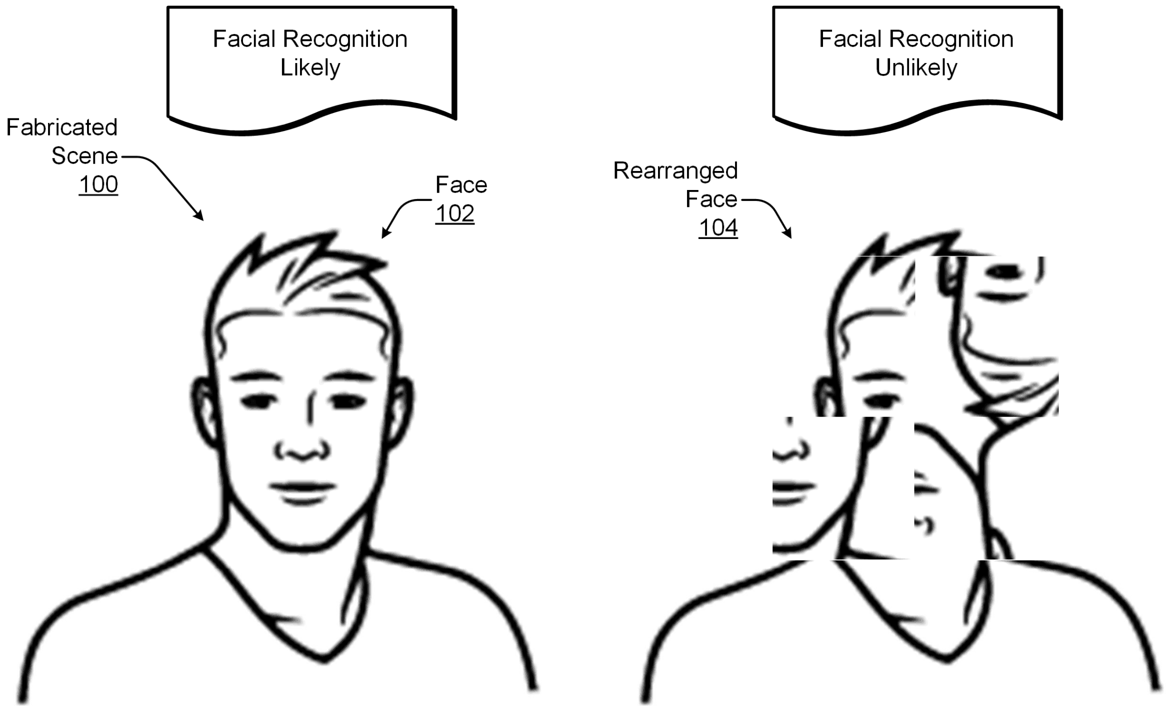

Fig. 1. Fabricated scene with face and rearranged face.

As shown in Fig. 1, a fabricated scene 100 includes a face 102 and a rearranged face 104. With many current facial recognition algorithms, the pixels of the face 102 are likely to be recognized as forming a face. In contrast, the pixels of the rearranged face 104 are unlikely to be recognized as forming a face. Consequently, the rearranged face 104 can be used as a control element to detect if automated beautification is occurring. Example approaches to rearranging a face are described below with reference to Fig. 3. An example technique for detecting automated beautification is described next with reference to Fig. 2.

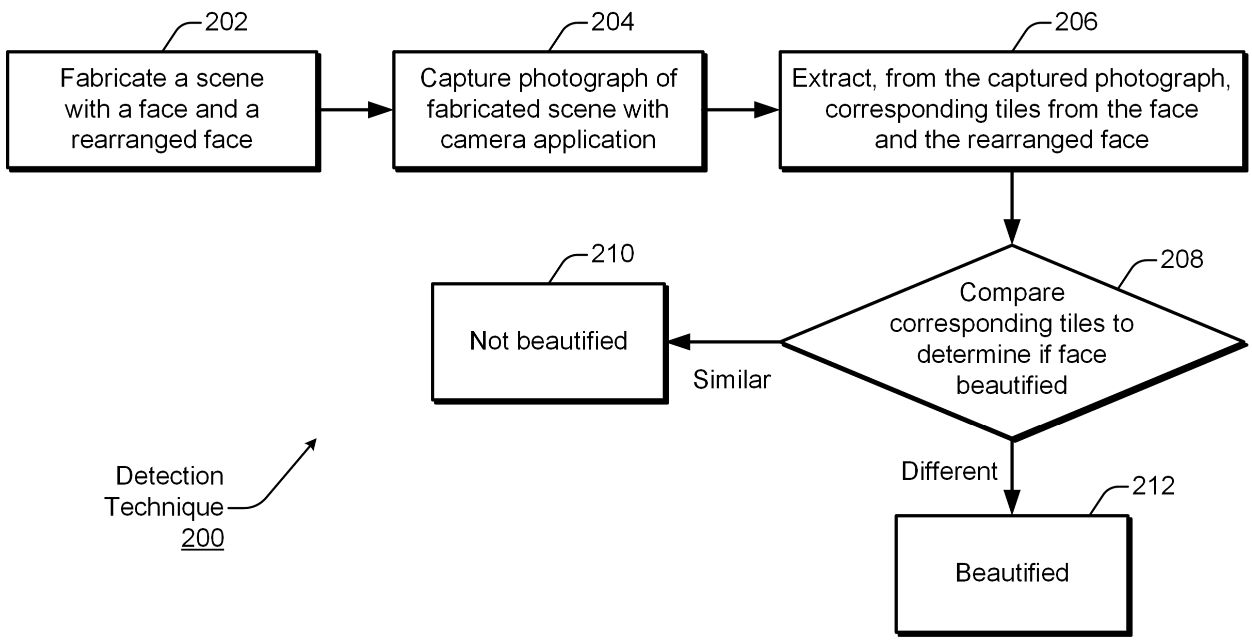

Fig. 2. Technique to detect automated beautification.

Fig. 2 depicts an example technique 200 to detect automated beautification. The technique 200 includes six (6) blocks 202-212. These blocks are described briefly here and in detail below. At block 202, a scene is fabricated with a face and a rearranged face. As depicted in Fig. 1 above, the fabricated scene 100 includes the face 102 and the rearranged face 104. At block 204, a photograph of the fabricated scene is captured with the camera application. At block 206, tiles from the face and corresponding tiles from the rearranged face are extracted from the captured photograph. Tile examples are depicted in Fig. 3 below. At block 208, the extracted tiles from the face are compared to corresponding extracted tiles from the rearranged face to determine if the face has been beautified. If the corresponding tiles are similar, then the face is determined to not be beautified at block 210. If, on the other hand, the corresponding tiles are different, then the face is determined to be beautified at block 212.

Creating the fabricated scene 100 of Fig. 1 with the face 102 and the rearranged face 104 entails duplicating the face 102 and partitioning the duplicated face into multiple tiles (e.g., partitioning into patches, pieces, pixel areas, or other portions). The tiles are then manipulated to produce the rearranged face 104. Fig. 3 explicitly indicates examples of such tiles.

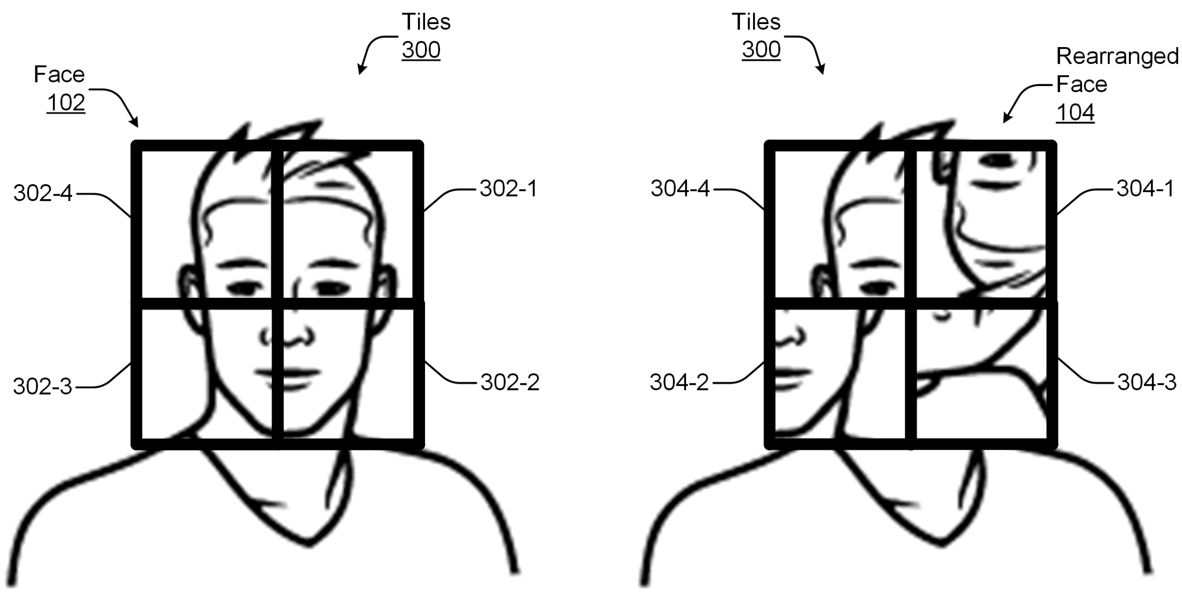

Fig. 3. Fabricated scene depicting a face partitioned into tiles for rearrangement.

As shown in Fig. 3, the face 102 and the rearranged face 104 are partitioned into multiple tiles 300. The tiles 300 include tiles 302 and tiles 304. The tiles 302 are associated with the face 102; the tiles 304 are associated with the rearranged face 104. Each tile 302 of the face 102 has a corresponding tile 304 of the rearranged face 104. The tile 304-1 corresponds to the tile 302-1. Specifically, the tile 304-1 is a version of the tile 302-1 that is rotated by 180 degrees (180°) or flipped upside down. The locations of the tiles 304-2 and 304-3 have been swapped relative to the locations of the respective tiles 302-2 and 302-3. Further, the tile 304-3 has been rotated 270 degrees (270°) clockwise relative to the orientation of the tile 302-3. The tile 304-4 is unchanged relative to the tile 302-4.

Thus, the tiles 304 are translated or rotated (or both) relative to corresponding ones of the tiles 302. Faces may, however, be rearranged in alternative manners. For example, tiles may also or instead be reflected or resized. Further, faces may be partitioned into more or fewer tiles, and the tiles may take other shapes, such as rectangles, triangles, or hexagons. Rearrangement is implemented at least to an extent that a facial recognition algorithm will not likely recognize the rearranged face 104 as a human face. An extent of the rearrangement may also be constrained to ensure that corresponding tiles 302 and 304, respectively of the face 102 and the rearranged face 104, can be identified as matching for the extraction of block 206 and the comparison of block 208, both of Fig. 2.

For block 204 of Fig. 2, a photograph of the fabricated scene 100 is captured using the camera application. To conduct a testing scenario, a controlled environment can be created that normalizes the light that is incident across the fabricated scene 100 so that differences between the face 102 and the rearranged face 104 are more likely to be due to automated beautification than the photographic testing environment. To further reduce differences between corresponding tiles that result from the testing scenario, the face 102 and the rearranged face 104 can be positioned close to one another in the fabricated scene 100. One or more tiles 304 of the rearranged face 104 may, for instance, be mirrored to place corresponding tiles next to each other in the scene to reduce lighting variations, which variations can create false positives. Also, the fabricated scene 100 may include multiple faces of varying skin tones or with variations of other facial characteristics that might be adjusted as part of an automated beautification mechanism.

For block 206 of Fig. 2, corresponding tiles from the face 102 and the rearranged face 104 are extracted from the captured photograph. To do so, pixels of the captured photograph are analyzed to identify two tiles with the same or matching content. An optimized pattern-matching search, for instance, can be used to find matching tiles. With reference to Fig. 3 above, four pairs of corresponding tiles 302 from the face 102 and tiles 304 from the rearranged face 104 can be located in the captured photograph. After the tiles are matched, the corresponding tiles can be compared pairwise.

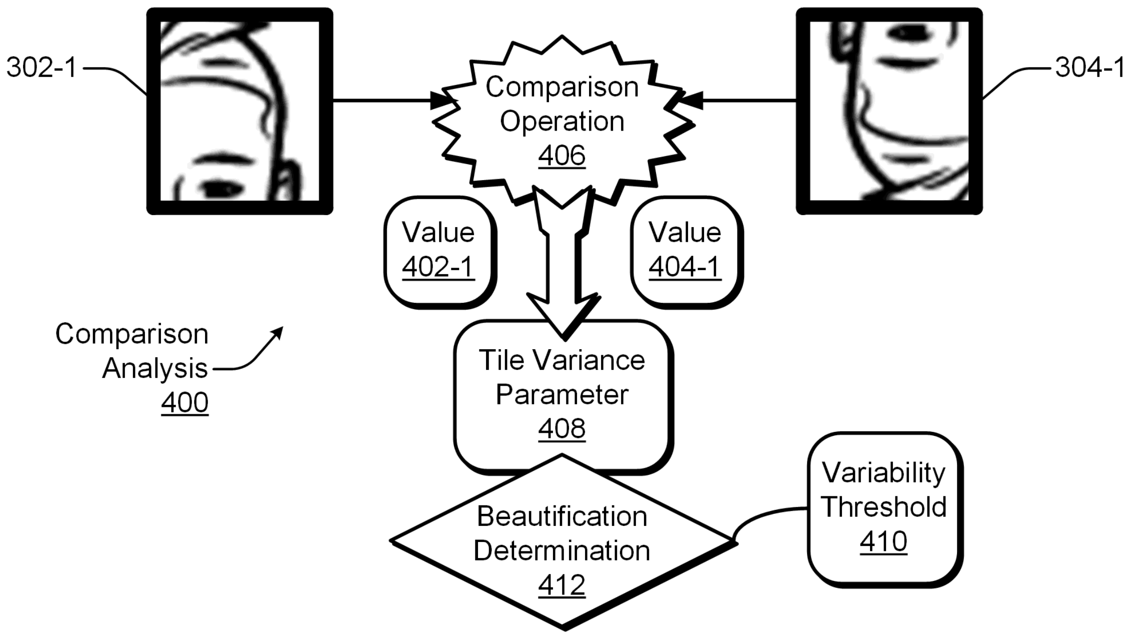

Fig. 4. Comparison analysis of corresponding tiles.

Fig. 4 depicts an example comparison analysis 400, which expands upon blocks 208-212 of Fig. 2. The comparison analysis 400 is for one pair of tiles: corresponding tiles 302-1 and 304-1. Each tile 302-1 and 304-1 represents an upper right quadrant of the face 102 and the rearranged face 104, respectively. For block 208 of Fig. 2, a comparison operation 406 is performed. For example, an RGB color-averaging algorithm (e.g., to compute an RGB mean) can be applied to each tile. Alternatively, one or more other metrics can be used individually or in combination, such as sharpness, a texture metric, or a shape metric. The RGB color-averaging algorithm produces two values: a face value 402-1 and a rearranged face value 404-1. The two values 402-1 and 404-1 are compared to determine a tile variance parameter 408. The tile variance parameter 408 reflects how similar or how different the face tile 302-1 is from the rearranged face tile 304-1.

The tile variance parameter 408 is used to determine if the face 102 is unbeautified (as indicated at block 210 of Fig. 2) or if the face 102 has been beautified (as indicated at block 212). A beautification determination 412 compares the tile variance parameter 408 to at least one variability threshold 410. If the tile variance parameter 408 is less than the variability threshold 410, then the two tiles 302-1 and 304-1 are deemed sufficiently similar such that no beautification has been performed. On the other hand, if the tile variance parameter 408 is greater than the variability threshold 410, then the two tiles 302-1 and 304-1 are deemed sufficiently different to infer that facial beautification has been performed on the tile 302-1, which includes pixels that are recognized as belonging to the face 102.

In some photographic capture environments, even identical tiles 300 that have not been adjusted by a beatification mechanism will likely exhibit some tile variance. This is due to the random nature of the light reflecting from the fabricated scene 100 and the individual pixel sensors of the camera being used to obtain the captured photograph. For example, with an RGB color-averaging algorithm, a tile variance parameter 408 indicating a 2-4% difference is possible, even between unchanged, identical tiles. Accordingly, a variability threshold 410 of between 10% and 20% may be used in some cases.

If facial beautification is detected, several actions can be taken. For example, an end-user of an electronic device can be notified. Additionally or alternatively, the end-user may be empowered to reject photographs in which beautification has been performed or prevent a photograph from being taken if beautification is automatically applied. This capability may, for instance, be offered as a setting in an operating system of the electronic device.

References:

[1] Patent Publication: WO2018188535A1. Face image processing method and apparatus, and electronic device. Priority Date: April 14, 2017.

[2] Jain, Anubhav, Richa Singh, and Mayank Vatsa. "On Detecting GANs and Retouching Based Synthetic Alterations." *2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS)*, October 2018. https://doi.org/10.1109/btas.2018.8698545.