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## **Automatic image adjustment based on user edit history**

### **ABSTRACT**

Users have extensive collections of digital photographs and videos available for display on their devices. This disclosure describes techniques to, with user permission, perform automatic modifications and provide automatic suggestions of modifications to digital images in a user's collection based on previous modifications to images performed by the user. With user permission, the automatic modifications are made to images that have particular characteristics, such as types of image content, similar to images previously edited by the user.

### **KEYWORDS**

- image editing
- photo filter
- automatic enhancement
- photo modification
- suggested modification
- suggested edit
- photo library

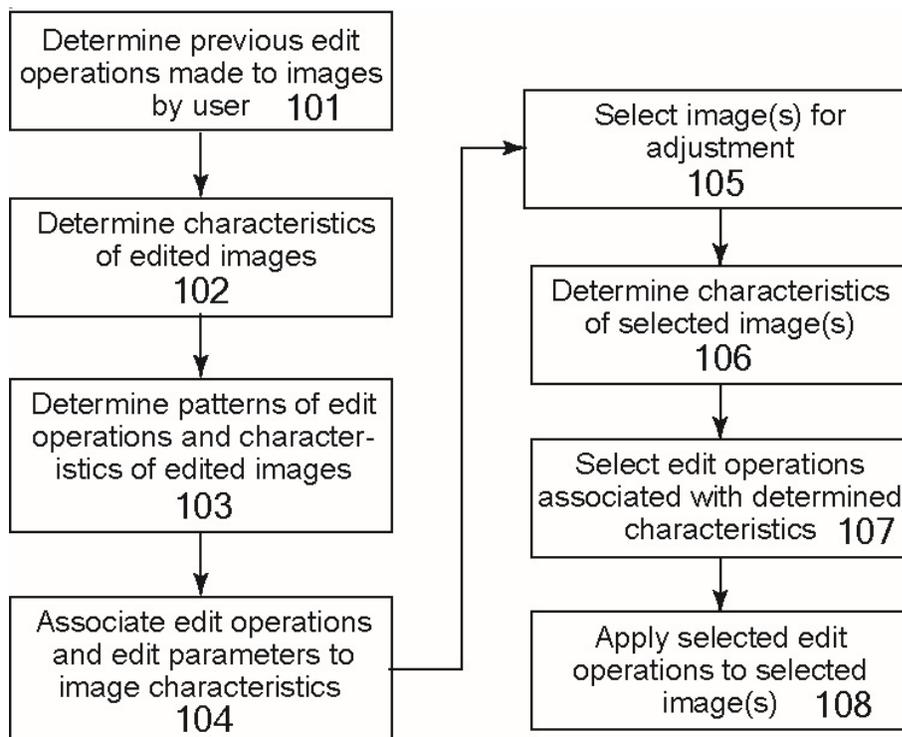
### **BACKGROUND**

Users capture extensive numbers of images such as digital photographs using their mobile devices. Users modify some of their images by performing editing operations using an image editing application to change exposure level, brightness, redeye, colors, saturation, or other visual characteristics. Such modifications are often specific to the user's individual preferences and tastes. However, making such modifications may take a significant amount of time, especially when the user's image collection includes a large number of images. Also,

editing photographs becomes a tedious and repetitive task if the same types of modifications are applied to many images. As a consequence, many users skip editing images and end up with image libraries that include photographs that do not match their tastes and preferences.

**DESCRIPTION**

This disclosure describes techniques that, with user permission, automatically perform adjustments to digital images (including static images, videos, animated images, etc.) that are in accordance with the user’s preferences. With user permission, described techniques determine previous modifications made to images by the user and the characteristics of the modified images, determine patterns of edits made by the users, and automatically perform similar modifications to images that have not been edited by the user. Fig. 1 illustrates an example technique.



**Fig. 1: Example method for applying automatic image modifications**

As shown in Fig. 1, a device (e.g., a client device of the user or other device that hosts the user's image library) determines (101) previous edit operations made to images by the user. For example, with user permission, the device examines a history of edit operations performed by the user to particular images, e.g., using an image editing application. Such a history can, with user permission, be stored in response to user editing of images, and can include the particular edit operations that were applied to images based on user instruction. Such edit operations can include operations to adjust pixel characteristics such as brightness, saturation, contrast, and color, as well as edit operations to reduce color noise, blur or sharpen pixel colors, change from color to black and white, or other modifications. Edit operations can also include adding special effects to an image (e.g., borders, animations, labels, stickers, sparkles, etc.), and applying image filters, e.g., that update images based on a combination of edits, such as to "sepia," "black and white," "HDR," "saturate colors," etc. The history can include the parameters that were used in the applied edit operations, e.g., the magnitude of edit operations, the size or radius of an edit operation, the location or area in the image where edit operations were applied, etc. Users are provided with options to provide or deny permission to obtain such information regarding edits made by the user. No history is collected if the user doesn't provide permission. Further, users can selectively deny permission for edits to specific images, or performed in specific contexts.

The device also, with user permission, determines (102) characteristics of the images that were edited previously by the user. Such image characteristics can include the content of the images, e.g., features depicted in each image, such as persons, objects, landscape features, indoor or outdoor setting, etc. For example, types or categories of detected image content

features can be determined. Types of features can include, e.g., faces, persons, animals (and/or types of animals), particular landscape features (e.g., trees, bridges, buildings, etc.), types of objects (e.g., vehicles, devices, etc.).

Image content features can be determined based on tags or labels that are assigned to an image that are descriptors of objects in the image. Tags or labels can be auto-generated, based on analyzing the image and/or image metadata. For example, image features can be determined using object recognition techniques for images, based on machine learning models, pattern matching techniques, etc. For example, machine learning models can run on a device to detect image content features. With user permission, a face detector can be used for isolating regions in images that include faces and detecting faces that belong to a same person (without determining the identity of the person). With user permission, the machine learning models for detecting classifications of subjects can be trained using the images in a user's collection of images. The machine learning models can be implemented on a local device, e.g., a mobile device or camera, and/or can be fully or partially implemented on a server or other remote device in communication with the local device, if permitted by the user. In some cases, heuristics and rules can be used instead of or in addition to machine learning models.

Detected image characteristics of the edited images can also include metadata characteristics such as the time an image was captured, the geographic location that the image was captured, camera settings of the camera that captured the image, etc. The image characteristics can also include image resolution, a user rating for the image, whether the image was shared with other users, user comments about the image, etc.

Based on the previous edit operations and the characteristics of the edited images, patterns of edit operations and image characteristics are determined (103). For example, by

examining the edit operations made to images having a particular content or type of content, a pattern is determined for which edit operations the user likes to apply to images having that content, and the magnitudes and other parameters of those edit operations.

For example, it can be determined that the user has increased saturation of images depicting a particular landscape feature (e.g., type of landscape feature) in a particular range of times of day, and has not changed saturation in the same way for other types of content. Furthermore, it can be determined that the user has commonly adjusted the color of images showing this landscape feature.

A machine learning model can be used to determine such patterns. For example, such a model can be trained with the previous edit operations and the characteristics of the edited images. The accuracy of the machine learning model may improve with the number of samples available of previous image edits. Other types of models or techniques can also be used, e.g., a statistical model.

If permitted by other users, samples of previous edit operations and image characteristics performed by the other users can be obtained and additionally used to determine the patterns, e.g., by training a model with the samples. Such samples are not specific to the particular user for whom the automatic image modifications are determined, but can be used to determine more general patterns of image edits, e.g., if there are insufficient samples from the particular user. Such determination is performed in an offline manner, e.g., to train a machine learning model, and no data of other users is provided to the device of the particular user.

Based on the patterns, particular edit operations and edit parameters are associated (104) with particular image characteristics, e.g., a set of image characteristics. A particular set of edit operations can be associated with a type of image content, and/or other image characteristics,

e.g., a time of day, day of the week or month of the year, a location or region, etc. The determined associations can be stored as a personalized style or profile for the user. Users can create different personalized styles that are applied under different conditions, e.g., different edit operations can be associated with a particular image content type captured in different locations, at different times, based on using different capture devices, etc.

The parameters of the associated edit operations can be determined as an average or other combined result. For example, it may be determined that an edit operation of lowering brightness is associated with an image content characteristic of buildings and capture times between noon and 4 pm. The magnitude of brightness can be determined as an average of the magnitudes used in the previous edit operations that were examined to determine the association.

The determined associations are applied to automatically perform modifications to images that have not been edited by the user. In this example of Fig. 1, the device selects (105) images for adjustment. For example, an image that has been recently captured by a camera of the device is selected. Other images of the user's image collection which have not previously been edited can also be selected. In some examples, a batch of images is selected to process all the images of the batch similarly, e.g., images that were captured at the same location and within a short period of time. For example, a set of images that were all captured by a camera burst mode may be selected.

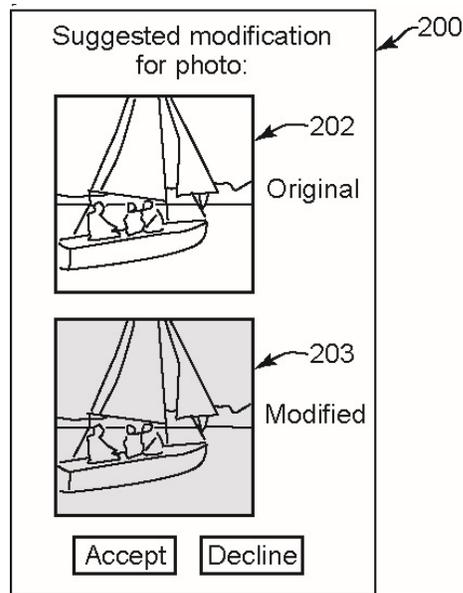
The characteristics of the selected image(s) are determined (106). For example, the content and/or types of content of the selected image(s) are detected using tags and/or image feature detection techniques similarly as described above, and the metadata and other characteristics of the selected image(s) are obtained.

Edit operations are then selected (107) which are associated with the determined image characteristics of the selected image(s). The determined associations between edit operations and image characteristics, as described above, are used to select the edit operations.

In some cases, the selected image may have multiple different image characteristics that are each associated with a different set of edit operations. In some cases, the device selects one of the sets of edit operations and ignores the other sets. For example, image characteristics can be associated with priority levels (e.g., as designated by the user), and the set of edit operations that are associated with the highest priority image characteristic are selected. In an example, faces may be assigned a higher priority than landscape features, such that if both a face and landscape feature appear in a selected image, the edit operations associated with the face are selected.

In another example, priority levels of image characteristics can be determined based on multiple factors, including size (image area covered), brightness, color, etc. For example, if the landscape feature is a particular threshold size (e.g., percentage of image pixel area covered) or is greater in size than the face appearing in the image by a threshold amount, the landscape feature may have an increased priority level, which may result in the landscape feature having a higher priority level than the face. Alternatively, multiple sets of edit operations that are associated with multiple different image characteristics of the selected image can be selected.

The selected edit operation(s) are applied (108) to the selected image(s). This causes adjustment of the pixel characteristics of the selected image(s) to automatically provide modified images for the user.



**Fig. 2**

**Fig. 2: Example user interface showing original and modified image**

Fig. 2 illustrates a view of an example user interface (200) that presents suggested modifications of images and allows a user to accept or decline suggested modifications. The device can present options related to determined edit operations for selected images to the user via the user interface.

As described above, images are selected for modification and edit operations that are associated with these image characteristics are determined. In some cases, the device can present for the user a modification of an image that is based on the determined edit operations. For example, as shown in Fig. 2, a selected image (202) can be displayed in the user interface in its original state, prior to determined edit operations being applied to the image. A modified image (203) is also presented, modified with the determined edit operations to change pixel characteristics. A prompt, such as options (e.g., buttons) to accept or decline the modified image, are also presented in the user interface. If the user provides input accepting the image

modification, the modified image is stored in place of the original image in the user's image collection. Further, the original image can also be stored, e.g., in backup storage. The determined characteristics (e.g., labels or other descriptors for image content, capture locations, capture times, etc.) can also be displayed in the user interface alongside or on top of presented images.

The suggested modifications and user interface can be displayed selectively, e.g., only if particular conditions are present, whereas if other conditions are present, selected images are modified automatically without displaying the suggestions and user interface. For example, the suggestions may be presented when confidence levels are below a particular threshold relating to a determined association of edit operations and image characteristics, e.g., due to a low amount of sample data for the determined edit operations and/or image characteristics of a selected image, the detection of content in the images being at a low confidence level, etc.

Multiple different modified images can be displayed in the user interface as different suggestions, e.g., each suggestion based on different image characteristic(s) of the original image. For example, if an image depicts a face that is associated with a first type of edit operation and depicts a landscape feature which is associated with a second type of edit operation, the device can present two modified images that have been modified with the first and second types of edit operations, respectively. The user can select which of the modified images are to be kept and stored in the user's collection.

If the user permits, acceptance of suggested modified images can be used as training data to train the model that is used to determine patterns and associations between edit operations and image characteristics, such that the model is updated based on user preferences to more accurately associate edit operations to particular image characteristics. In some cases,

user acceptance of suggested modified images can be used to determine when to present suggested modified images for user acceptance, and when to automatically perform the modifications without user input.

Described techniques can also be used to modify the pixels of frames in video, including in real-time video communications such as video conferencing or video chat. For example, if the device has determined that in response to a low brightness characteristic in video frames, the user typically raises the brightness of the video by a particular amount, and a similar brightness is currently displayed in frames during a video communication, that same brightness adjustment can be automatically performed by the device.

Described features for determining and applying image modifications can be implemented on a local device without contacting a server, and/or, with user permission, can be fully or partially implemented on a server or other remote device in communication with local devices.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information (e.g., information about a user's activities, social network, or social actions, profession, a user's preferences, or a user's current location), and if a user device is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control

over what information is collected about the user, how that information is used, and what information is provided to the user.

## CONCLUSION

This disclosure describes techniques for automatically adjusting images from a user's collection of images based on image modifications previously made by the user. With user consent, previous image modifications made by the user are correlated with characteristics of the modified images to determine which modifications the user prefers to make based on image characteristics such as image content, time and location of image capture, etc. This allows a device to automatically and accurately perform preferred types of image modifications to large amounts of images without the user having to perform such modifications manually.