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Image Capture via Multiple Optical Paths

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IMAGE CAPTURE VIA MULTIPLE OPTICAL PATHS

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Introduction:

An optical path can allow for optical information (e.g., light) representing an image to reach an image sensor. The image sensor can convert the optical information into image data to capture the image. Optionally, an optical image stabilizer can adjust the alignment of the optical information relative to the image sensor to stabilize the captured image.

The present disclosure can enable a system (e.g., image capture system), and methods for controlling the same, to capture multiple images via multiple optical paths directed to a single image sensor. The multiple optical paths can each correspond to different cameras or a single camera that can take images from multiple directions. The systems and methods can also enable an optical image stabilization system to actuate an assembly of optical path folding elements (e.g., folding elements assembly) to select the multiple optical paths to be imaged, and/or stabilize the multiple captured images. The folding elements assembly can also be actuated to auto-focus the multiple captured images. In this way, the present disclosure can enable an image capture system that can capture images from multiple optical paths included in a single device. Additionally, the present disclosure can enable an image capture system that has a reduced size (e.g., by coupling multiple optical paths to a single image sensor), reduced cost (e.g., by reducing a part count), and reduced power consumption (e.g., by partitioning/windowing an image sensor).

Summary:

Aspects of the present disclosure are directed to an image capture system that includes a single image sensor. The single image sensor can be partitioned into one or more separate regions. The image capture system can include one or more optical paths directed to the single image sensor. The one or more optical paths can allow for optical information representing an image to reach the single image sensor. The image capture system can include an assembly of optical path folding elements (e.g., fold mirror, prism, lens, reflector, etc.) that can select images from the one or more optical paths to be imaged on the image sensor. The image capture system can actuate the folding elements assembly to select one or more images to be captured via the one or more optical paths. The image capture system can also actuate the folding elements assembly to achieve optical image stabilization of the one or more captured images.

Detailed Description:

In some implementations, the image capture system can include a first optical path and a second optical path directed to the single image sensor. The image sensor can be partitioned into a first region corresponding to the first optical path, and a second region corresponding to the second optical path. The folding elements assembly can allow an image from the first optical path to reach the first region of the image sensor, and an image from the second optical path to reach the second region of the image sensor. As shown in Figures 1A and 1B, for example, the folding elements assembly can allow Image A from Optical Path A to be imaged on a first region of the image sensor, and simultaneously allow Image B from Optical Path B to be imaged on a second region of the image sensor. The first and second regions of the image sensor can capture Image A and Image B, respectively. The first and second regions of the image sensor can be adjusted to range from 0-100% of the total sensor area of the image sensor, with 0% being no region of the image sensor. The folding elements assembly can be actuated to direct the optical

information from Optical Path A and Optical Path B to the appropriate region of the image sensor when a range of the first and/or second regions is adjusted. The folding elements assembly can also be actuated to achieve optical image stabilization and/or auto-focus of the captured Image A and/or captured Image B.

In some implementations, the single image sensor can be partitioned into a plurality of regions, or as many regions as can be practically imaged onto the image sensor. Additionally, the partitioned regions need not be of equal size. As shown in Figure 2, for example, the image sensor can be partitioned into four regions of unequal size. The image capture system can include optical paths A, B, C, and D directed to the image sensor. The folding elements assembly of the image capture system can allow Image A, B, C, and D, from the optical path A, B, C, and D, respectively, to be imaged on the corresponding region of the image sensor.

In some implementations, the image capture system can dynamically adjust a partitioned region of the single image sensor. For example, each of a plurality of images being captured via a plurality of optical paths can be assigned a relative weight that can be adjusted at one or more times. The image capture system can partition the single image sensor according to the weight assigned to each of the plurality of images being captured. If the weight corresponding to a captured image changes, then the image capture system can adjust a partitioned region of the image sensor corresponding to the captured image, and actuate the folding elements assembly to capture the image on the adjusted region of the image sensor.

In some implementations, the image capture system can use windowing on the single image sensor. For example, image data from one or more regions of the image sensor that are not being used to capture an image from an optical path can be disregarded. As another

example, one or more regions of the image sensor that are being used to capture an image from an optical path can be disregarded.

In some implementations, the folding elements assembly can be actuated via rotation to select for an image from one or more optical paths to be imaged on the single image sensor. As shown in Figure 3, for example, the folding elements assembly can include a mirror that can be rotated to select an image from optical paths 1 – n to be captured by 100% of the image sensor. The folding elements assembly can also be actuated to achieve optical image stabilization and/or auto-focus of the captured image.

In some implementations, the folding elements assembly can be actuated via rotation to select for multiple images from two or more optical paths to be imaged on the single image sensor. As shown in Figures 4A and 4B, for example, the folding elements assembly can be rotated to select a first pair of images (Image A and Image B) or a second pair of images (Image C and Image D) to be imaged on a corresponding region of the image sensor at any given moment. The folding elements assembly can also be actuated to achieve optical image stabilization and/or auto-focus of the captured pair of images.

In some implementations, the folding elements assembly can include one or more apertures corresponding to one or more optical paths. The one or more apertures can be actuated to open or close. When an aperture is open, it can allow an image from a corresponding optical path to be captured. When an aperture is closed, it can block an image from a corresponding optical path from being captured. As shown in Figure 5, for example, the image capture system can include optical paths A, B, C, and D directed to the image sensor. The system can include apertures corresponding to each of the optical paths. Each of the apertures can be actuated independently of one another, to allow or block capture of an image from the corresponding

optical path. The aperture corresponding to optical path A can be opened to allow an image from optical path A to be imaged on the image sensor, or closed to block the image from optical path A from being imaged. Similarly, the apertures corresponding to optical paths B, C, and D can be opened or closed to allow or block capture of an image from the optical path.

In some implementations, the image capture system can be used in a device (e.g., smartphone, tablet, laptop, smart watch, wearable, AR/VR headset, or other computing system that can include one or more cameras) to couple multiple cameras (e.g., a front-facing camera and a rear-facing camera) to a single image sensor. The image capture system can include a first optical path coupled to the front-facing camera, and a second optical path coupled to the rear-facing camera. The first and second optical paths can be directed to the single image sensor. The folding elements assembly can be actuated to select between the first and second optical paths to allow an image from the front-facing camera to be captured by the image sensor, or an image from the rear-facing camera to be captured by the image sensor. As an example, a user can interact with the device and select to capture an image from the front-facing camera (e.g., front image), or an image from the rear-facing camera (e.g., rear image). In response, the device can control the image capture system to actuate the folding elements assembly and allow the front or rear image to be captured by the image sensor. As another example, the user device can determine whether it is positioned/oriented to use the front-facing camera or rear-facing camera, and control the image capture system to actuate the folding elements assembly based on the determination.

In some implementations, the image capture system can be used in a device to image both a front image corresponding to a front-facing camera, and a rear image corresponding to a rear-facing camera, on the single image sensor. The image sensor can be partitioned into a first

region and a second region, and the image capture system can include a folding elements assembly that can be actuated to allow the front image to be imaged on the first region and the rear image to be imaged on the second region. As an example, a user can select to capture both an image from the front-facing camera and the rear-facing camera. In response, the image capture system can actuate the folding elements assembly to allow the front image to be imaged on a first region of the image sensor, and simultaneously allow the rear image to be imaged on a second region of the image sensor. As another example, a user can assign/adjust a weight to each of the first image and rear image. If the weight associated with a front image is greater than the weight associated with the rear image, then the partitioned region of the image sensor corresponding to the front image can be larger than the partitioned region of the image sensor corresponding to the rear image, and vice versa.

In some implementations, the image capture system can be used in a device to capture one or more images via a plurality of optical paths, on a single image sensor. Each of the plurality of optical paths can correspond to a different camera included in the device. The one or more images via the plurality of optical paths can be simultaneously imaged on the single image sensor, on a partitioned region of the image sensor corresponding to the captured image.

Drawings:

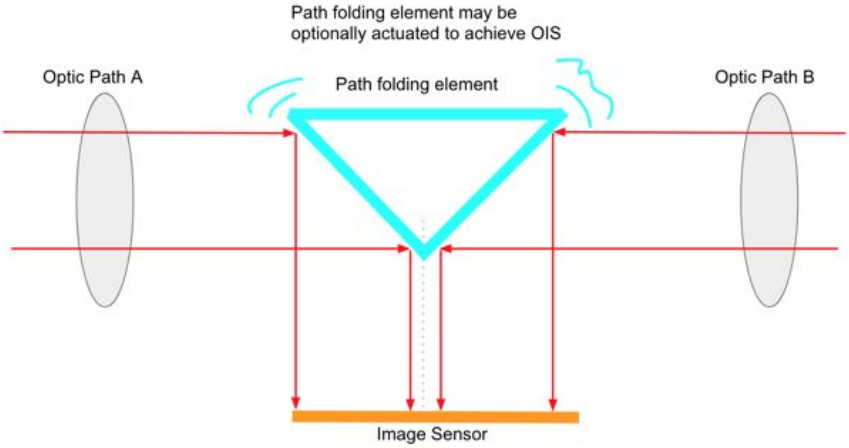

Figure 1A

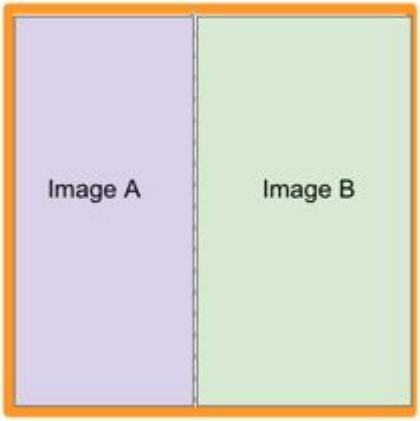

Figure 1B

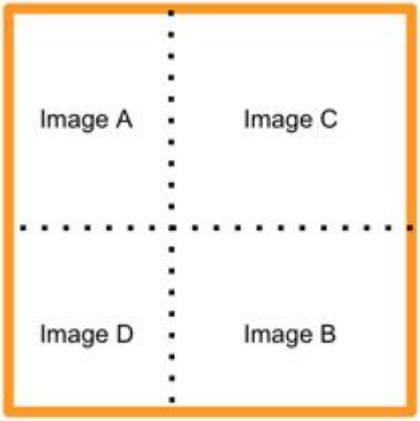

Figure 2

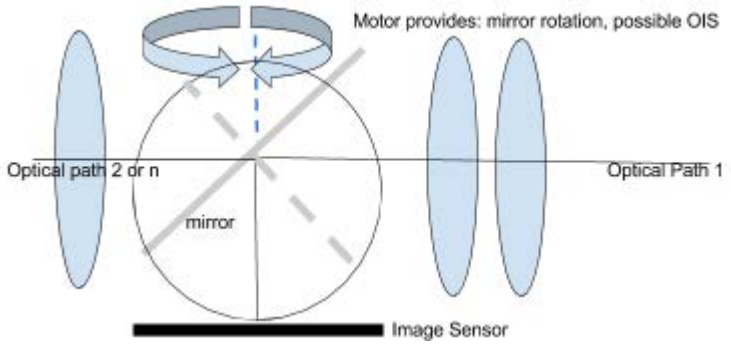

Figure 3

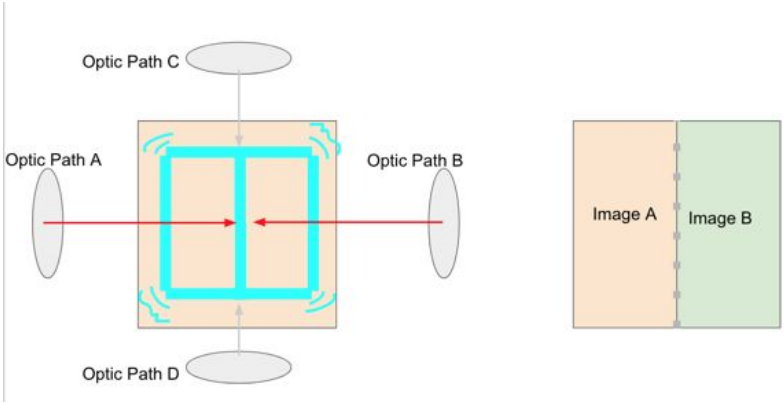

Figure 4A

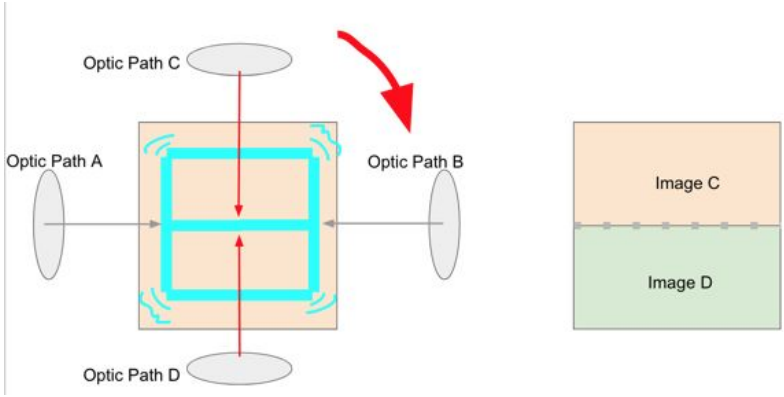

Figure 4B

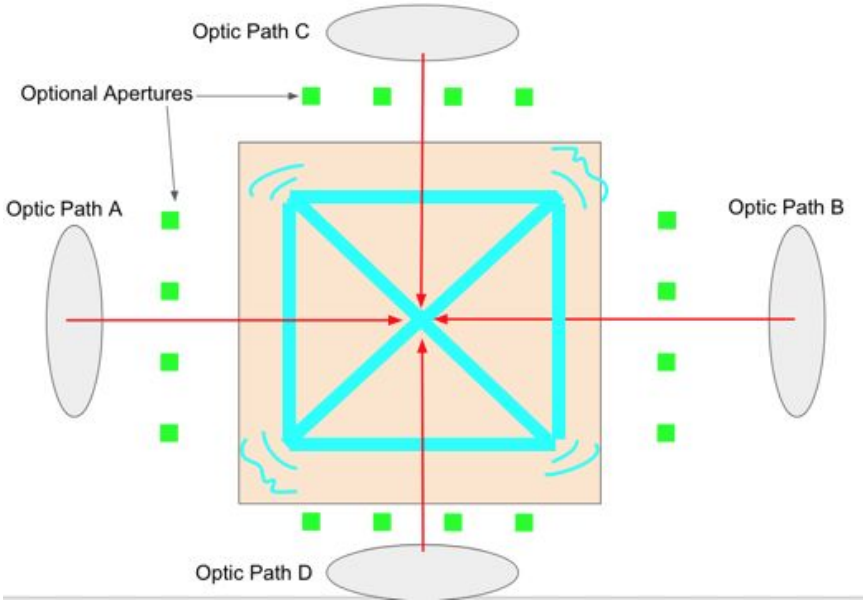
Optic Path C
Optional Apertures
Optic Path A
Optic Path B
Optic Path D

Figure 5

Abstract:

The present disclosure describes systems and methods that can capture multiple images from multiple optical paths on a single image sensor. More particularly, the multiple optical paths can be directed to the single image sensor, and the image sensor can be partitioned into one or more separate regions to capture the multiple images. An assembly of optical path folding elements can be configured to select one or more images from the multiple optical paths, and allow the selected images to be imaged on a corresponding partitioned region of the single image sensor. The system can actuate the assembly of optical path folding elements to select one or more images to be captured and/or achieve optical image stabilization of the one or more captured images. Keywords associated with the present disclosure include: computing systems (e.g., smartphone, smartwatch, mobile phone, mobile computer, laptop, headset, wearabale); camera; augmented reality; virtual reality; image capture; optical path; folding element; optical image stabilization; image sensor.