

IMAGE SHAPING OPTICAL DEVICE

FIELD OF THE INVENTION

[0001] This invention relates to an image shaping optical device for use in obtaining an image of an area of interest, and more particular to obtaining selected segments of the area of interest with the same original horizontal resolution at a camera.

BACKGROUND OF THE INVENTION

[0002] Capturing an image on a conventional camera, particularly when used for long distance surveillance usually yield scenes with a large amount of information that is not important. For example, a view of a horizon shows large amounts of sky and earth, but little of the actual horizon. Camera pixels are not optimally used since camera detector arrays are typically square or near square. Often, the desired result or area of interest is only a portion of the scene which is not square in shape. In such circumstances, capturing all of the scene would result in wastage of pixels directed to the areas of the scene which are not of interest – i.e., above and below the area of interest.

[0003] It would be desirable to provide an image shaping optical device which allows a user to select an area of interest of a scene and enhance usage of the camera detector array of a camera. It would also be desirable to provide an image shaping optical

1 device which allows a user to switch between a normal generally square shaped area of
2 interest of a scene and a thinner, wider area of interest of a scene.

3 4 SUMMARY OF THE INVENTION

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6 [0004] An optical device adapted to transmit light from an area of interest to a field of
7 view of a camera detector array of a camera, comprising at least two wedges, each
8 wedge having a top wall, a bottom wall, a front wall adapted to receive light from a
9 segment of the area of interest, and a rear wall, wherein each of the at least two
10 wedges is adapted to transmit the light from the segment to a corresponding segment of
11 the field of view of the camera detector array.

12
13 [0005] The wedges comprise a first wedge and a second wedge, and the bottom wall of
14 the first wedge contacts the top wall of the second wedge such that each wedge is
15 vertically offset from each other corresponding wedge, and each segment is horizontally
16 offset from each other segment.

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18 [0006] From the foregoing disclosure and the following more detailed description of
19 various embodiments it will be apparent to those skilled in the art that the present
20 invention provides a significant advance in the technology of optical devices.

21 Particularly significant in this regard is the potential the invention affords for providing a
22 high quality image shaping optical device. Additional features and advantages of

various embodiments will be better understood in view of the detailed description provided below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Fig. 1 is an overall schematic view of the image shaping optical device, receiving light from an area of interest of a scene and transmitting the light rays to a camera.

[0008] Fig. 2 is an isometric view of one embodiment of the image shaping optical device.

[0009] Fig. 3 is a isometric front view of the image shaping optical device of Fig. 2.

[0010] Fig. 4 is a top view of the image shaping optical device of Fig. 2.

[0011] Fig. 5 is an exploded view of the image shaping optical device of Fig. 2.

[0012] Fig. 6 is the area of interest of a scene.

[0013] Fig. 7 is a field of view of a camera detector array of a camera receiving segments of the area of interest of Fig. 6.

1 [0014] It should be understood that the appended drawings are not necessarily to scale,
2 presenting a somewhat simplified representation of various features illustrative of the
3 basic principles of the invention. The specific design features of the image shaping
4 optical device as disclosed here, including, for example, the number of wedges, will be
5 determined in part by the particular intended application and use environment. Certain
6 features of the illustrated embodiments have been enlarged or distorted relative to
7 others to help provide clear understanding. In particular, thin features may be
8 thickened, for example, for clarity of illustration. All references to direction and position,
9 unless otherwise indicated, refer to the orientation illustrated in the drawings.

11 DETAILED DESCRIPTION OF CERTAIN EMBODIMENTS

13 [0015] It will be apparent to those skilled in the art, that is, to those who have knowledge
14 or experience in this area of technology, that many uses and design variations are
15 possible for the elegant image shaping optical device disclosed here. The following
16 detailed discussion of various alternate features and embodiments will illustrate the
17 general principles of the invention with reference to an image shaping optical device
18 which allows a user to switch between a normal generally square shaped area of
19 interest of a scene and a thinner, wider area of interest of a scene. Other embodiments
20 suitable for other applications will be apparent to those skilled in the art given the benefit
21 of this disclosure.

[0016] Turning now to the drawings, Fig 1 shows a scene 90 having a preferred area of interest 70, an image shaping optical device 10 adapted to transmit light received from the area of interest to a camera 100. Typically the camera would be a digital camera, and most digital cameras have a camera detector array with a generally square or nearly square shaped field of view. As shown in Fig. 1, the area of interest is near the horizon and with normal optics the undesired portions of the scene above and below the field of interest 70 would be transmitted to the field of view of the detector array.

[0017] Figs 2-5 are various views of one embodiment of the image shaping optical device 10. The optical device 10 is made up of at least two wedges, for example, 30 and 40. In the embodiment shown in Figs. 2-3, there are five wedges 20, 30, 40, 50 and 60. Each of the wedges has a corresponding top wall (21, 31, 41, 51, and 61, respectively), and a corresponding bottom wall (22, 32, 42, 52, and 62, respectively).

[0018] Each wedge has a corresponding front wall (23, 33, 43, 53, and 63, respectively), and a corresponding back wall (24, 34, 44, 54, and 64, respectively). The front wall of each wedge and its corresponding top wall can be perpendicular with respect to each other. Preferably, each of the top walls and bottom walls, the left walls and right walls of each of the wedges can have a trapezium shape, as shown in the Figs. Alternate geometries of wedges suitable for use here will be readily apparent to those skilled in the art given the benefit of this disclosure. Each front wall and each back wall has a rectangular shape. However, the back wall can be angled with respect to vertical as discussed in greater detail below.

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2 [0019] Each wedge can comprise a transparent or translucent plastic, quartz or glass, or
3 any optically transmitting material, including those transmitting in non-visible spectra
4 such as infrared, for example. Advantageously, the wedges are adapted to receive light
5 at its corresponding front wall from a segment of the area of interest 70. The wedges
6 are adapted to transmit light from the segment to a corresponding segment of the field
7 of view of the camera detector array, at the rear walls. If there are five wedges, then
8 there would be five segments, one per wedge. As shown in Fig. 6, three wedges are
9 required when the area of interest of the scene is broken into three segments 71, 72,
10 73. Each back wall is adapted to transmit the light to a corresponding segment 81, 82,
11 83, respectively of the field of view 80 of the camera detector array shown in Fig. 7.

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13 [0020] At least two wedges must be used, or a single piece of optical material having
14 multiple sections with different refractive or light bending properties. For example, in the
15 embodiment shown in Fig. 3, a first wedge can be wedge 30 and a second wedge 40.
16 The bottom wall 32 of the first wedge 30 contacts the top wall 41 (shown in phantom in
17 Fig. 5) of the second wedge 40. In a similar manner, a third wedge 50 has a top wall 51
18 which contacts a bottom wall 42 of the second wedge 40. Two additional wedges, 20
19 and 60, one on the top and one on the bottom, can also be attached as shown such that
20 five wedges are connected together where the fourth wedge 20 is attached to the top
21 wall 31 of the first wedge, and the fifth wedge 60 is attached to the bottom wall 52 of the
22 third wedge. The top walls and the corresponding left walls of each wedge meet at a
23 first length – 27 for wedge 20, and continuing in a similar manner for the other wedges

as first length 37, 47, 57, 67, respectively. The left wall meets the bottom wall of each of the wedges at a second length 28 (and 38, 48, 58, 68 for each corresponding wedge, respectively) parallel to the first length 27. For each wedge above the second wedge (as shown in the Figs. wedges 20 and 30), the second length is greater than the first length. Second wedge 40 can have first length 47 equal to second length 48, such that each face is rectangular and wedge 40 is shaped as a rectangular cuboid. Light is transmitted through the wedge and is offset by horizontal distance of zero. For each wedge below the second wedge 40 (as shown in the Figs. wedges 50 and 60), the first length is greater than the second length.

[0021] The top walls of each wedge meet the corresponding right walls of each wedge at a third length. For each wedge above the second wedge (as shown in the Figs. wedges 20 and 30), the first lengths are greater than a corresponding third length. Third length 39 of wedge 30 is not shown, but is analogous to third length 29 of wedge 20). For example, for wedge 20, top wall 21 meets right wall 26 at third length 29, which is clearly shown in Fig. 2 to be shorter than first length 27. Second wedge 40 can have first length 47 equal to third length 49, such that each face is rectangular and wedge 40 is shaped as a rectangular cuboid. Again, wedge 40, since it is rectangular cuboid shaped, has third length 49 (shown in phantom in Fig. 5) equal to first length 47. For each wedge below the second wedge 40 (as shown in the Figs. wedges 50 and 60), the third length 59, 69 is greater than the first length 57, 67, respectively.

[0022] As shown in Fig. 6 and in accordance with a highly advantageous feature, each segment 71, 72, 73 of the area of interest is horizontally offset from each other segment, and each corresponding wedge is vertically offset from each other corresponding wedge. Thus in an embodiment where the area of interest is fragmented into three segments, three wedges 30, 40 and 50 are used. These wedges are stacked on top of each other, along an axis generally perpendicular to an axis corresponding to the array of segments of the area of interest. Each of the wedges offsets light scattered from the segment to the corresponding segment of the field of view of the array by a horizontal distance and a vertical distance. In the case of the second wedge 40 the amount of offset of horizontal distance can be zero, in which case the second wedge need not even be present, and the third wedge takes the place of the second wedge, or can be present to act as a support for the other wedges. The first wedge and the third wedge can each have a nonuniform length extending between its corresponding front wall and its corresponding back wall, and the second wedge can have a uniform length. Further, the image generated passing through the wedges to the camera detector array may be shrunken or enlarged, as needed.

[0023] Generally, light is offset so that the segments 71, 72, 73 are transmitted to corresponding segments 81, 82, 83 of the field of view 80 of the camera detector array of the camera so as to fill most if not all of the field of view. This is highly advantageous as it allows for more pertinent information about a scene to be delivered to the camera.

[0024] The wedges may be chromatic or achromatic, as needed. Also, the device may include a switching element (not shown). The wedges of the optical device can be moved into and out of alignment with the area of interest and the detector array of the camera by the switching element.

[0025] From the foregoing disclosure and detailed description of certain embodiments, it will be apparent that various modifications, additions and other alternative embodiments are possible without departing from the true scope and spirit of the invention. The embodiments discussed were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to use the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

CLAIMS

What is claimed is:

1. An optical device adapted to transmit light from an area of interest to a field of view of a camera detector array of a camera, comprising, in combination:
at least two wedges, each wedge having a top wall, a bottom wall, a front wall adapted to receive light from a segment of the area of interest, and a rear wall, wherein each of the at least two wedges is adapted to transmit the light from the segment to a corresponding segment of the field of view of the camera detector array; and
wherein the at least two wedges comprises a first wedge and a second wedge, each wedge is vertically offset from each other corresponding wedge; and each segment is horizontally offset from each other segment.
2. The optical device of claim 1, wherein each wedge comprises one of a plastic, quartz and glass.
3. The optical device of claim 1 wherein the at least two wedges further comprise a third wedge, wherein each of the wedges offsets light by a horizontal distance and a vertical distance, and the third wedge is positioned adjacent the second wedge.
4. The optical device of claim 3 wherein the top wall and left wall of each of the wedges has a trapezium shape.

5. The optical device of claim 4 wherein the second wedge is a rectangular cuboid.
6. The optical device of claim 3 wherein the top wall and left wall meet at a first length, and the left wall and the bottom wall meet at a second length which is parallel to the first length, and the top wall and right wall meet at a third length.
7. The optical device of claim 6 wherein for the first wedge the second length is greater than the first length, for the second wedge, the second length is equal to the first length, and for the third wedge, the first length is greater than the second length.
8. The optical device of claim 4 wherein the back wall has a rectangular shape.
9. The optical device of claim 1 wherein the at least two wedges comprises five wedges connected together.
10. The optical device of claim 9 wherein the third wedge is attached to the bottom wall of the second wedge, the fourth wedge is attached to the top wall of the first wedge, and the fifth wedge is attached to the bottom wall of the third wedge.
11. The optical device of claim 10 wherein at least one of each wedge offsets light from the segment to the corresponding segment at the array by a horizontal distance and by a vertical distance.

12. The optical device of claim 1, wherein each front wall and corresponding top wall are perpendicular with respect to each other.
13. The optical device of claim 1, wherein one or more of the wedges are achromatic.
14. The optical device of claim 1, wherein a camera has the camera detector array, and further comprising a switching element, wherein the optical device can be moved into and out of alignment between the area of interest and the camera by the switching element.
15. The optical device of claim 1 wherein the bottom wall of the first wedge contacts the top wall of the second wedge.