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Modifying Photos Based on Photo Capture from Multiple Device Cameras

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Modifying Photos Based on Photo Capture from Multiple Device Cameras

ABSTRACT

This disclosure describes techniques to modify photos based on additional photos captured from multiple cameras of a device. A user captures a main photo of a scene with one camera of a device, and, in the background, additional photo(s) are automatically captured by other camera(s) of the device. Portions from the additional photos can be used to modify the main photo. For example, the view and/or aspect ratio of the captured photo can be modified to show portions of the scene that are not present in the main photo. This saves the user time and effort by automatically capturing additional photos of a scene and providing a range of editing options that take advantage of the additional photos.

KEYWORDS

- Photo editing
- Multiple cameras
- Field of View (FoV)
- Photo stitching
- Image stitching
- Photo composition
- Photo capture

BACKGROUND

Users may often capture a photo of a scene with a camera and edit the photo at a later time. For example, the photo can be cropped to focus on a particular viewframe of the captured scene. A photo may be edited to change its aspect ratio to fit a particular display aspect ratio, e.g., an aspect ratio of posts on a social networking service or website. For example, the

orientation of a photo may be later edited based on how that photo is to be presented; e.g., a vertical orientation for a story of photos on a website, or a horizontal orientation for other presentations. However, a photo cannot later be edited to include portions of the scene that were not captured in the original photo. Thus, in many cases, when later editing the photo, the user may regret that they did not capture the photo from a different camera angle, with a wider zoom level, or with a different camera orientation (e.g., landscape or portrait) to include additional portions of the scene.

Some users may manually capture multiple photos of a scene with their camera, from multiple angles, in different camera orientations, and/or with different lenses, so that they have more options to choose from when later presenting or editing the photo. However, capturing multiple photos takes additional time and effort for the user.

DESCRIPTION

This disclosure describes techniques for automatically capturing additional photos from one or more cameras of a device at the time of capturing a main photo and using the additional photos during the modification of the main photo. These techniques enable a user to easily edit a photo with various different configurations, e.g., zoom levels, orientations, aspect ratios, compositions, or focal points.

The described techniques can be implemented on any suitable device, e.g., a camera device, portable user device (e.g., a smartphone), etc. The user is provided with options to enable or disable described techniques. The user can permit specific data or types of data (e.g., specific photos) to be processed and can deny processing of other data or types of data.

Capturing photos with multiple cameras of a device

According to described features, the user captures a main photo using a device that includes multiple cameras that are directed toward the same scene. For example, many smartphones include multiple outward-facing cameras that provide different lenses and/or capture characteristics, such as different focal lengths, different angles of view, telephoto capability, monochrome capture, etc. In some examples, a device may have cameras that provide wide angle, ultrawide angle, telephoto focal lengths, and/or other cameras and lenses that can be used for different types of scenes and/or visual effects (e.g., portraits of people, landscapes, bokeh blur, etc.). In some cases, one or more of the multiple cameras on a device may each have multiple lenses available for that camera to select and use, providing additional options for capturing a photo.

In operation, the user points the device at a scene and instructs that a photo be captured, e.g., the user provides a shutter command by selecting a displayed button on a touchscreen of the device, or presses a physical button on the device. In standard operation, in response to the capture instruction, the device selects one of the multiple cameras to capture a photo of the scene. The particular camera that performs the capture can be automatically selected by the device based on the characteristics of the scene to be captured as indicated by a preview screen of the camera (e.g., zoom level, camera orientation, type of subject matter, etc.), or the user can manually select a particular camera to capture the photo.

According to described features, the user inputs the standard shutter command to capture a photo of a scene. However, instead of using only a single camera to capture a photo, one or more additional cameras of the device are also used in the background (not noticeable by the user) to simultaneously capture respective photos of the scene (or the photos can be captured in

quick succession). In some cases, all available cameras directed at the scene are used to capture photos of the scene.

A main photo is the photo that is captured by the camera selected by the device as in standard operation, as indicated in the preview screen or viewfinder of the device. The other photos from the other cameras can be designated as additional photos. The additional photo(s) are stored on the device in a manner that indicates that they are associated with the main photo. For example, the additional photos can be compressed in a package in which they are attached to the main photo, such that when the main photo is copied or moved, the associated additional photos are also copied or moved to the same location as the main photo.

In some cases, the user can indicate (e.g., via camera settings) to display the additional photos, e.g., in a user interface of the device, in addition to displaying the captured main photo.

A similar technique can be used for videos in addition to photos. Additional cameras of a device can capture additional videos at the same time a main video is being captured by a selected camera of the device. The additional videos can be captured in the background similarly to the additional photos as described above.

Editing a main photo using additional photos

A user may edit a main photo that has been captured with additional photos as described above. A standard editing interface of an image editing application can be used. When the user indicates to modify the main photo, the editing application determines whether there are additional photos associated with the main photo. If such additional photos are available, the editing application uses those additional photos when providing editing options for modifying the main photo and when determining preview images to display in the editing interface as a result of user modifications to the main photo.

For example, the editing interface can provide an option to move the viewframe of the main photo to center on a different portion of the depicted scene. One or more of the additional photos may include portions of the scene that were not captured in the main photo, e.g., were captured using a wider angle lens than the lens used to capture the main photo. In some examples, a rectangular viewframe outline can be displayed on a screen in the editing interface, over an image that can include the main photo and other portions of the scene from the additional photos (or the image can be an additional photo captured with a wide angle). The user can move the viewframe outline to a different portion of the image to center on that portion and indicate to modify the main photo to include the framed part of the scene. The editing application then determines additional portion(s) of the additional photos to add to the main photo and/or crops the main photo to obtain the desired view.

In another example, the aspect ratio of the main photo may be changed. The user inputs the desired aspect ratio in the editing interface. The editing application examines the additional photos to provide any additional portions of the scene that are not present in the main photo. In a preview mode, the editing application can display different aspect ratios that include portions from the additional photos filled into missing portions of the main photo.

In some cases, user instructions to modify the main photo may cause one of the additional photos to be used as a new main photo in place of the original main photo, if approved by the user. For example, if the user instructs to zoom the view to a smaller area of the main photo, one of the additional photos that shows the smaller area and which has greater resolution can replace the main photo. In another example, if the user instructs to pan the view to a different location of the scene, one of the additional photos that shows the scene area at the new location can replace the main photo.

The user can also select to edit an additional photo instead of the main photo, similarly as editing a main photo as described above. In this case, the main photo can be used as an additional photo in the modification of the additional photo.

After adding one or more portions of additional photo(s) to the main photo, additional processing can be performed on the modified main photo to remove undesired visual effects resulting from joining portions of different photos or modifying pixels of the main photo based on additional photos. For example, such processing can reduce visual artifacts or inconsistencies, smooth transitions or edges of joined photo portions, adjust or remove distortion within a scene due to joined portions of different photos having different foci or lens angles, etc.

Some applications may also be able to construct a 3D model of the captured scene based on the main photo and additional photos, in which objects in the scene are modeled and depth in photo is determined. The 3D model can provide different perspective angles on the scene and can be used to, for example, alter a view angle of the scene in the main photo, to fill in areas of the modified main photo that may not be shown in any of the photos, and/or to remove undesired effects from the modified main photo.

Videos captured by a device can be similarly edited. For example, video frames of a main video can be modified by an editing application using portions of additional videos that were captured substantially at the same time as the main video, similarly as modifying a main photo as described above.

Examples

Examples of the above techniques are presented below.

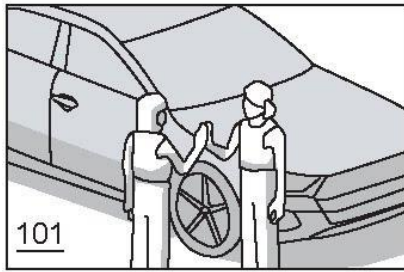


Fig. 1: Example of captured main photo

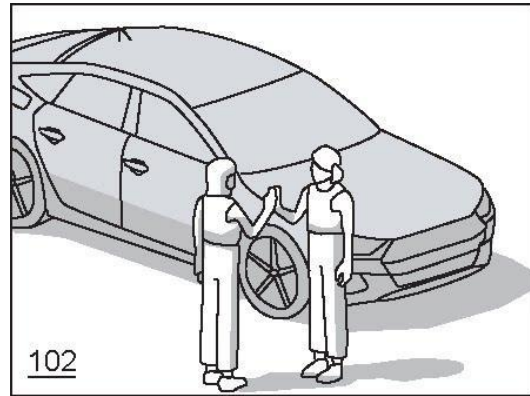


Fig. 2: Additional captured photo

Fig. 1 shows a main photo (101) that has been captured by a camera of a device such as a smartphone. The user has oriented the device to view a scene in a preview image displayed by the device. A camera of the device is selected to capture the photo and the user presses a shutter button to capture the main photo that is shown in the preview display.

At about the same time that the main photo is captured, the device automatically captures one or more additional photos in the background using additional camera(s) of the device. Fig. 2 shows an example of an additional photo (102) that has been captured by a second camera of the device. In this example, the second camera has a wide angle lens that has a larger field of view, such that the additional photo captures a larger area of the scene than the main photo. Other additional photos may also be captured by other additional cameras of the device.

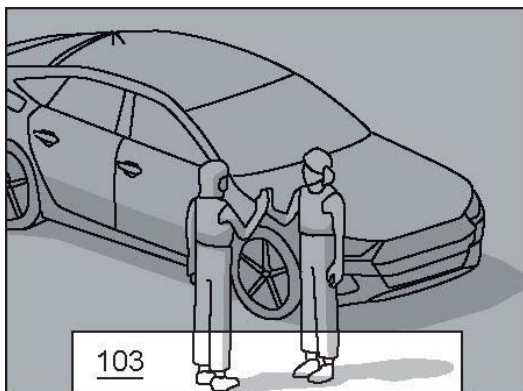


Fig. 3: Portion of additional photo used to modify main photo

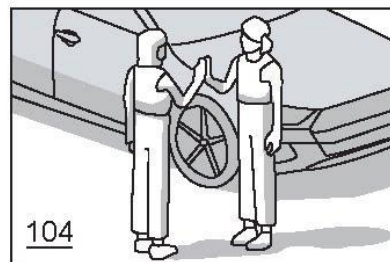


Fig. 4: Resulting modified main photo

Fig. 3 shows an example of using a portion (103) of the additional photo of Fig. 2 to modify the main photo shown in Fig. 1. In this example, the user wants to move the view of the main photo lower so that the main photo shows the feet of the people in the scene. The main photo of Fig. 1 does not include this lower portion of the scene, but the additional photo of Fig. 2 includes a lower portion that can be used to modify the main photo.

An editing interface of an image editing application can be used to display the larger area of the additional photo, and a displayed viewframe outline can be moved by the user within the additional photo to indicate a desired view for the main photo. Alternatively, the user instructs the editing application to move the viewframe lower, and the editing application automatically moves the view to the lowest position in the additional photo. In this example, Fig. 3 highlights the portion of the additional photo that covers a lower area of the scene that is needed to fill in the moved view of the main photo and which is missing from the main photo.

Fig. 4 shows a photo (104) resulting from modifying the main photo to change its view to a position that is lower in the scene. The lower portion of the modified photo is from the additional photo and is stitched to the bottom side of the main photo, and a top portion of the main photo (equal in height to the added lower portion) is removed preserving the aspect ratio.

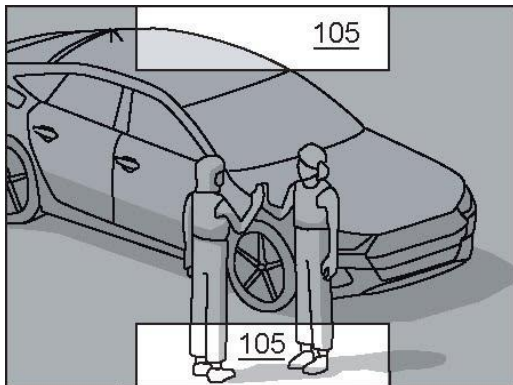


Fig. 5: Portions of additional photo used to modify main photo



Fig. 6: Resulting modified main photo

Fig. 5 shows another example of using top and bottom portions (105) of the additional photo to modify the main photo of Fig. 1. Fig. 5 highlights the portions of the additional photo that are used to fill the top and bottom areas of the modified main photo. In this example, the user wants to change the aspect ratio of the main photo from a horizontal orientation (landscape) to a vertical orientation (portrait). If the same zoom level is maintained for the main photo when changing the aspect ratio, the main photo does not include top and bottom portions of the scene needed to fill the entire frame of the modified main photo. Previously, these portions could be filled with black pixels (e.g., letterboxing), or the main photo could be zoomed and cropped to fill the frame of the new aspect ratio. Using described techniques, the top and bottom portions are filled with portions from the additional photo, preserving the content of the main photo.

The larger area of the additional photo can be used to present editing options in an image editing interface to rotate the main photo and/or change its aspect ratio, and the interface can display previews of the editing options. The user instructs the editing application to change the aspect ratio of the main photo to a portrait orientation, and the editing application fills in the top

and bottom portions with the corresponding portions of the additional photo and crops the left and right portions of the main photo to fit the aspect ratio.

Fig. 6 shows a photo (106) resulting from modifying the main photo to change its aspect ratio to a portrait orientation. The top and bottom portions from the additional photo are stitched to the top and bottom sides of the main photo, and left and right portions of the main photo are cropped to obtain the desired aspect ratio.

Users are provided with options to grant permissions to and/or to disable described features entirely. The various features of the system are implemented only with user permission to access user information that serves as input to the system (e.g., camera settings, user images and/or videos, user context information, camera input, user's preferences, etc.). Users 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, and if the user is sent content or communications from a server. Certain techniques are not implemented if users deny permission. 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. 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 to modify photos based on additional photos captured from multiple cameras of a device. A user captures a main photo of a scene with one camera of a device, and, in the background, additional photo(s) are automatically captured by other camera(s) of the device. Portions from the additional photos can be used to modify the

main photo. For example, the view and/or aspect ratio of the captured photo can be modified to show portions of the scene that are not present in the main photo. This saves the user time and effort by automatically capturing additional photos of a scene and providing a range of editing options that take advantage of the additional photos.

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