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Automatic Removal of Lens Flare Artifacts

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Automatic Removal of Lens Flare Artifacts

ABSTRACT

A strong light source in the field of view of a camera can cause small circular artifacts, known as lens flares or ghost dots, to appear at the mirror location of the light source with respect to the image center. Lens flares occur due to internal reflections within the lenses of the camera. While lens flares can be reduced with lens coatings, it is difficult to entirely eliminate lens flares. This disclosure describes software techniques to automatically detect and remove lens flare artifacts in images. Per the techniques, the presence and position of a strong light source in the field of view is detected in the captured image. Based on the detection, the flare ghosting dot is identified at the mirror location. The flare ghosting dot is masked using inpainting techniques and the result is evaluated. The described techniques can reliably remove lens flares of a wide variety of flare shapes. The techniques can be implemented in any camera device, including smartphone cameras.

KEYWORDS

- Lens flare
- Ghost artifact
- Ghost dot
- Flare removal
- Strong light source
- Image inpainting
- Large mask inpainting
- Lens coating

BACKGROUND

Fig. 1: Flare artifact

As illustrated in the example image of Fig, 1, when there is a strong light source, e.g., the sun (yellow arrow) in the field of view of a camera, small circular or disc-shaped artifacts, known as lens flares or ghosts (red arrow) may appear in the captured image at the mirror location of the light source with respect to the image center. Lens flares occur due to internal reflections within the lenses of the camera. While lens flares can be reduced with lens coatings, it is difficult to entirely eliminate lens flares.

DESCRIPTION

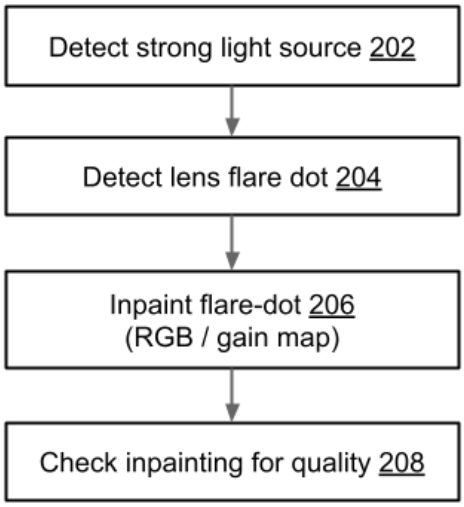

Fig. 2: Removing lens flare artifacts in images

This disclosure describes software techniques to remove flare artifacts in images. The techniques are adaptable to a wide variety of flare shapes. As illustrated in Fig. 2, the strong light source is detected (202) in the image. Then, the flare ghosting dot is detected (204) . The detected region corresponding to the flare ghosting dot is inpainted (206). The resultant image after the inpainting is evaluated for quality (208).

The detection of a strong, e.g., concentrated, source of light can be performed using any suitable technique, e.g., by testing for sharp peaks in the pixel intensity map; by isolating small regions that contrast sharply with their backgrounds; etc. Flare ghosting dots can then be located at the mirror locations (with reference to the image center) of the corresponding light source.

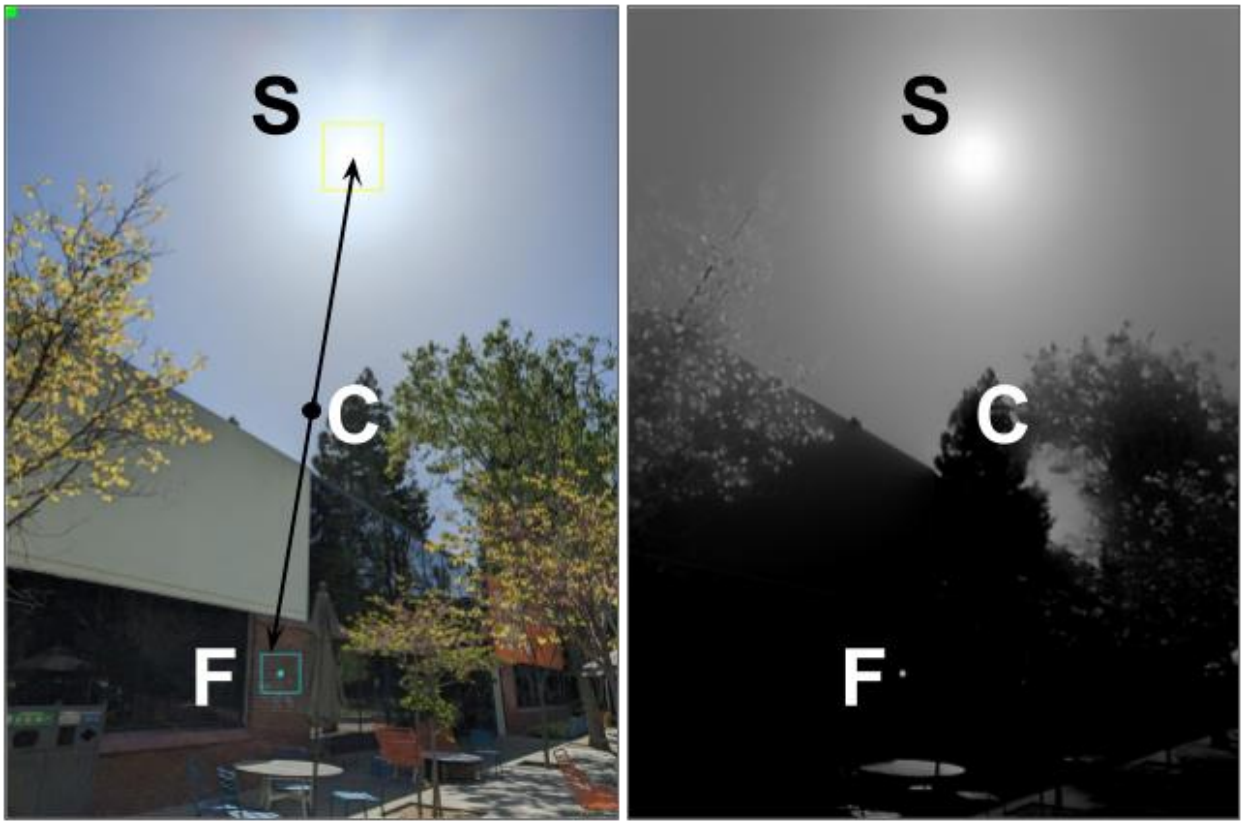

Fig. 3: Locating a strong source of light and its corresponding lens flare: (a) Original image; (b) Gain map for the image

In the example illustrated in Fig. 3, a flare (F) is located at a mirror location about the image center (C) from the strong source of light (the sun, S). The flare is better seen in Fig. 3(b), which is a gain map for the image in Fig. 3(a). The lens flare or ghost dot can be delineated (segmented) using any suitable technique, e.g., an object-detecting neural network such as retina net [3].

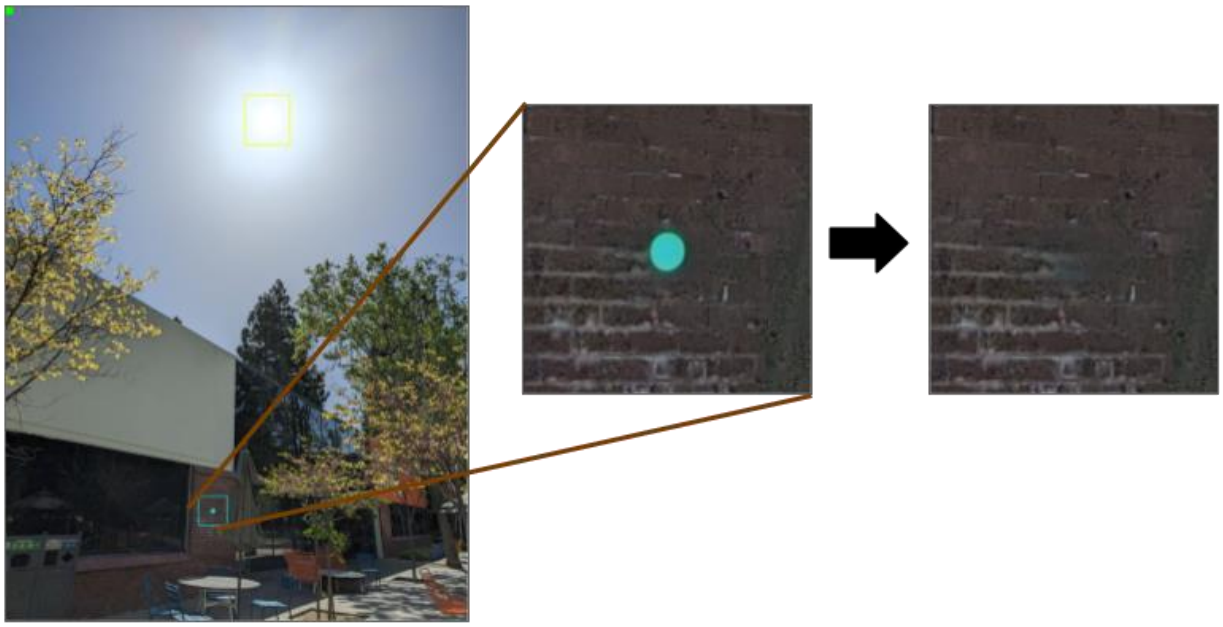

Fig. 4: Inpainting over a lens flare

Once located and delineated, the lens flare or ghost can be inpainted using a suitable inpainting technique, e.g., using an artificial intelligence (AI) based inpainter such as a large mask inpainter [4]. Fig. 4 illustrates an example of an image with a ghost dot (left image). The image is inpainted such that the detected dot (shown enlarged in middle image) is masked based on neighboring pixels (shown enlarged in the right image).

The described techniques can reliably remove lens flares of a wide variety of flare shapes. The techniques can be implemented in any camera device, including smartphone cameras.

CONCLUSION

This disclosure describes software techniques to automatically detect and remove lens flare artifacts in images. Per the techniques, the presence and position of a strong light source in the field of view is detected in the captured image. Based on the detection, the flare ghosting dot is identified at the mirror location. The flare ghosting dot is masked using inpainting techniques

and the result is evaluated. The described techniques can reliably remove lens flares of a wide variety of flare shapes. The techniques can be implemented in any camera device, including smartphone cameras.

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