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(54) **THIN MULTI-APERTURE IMAGING SYSTEM WITH AUTO-FOCUS AND METHODS FOR USING SAME**

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(63) Continuation of application No. 15/982,401, filed on May 17, 2018, now Pat. No. 10,250,797, which is a (Continued)

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H04N 5/225 (2006.01)

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(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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(Continued)

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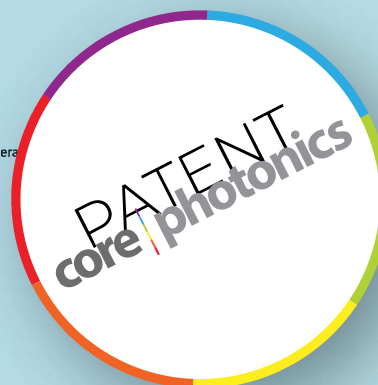
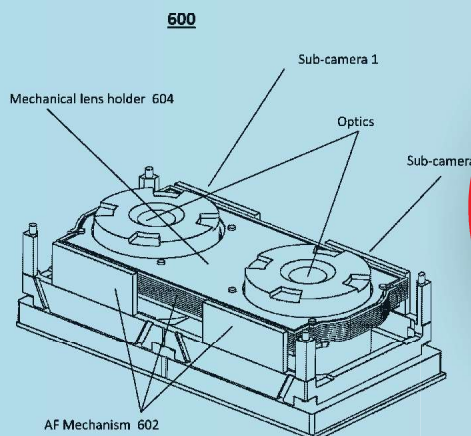
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(57) **ABSTRACT**

Dual-aperture digital cameras with auto-focus (AF) and related methods for obtaining a focused and, optionally optically stabilized color image of an object or scene. A dual-aperture camera includes a first sub-camera having a first optics bloc and a color image sensor for providing a color image, a second sub-camera having a second optics bloc and a clear image sensor for providing a luminance image, the first and second sub-cameras having substantially the same field of view, an AF mechanism coupled mechanically at least to the first optics bloc, and a camera controller coupled to the AF mechanism and to the two image sensors and configured to control the AF mechanism, to calculate a scaling difference and a sharpness difference between the color and luminance images, the scaling and sharpness differences being due to the AF mechanism, and to process the color and luminance images into a fused color image using the calculated differences.

19 Claims, 10 Drawing Sheets





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(54) **THIN MULTI-APERTURE IMAGING SYSTEM WITH AUTO-FOCUS AND METHODS FOR USING SAME**

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Related U.S. Application Data

(63) Continuation of application No. 16/249,937, filed on Jan. 17, 2019, which is a continuation of application No. 15/982,401, filed on May 17, 2018, now Pat. No. 10,250,797, which is a continuation of application No. 15/407,271, filed on Jan. 17, 2017, now Pat. No. 9,998,653, which is a continuation of application No. 14/906,116, filed on Jan. 19, 2016, now Pat. No. 9,571,731, filed as application No. PCT/IB2014/063393 on Jul. 24, 2014.

(60) Provisional application No. 61/861,185, filed on Aug. 1, 2013.

Publication Classification

(51) **Int. Cl.**

H04N 5/232 (2006.01)

H04N 9/09 (2006.01)

(57) **ABSTRACT**

Dual-aperture digital cameras with auto-focus (AF) and related methods for obtaining a focused and, optionally optically stabilized color image of an object or scene. A dual-aperture camera includes a first sub-camera having a first optics bloc and a color image sensor for providing a color image, a second sub-camera having a second optics bloc and a clear image sensor for providing a luminance image, the first and second sub-cameras having substantially the same field of view, an AF mechanism coupled mechanically at least to the first optics bloc, and a camera controller coupled to the AF mechanism and to the two image sensors and configured to control the AF mechanism, to calculate a scaling difference and a sharpness difference between the color and luminance images, the scaling and sharpness differences being due to the AF mechanism, and to process the color and luminance images into a fused color image using the calculated differences.

