Method and Apparatus For Generating an Infrared Illumination Beam with a Variable Illumination Pattern

Field

This disclosure relates generally to a method for generating an infrared ("IR") illumination beam with a variable illumination pattern, and an IR illuminator for performing such method. Such IR illuminator can be part of an imaging apparatus having a zoom lens, and generate an IR illumination beam with an illumination pattern that varies with the focal length of the zoom lens.

Background

Some conventional security or surveillance cameras use varifocal lenses that allow an adjustable field-of-view. When equipped with an IR illuminator, the illumination pattern is fixed for all focal lengths and is generally optimized for a specific field of view at one focal length. For field of views that are larger than the optimized field of view, a non-optimal illumination pattern will appear as a bright spot in the centre of the image, saturating the sensor in that region and obscuring detail. Conversely, for field of views that are narrower than the optimized field of view, some of the illumination power will be projected outside of the imaging area and therefore be wasted. As a result, a less than optimal IR image is captured by surveillance cameras that use such IR illuminators.

Summary

According to one aspect of the invention, there is provided a method for generating an infrared (IR) beam for illuminating a scene to be imaged, the method comprising:

(a) providing at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) determining a current focal length, and using a processor, automatically selecting a power ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces the IR beam with a desired linear profile for the determined current focal length when the narrow beam component and wide beam component are combined, wherein the power ratio is selected from a beam profile-to-focal length map comprising a series of focal length increments and their corresponding power ratios that produce an IR beam with the desired linear profile; and

(c) producing the IR beam by directing power to the first and second IR emitters at the selected power ratio to generate the wide and narrow beam components, and combining the generated wide and narrow beam components.

The method can further comprise imaging the scene at a selected focal length, wherein the selected focal length has an associated field of view. The desired linear profile for the selected focal length has a standard deviation that is less than or equal to the target standard deviation and a highest available irradiance within the field of view. The highest available irradiance can be the power ratio having the highest proportion of power directed to second IR emitter and which produces an IR beam with a standard deviation less than or equal to the target standard deviation.

The method can further comprise imaging the scene at different focal lengths each having a respective different field of view, and producing an IR beam with a desired linear profile corresponding to each different focal length. Each desired linear profile has a standard deviation that is less than or equal to the target standard deviation and the highest available irradiance for the field of view associated with the corresponding focal length.

The imaging can be performed by an imaging apparatus having a zoom lens with variable focal lengths, in which case the method comprises determining a current focal length of the zoom lens, selecting the desired linear profile corresponding to the current focal length, producing an IR beam at the desired focal length, and imaging a scene illuminated by the IR beam at the current focal length. Selecting the desired linear profile corresponding to the current focal length can comprise accessing a beam profile-

to-focal length map comprising a series of focal length increments and their corresponding desired linear profiles, and selecting the linear profile in the map with a corresponding focal length increment equal to the current focal length.

According to a second aspect of the invention, there is provided an apparatus for illuminating a scene to be imaged with infrared (IR) radiation, comprising:

(a) at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) at least two current drivers, including a first current driver coupled to the first IR emitter, and a second current driver coupled to the second IR emitter; and

(c) processing circuitry communicative with the current drivers to instruct each current driver to deliver a selected amount of power to the coupled IR emitter, and comprising a processor and a memory having encoded thereon: (i) a beam profile-to-focal length map comprising a series of focal length increments and their corresponding power ratios, wherein each power ratio is a ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces an IR beam with a desired linear profile for the corresponding focal length increment when the narrow beam component and wide beam component are combined; and (ii) program code executable by the processor to select a power ratio for a determined current focal length by selecting from the beam profile-to-focal length map the power ratio corresponding to the focal length increment matching the determined current focal length; and control the current drivers to direct power to the first and second IR emitters at the selected power ratio to generate the wide and narrow beam components and combine the generated wide and narrow beam components.

The apparatus can further comprise an imager communicative with the processing circuitry, a zoom lens having variable focal lengths and being optically coupled to the imager, and a lens driver communicative with the zoom lens and the processing circuitry. The memory can further comprise a beam profile-to-focal length map comprising a series of focal length increments of the zoom lens and their corresponding desired linear profiles.

According to another aspect of the invention, there is provided a method for generating a beam profile-to-focal length map for use in an apparatus that illuminates a scene with an infrared (IR) beam composed of a wide beam component and a narrow beam component, wherein the apparatus comprises at least a first IR emitter operable to emit the wide beam component and a second IR emitter operable to emit the narrow beam component, and wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component; the method comprising:

(a) for each focal length increment in a group of focal length increments, determining a suitable wide beam-to-narrow beam power ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces an IR beam with a desired linear profile for the focal length increment when the narrow beam component and wide beam component are combined; and

(b) storing the determined suitable wide-beam-to-narrow-beam power ratio and corresponding focal length increment in a database readable by the apparatus.

According to another aspect of the invention, there is provided an apparatus for illuminating a scene to be imaged with infrared (IR) radiation, comprising:

(a) at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) at least two current drivers, including a first current driver coupled to the first IR emitter, and a second current driver coupled to the second IR emitter; and

(c) processing circuitry communicative with the current drivers to instruct each current driver to deliver a selected amount of power to the coupled IR emitter, and comprising a processor and a memory having encoded thereon program code for generating a beam profile-to-focal length map, and for using the map to instruct the IR emitters to produce an IR beam with a suitable wide beam-to-narrow beam power ratio of power directed to the first IR emitter and power directed to the second IR emitter, wherein the program code for generating the map comprises: (i) for each focal length increment in a group of focal length increments, determining a wide beam-to-narrow beam power ratio that produces an IR beam with a desired linear profile for the focal length increment when the narrow beam component and wide beam component are combined and selecting this determined power ratio as the suitable wide beam-to-narrow beam power ratio; and (ii) storing the suitable wide beam-to-narrow beam power

ratio and corresponding focal length increment in a database readable by the processing circuitry.

Brief Description of Drawings

Figure 1 is a schematic block diagram of components of an imaging apparatus with a zoom adaptive IR beam according to one embodiment of the invention.

Figure 2 is a perspective view of the imaging apparatus embodied as a security camera.

Claims

What is claimed is:

1. A method for generating an infrared (IR) beam for illuminating a scene to be imaged, the method comprising:

(a) providing at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) determining a current focal length, and using a processor, automatically selecting a power ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces the IR beam with a desired linear profile for the determined current focal length when the narrow beam component and wide beam component are combined, wherein the power ratio is selected from a beam profile-to-focal length map comprising a series of focal length increments and their corresponding power ratios that produce an IR beam with the desired linear profile; and

(c) producing the IR beam by directing power to the first and second IR emitters at the selected power ratio to generate the wide and narrow beam components, and combining the generated wide and narrow beam components.

2. A method as claimed in claim 1 wherein the generated wide and narrow beam components are combined by directing the centres of the wide and narrow beam components on the same location in the scene.

3. A method as claimed in claim 2 wherein the desired linear profile of the IR beam has a standard deviation that is less than or equal to a target standard deviation.

4. A method as claimed in claim 3 further comprising imaging the scene at a selected focal length, wherein the selected focal length has an associated field of view, and the desired linear profile for the selected focal length has a standard deviation that is less than or equal to the target standard deviation and a highest available irradiance within the field of view.

5. A method as claimed in claim 4 wherein the highest available irradiance is the power ratio having the highest proportion of power directed to second IR emitter and which produces an IR beam with a standard deviation less than or equal to the target standard deviation.

6. A method as claimed in claim 5 further comprising imaging the scene at different focal lengths each having a respective different field of view, and producing an IR beam with a desired linear profile corresponding to each different focal length, wherein each desired linear profile has a standard deviation that is less than or equal to the target standard deviation and

the highest available irradiance for the field of view associated with the corresponding focal length.

7. A method as claimed in claim 6 wherein the imaging is performed by an imaging apparatus having a zoom lens with variable focal lengths, and the method comprises determining a current focal length of the zoom lens, selecting the desired linear profile corresponding to the current focal length, producing an IR beam at the desired focal length, and imaging a scene illuminated by the IR beam at the current focal length.

8. An apparatus for illuminating a scene to be imaged with infrared (IR) radiation, comprising:

(a) at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) at least two current drivers, including a first current driver coupled to the first IR emitter, and a second current driver coupled to the second IR emitter; and

(c) processing circuitry communicative with the current drivers to instruct each current driver to deliver a selected amount of power to the coupled IR emitter, and comprising a processor and a memory having encoded thereon: (i) a beam profile-to-focal length map comprising a series of focal length increments and their corresponding power ratios, wherein each power ratio is a ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces an IR beam with a desired linear profile for the corresponding focal length increment when the narrow beam component and wide beam component are combined; and (ii) program code executable by the processor to select a power ratio for a determined current focal length by selecting from the beam profile-to-focal length map the power ratio corresponding to the focal length increment matching the determined current focal length; and control the current drivers to direct power to the first and second IR emitters at the selected power ratio to generate the wide and narrow beam components and combine the generated wide and narrow beam components.

9. An apparatus as claimed in claim 8 wherein the first and second IR emitters are aligned such that the wide and narrow beam components are directed at the same location in the scene.

10. An apparatus as claimed in claim 9 further comprising an imager communicative with the processing circuitry, a zoom lens having variable focal lengths and being optically coupled to the imager, and a lens driver communicative with the zoom lens and the processing circuitry.

11. An apparatus as claimed in claim 10 wherein the memory further comprises a beam

profile-to-focal length map comprising a series of focal length increments of the zoom lens and their corresponding desired linear profiles.

12. A method for generating a beam profile-to-focal length map for use in an apparatus that illuminates a scene with an infrared (IR) beam composed of a wide beam component and a narrow beam component, wherein the apparatus comprises at least a first IR emitter operable to emit the wide beam component and a second IR emitter operable to emit the narrow beam component, and wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component; the method comprising:

(a) for each focal length increment in a group of focal length increments, determining a suitable wide beam-to-narrow beam power ratio of power directed to the first IR emitter and power directed to the second IR emitter that produces an IR beam with a desired linear profile for the focal length increment when the narrow beam component and wide beam component are combined; and

(b) storing the determined suitable wide-beam-to-narrow-beam power ratio and corresponding focal length increment in a database readable by the apparatus.

13. A method as claimed in claim 12 wherein the step of determining the suitable wide beam-to-narrow beam power ratio for the focal length increment comprises determining a power ratio which produces an IR beam having a maximum IR power delivered to a field of view at the focal length increment and a linear profile that has a standard deviation that is below a target standard deviation.

14. A method as claimed in claim 13 wherein determining a wide beam-to-narrow beam power ratio which produces an IR beam having the maximum IR power comprises performing an iterative loop starting with a low wide-beam-to-narrow beam power ratio and iterating through a selected number of power ratio increments of decreasing increments of power to the second IR emitter, then selecting the lowest power ratio increment that produces a linear profile with a standard deviation that is less the target standard deviation.

15. A method as claimed in claim 13 wherein after the lowest power ratio increment has been selected, linearly interpolating for an optimal power ratio, and using the optimal power ratio as the suitable power ratio for the focal length increment in the database.

16. An apparatus for illuminating a scene to be imaged with infrared (IR) radiation, comprising:

(a) at least two IR emitters, including a first IR emitter operable to emit a wide beam component of the IR beam, and a second IR emitter operable to emit a narrow beam

component of the IR beam, wherein the wide beam component has a linear profile that has a lower standard deviation than a linear profile of the narrow beam component;

(b) at least two current drivers, including a first current driver coupled to the first IR emitter, and a second current driver coupled to the second IR emitter; and

(c) processing circuitry communicative with the current drivers to instruct each current driver to deliver a selected amount of power to the coupled IR emitter, and comprising a processor and a memory having encoded thereon program code for generating a beam profile-to-focal length map, and for using the map to instruct the IR emitters to produce an IR beam with a suitable wide beam-to-narrow beam power ratio of power directed to the first IR emitter and power directed to the second IR emitter, wherein the program code for generating the map comprises: (i) for each focal length increment in a group of focal length increments, determining a wide beam-to-narrow beam power ratio that produces an IR beam with a desired linear profile for the focal length increment when the narrow beam component and wide beam component are combined and selecting this determined power ratio as the suitable wide beam-to-narrow beam power ratio; and (ii) storing the suitable wide beam-to-narrow beam power ratio and corresponding focal length increment in a database readable by the processing circuitry.

17. An apparatus as claimed in claim 16 wherein program code for determining the suitable wide beam-to-narrow beam power ratio for the focal length increment comprises determining a power ratio which produces an IR beam having a maximum IR power delivered to a field of view at the focal length increment and a linear profile that has a standard deviation that is below a target standard deviation.

18. An apparatus as claimed in claim 17 wherein the program code for determining a wide beam-to-narrow beam power ratio which produces an IR beam having the maximum IR power comprises performing an iterative loop starting with a low wide-beam-to-narrow beam power ratio and iterating through a selected number of power ratio increments of decreasing increments of power to the second IR emitter, then selecting the lowest power ratio increment that produces a linear profile with a standard deviation that is less the target standard deviation.

19. An apparatus as claimed in claim 18 wherein after the lowest power ratio increment has been selected, linearly interpolating for an optimal power ratio, and using the optimal power ratio as the suitable power ratio for the focal length increment in the database.