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(54) ## DETECTION OF A MOVEMENT OF A BODY IN AN AREA WHICH IS TO BE MONITORED

(57) Provided is a device for detecting a movement of a body in an area which is to be monitored by the device. The device comprises a first sensor which is configured to output a first signal that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region of said first sensor and a second sensor which is configured to output a second signal that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region of said second sensor. The device further comprises an arrangement which images discrete first portions of the area onto the first surface region and discrete second portions of the area onto the second surface region, thereby segmenting the area along a first curve traversing the area from a first side of the area to a second side of the area, into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions.

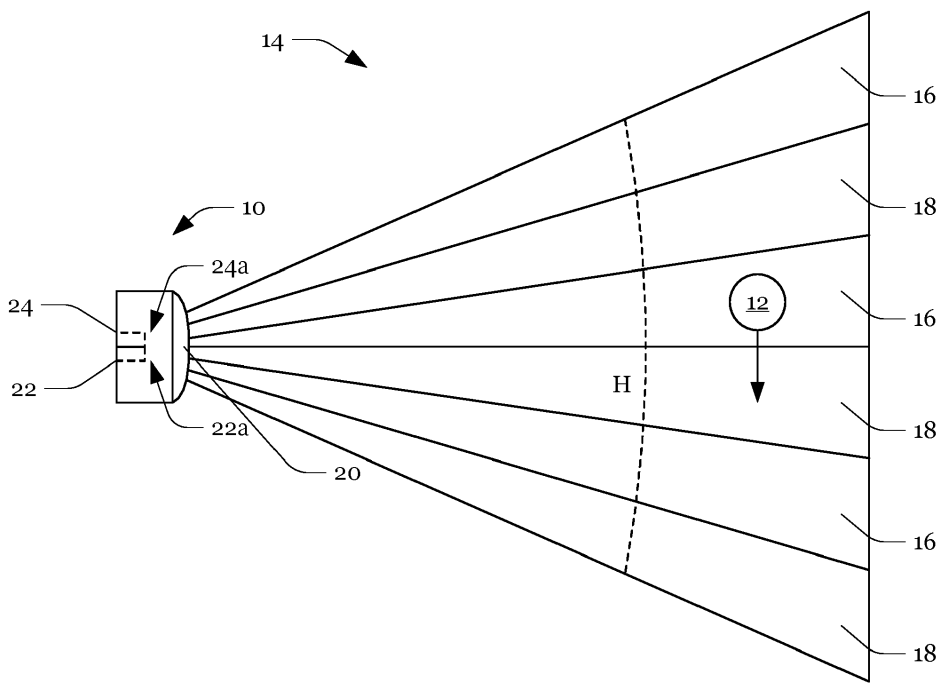

Fig. 1a

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Description

FIELD

[0001] The present disclosure relates to the detection of a movement of a body in an area which is to be monitored. In particular, the present disclosure relates to the detection of a movement of a body based on pyroelectric sensors.

BACKGROUND

[0002] The use of pyroelectric sensors for detecting a movement of a body in an area which is to be monitored is known, for example, from DE 42 18 151 C2. However, conventional pyroelectric sensors may suffer from blind spots or weak detection accuracy in parts of the area.

SUMMARY

[0003] The present invention is directed at a device for and a method of detecting a movement of a body in an area.

[0004] The device comprises a first sensor which is configured to output a first signal that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region of said first sensor, a second sensor which is configured to output a second signal that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region of said second sensor, and an arrangement which images discrete first portions of the area onto the first surface region and discrete second portions of the area onto the second surface region, thereby segmenting the area along a first curve traversing the area from a first side of the area to a second side of the area, into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions.

[0005] In this regard, the term "electromagnetic radiation", as used throughout the description and the claims, particularly refers to electromagnetic waves having a wavelength within the infrared spectrum (e.g., 700 nm to 1 mm). Moreover, the term "body", as used throughout the description and the claims, particularly refers, but is not limited, to a body of a human being. I.e., the term "body", as used throughout the description and the claims, shall encompass any object of whatever shape or form that is moved (or moves) through the area.

[0006] Furthermore, the wording "discrete first portions", "discrete second portions", "discrete third portions", and "discrete fourth portions", as used throughout the description and the claims, particularly refers to, first portions which neither overlap with nor abut on any other first portion, second portions which neither overlap with nor abut on any other second portion, third portions which neither overlap with nor abut on any other third portion and fourth portions which neither overlap with nor abut on any other fourth portion, respectively. In this regard, the term "area", as used throughout the description and the claims, refers to the three-dimensional space (volume) in which a moving body may be detected.

[0007] Moreover, the words "first", "second", "third", etc., are used in a nominal sense rather than in an ordinal sense throughout the description and the claims, unless the context clearly provides otherwise. So, for example, the wording "a second surface region of said second sensor" does not necessarily mean that the second sensor also has a first surface region, although that is entirely possible. Instead, this wording is used to avoid confusion which might otherwise occur when referring to the "first surface region". In fact, each sensor may have exactly one (active) surface region so that a signal which is output by a sensor may only be indicative of electromagnetic radiation incident upon said (single) surface region.

[0008] In addition, the term "sequence", as used throughout the description and the claims, particularly refers to a succession of individual portions, wherein the succession contains each individual portion only once. In this regard, the formulation "alternating first and second portions", as used throughout the description and the claims, particularly refers to a sequence of the type "ABABA ..." or "BABAB ..." where "A" stands for a first portion and "B" stands for a second portion. Analogously, the formulation "alternating discrete third and fourth portions", as used throughout the description and the claims, particularly refers to a sequence of the type "CDCDC ..." or "DCDCD ..." where "C" stands for a discrete third portion and "D" stands for a discrete fourth portion. Finally, the formulation that the arrangement "images discrete portions of the area onto a surface region", as used throughout the description and the claims, particularly refers to a projection where each discrete portion projected onto the surface region covers the whole surface region. In other words, the surface region may "see" through the arrangement all of, but not more than, the discrete portions imaged onto it.

[0009] The first curve may lie in a first plane. For example, the first curve may be a horizontal curve.

[0010] The first curve may be a (straight) line, a curve comprising one or more straight segments, a curve consisting of straight segments or a curve that has no straight segment.

[0011] The first sensor may comprise a first pyroelectric element and the second sensor may comprise a second pyroelectric element, wherein the first surface region is a surface region of the first pyroelectric element and the second surface region is a surface region of the second pyroelectric element.

[0012] For example, the first signal may be a first voltage generated by the first pyroelectric element and the second signal may be a second voltage generated by the second pyroelectric element.

[0013] Alternatively, or in addition, the first sensor may comprise a first thermopile element and the second sensor may comprise a second thermopile element, wherein the first surface region is a surface region of the first thermopile element and the second surface region is a surface region of the second thermopile element.

[0014] Alternatively, or in addition, the first sensor may be a first bolometer and the second sensor may be a second bolometer, wherein the first surface region is a surface region of an absorptive element of the first bolometer and the second surface region is a surface region of an absorptive element of the second bolometer.

[0015] Hence, a body may only be detectable if its surface temperature differs from the temperature of a background which it temporarily occludes. Accordingly, the formulation "detecting a movement of a body in an area" is to be understood to mean that detecting a movement of a body in an area is desired but may not be achieved (with sufficient accuracy) under each and any circumstances.

[0016] The arrangement may comprise a plurality of optical elements. The optical elements may be mirrors and/or lenses. Moreover, the plurality of optical elements may be distinct sections of a single lens or mirror (wherein different sections differ with regard to their imaging properties).

[0017] For example, the arrangement may comprise a first lens and a second lens, wherein a first fraction of the electromagnetic radiation incident upon the first surface region of the first sensor travels through the first lens, a second fraction of the electromagnetic radiation incident upon the first surface region of the first sensor travels through the second lens, and a first fraction of the electromagnetic radiation incident upon the second surface region of the second sensor travels through the first lens, and a second fraction of the electromagnetic radiation incident upon the second surface region of the second sensor travels through the second lens.

[0018] A first optical axis of the first lens and a second optical axis of the second lens may be parallel and/or the first surface region and the second surface region may be coplanar.

[0019] Accordingly, keeping the images focused on the surface regions may be facilitated. For example, a first sensor-side focal point of the first lens and a second sensor-side focal point of the second lens may lie in a plane defined by the first surface region and the second surface region.

[0020] There may be a horizontal gap and/or a vertical gap between the first surface region and the second surface region.

[0021] The horizontal gap between the first surface region and the second surface region may be substantially zero or a multiple of a horizontal distance between the first optical axis and the second optical axis.

[0022] The horizontal distance between the first optical axis and the second optical axis may be equal to or larger than a combined width of the first surface region and the second surface region.

[0023] This may avoid (horizontal) gaps between the discrete first and discrete second portions. For example, if the horizontal distance between the first optical axis and the second optical axis is equal to the combined width of the first surface region and the second surface region, a (horizontal) overlap between the discrete first and discrete second portions may be avoided. Accordingly, there may be no space (between the portions) that is not covered by the device, yet the width of the portions may be adjusted to increase the device's sensitivity.

[0024] The width of the first surface region may be equal to the width of the second surface region.

[0025] Accordingly, the segmentation may be mirror-symmetric. For example, the segmentation may be mirror-symmetric to a horizontal axis.

[0026] The vertical gap between the first surface region and the second surface region may be substantially zero or a multiple of a vertical distance between the first optical axis and the second optical axis.

[0027] The vertical distance between the first optical axis and the second optical axis may be equal to or larger than a combined height of the first surface region and the second surface region.

[0028] This may avoid (vertical) gaps between the discrete first and discrete second portions. For example, if the vertical distance between the first optical axis and the second optical axis is equal to the combined height of the first surface region and the second surface region, a (vertical) overlap between the discrete first and discrete second portions may be avoided. Accordingly, there may be no space (between the portions) that is not covered by the device, yet the height of the portions may be adjusted to increase the device's sensitivity.

[0029] The height of the first surface region may be equal to the height of the second surface region.

[0030] Accordingly, the segmentation may be mirror-symmetric. For example, the segmentation may be mirror-symmetric to a vertical axis.

[0031] The device may further comprise a first output for outputting the first signal and a second output for outputting the second signal, or circuitry which is configured to combine the first signal and the second signal, wherein said circuitry may be further configured to ensure that an effect of a decreasing first intensity on the combined signal is not compensated by an effect of an increasing second intensity on the combined signal, and vice versa.

[0032] Hence, the device may be able to detect a body that moves (e.g., in the horizontal direction) out of a discrete first portion and (directly) into an (abutting) discrete second portion, or out of a discrete second portion and (directly) into an (abutting) discrete first portion.

[0033] The device may further comprise a third sensor which is configured to output a third signal that is indicative of a third intensity of electromagnetic radiation incident upon a third surface region of said third sensor, wherein the arrangement images discrete third portions of the area onto the third surface region, thereby segmenting the area along a second curve, the first curve and the second curve being lines that are perpendicular to each other, into a sequence comprising alternating, overlapping or non-overlapping, discrete third and discrete fourth portions.

[0034] The second curve may lie in a second plane, wherein the second plane is preferably not aligned coplanar/parallel to the first plane. For example, the second curve may be a vertical curve.

[0035] Thus, a two-dimensional segmentation may be achieved.

[0036] For example, a horizontal segmentation and a vertical segmentation of the area may be combined, thereby facilitating the accurate detection of both, horizontal and vertical movements of a body within said area.

[0037] The arrangement may image the discrete fourth portions of the area onto a fourth surface region of a fourth sensor of the device, which may be configured to output a fourth signal that is indicative of a fourth intensity of electromagnetic radiation incident upon the fourth surface region. Moreover, instead of adding a fourth sensor and imaging the discrete fourth portions of the area onto the fourth surface region of the fourth sensor, the discrete fourth portions may also be imaged onto the first surface region of the first sensor.

[0038] The arrangement may comprise a third lens and a fourth lens, wherein a first fraction of the electromagnetic radiation incident upon the third surface region of the third sensor travels through the third lens, and a second fraction of the electromagnetic radiation incident upon the third surface region of the third sensor travels through the fourth lens. Moreover, a third fraction of the electromagnetic radiation incident upon the third surface region of the third sensor may travel through the first lens. For example, in a scenario where only two lenses (or two lens rows) are vertically stacked, the electromagnetic radiation incident upon the third surface region of the third sensor may also only travel through the first lens and the third lens.

[0039] If, however, the arrangement images the discrete fourth portions of the area onto the fourth surface region of the fourth sensor, a first fraction of the electromagnetic radiation incident upon the fourth surface region of the fourth sensor may travel through the third lens, and a second fraction of the electromagnetic radiation incident upon the fourth surface region of the fourth sensor may travel through the fourth lens. Again, if, for instance, only two lenses (or two lens rows) are vertically stacked, the electromagnetic radiation incident upon the third surface region of the third sensor may also only travel through the first lens and the third lens.

[0040] Yet, if the arrangement images the discrete fourth portions of the area onto the first surface region of the first sensor, a third fraction of the electromagnetic radiation incident upon the first surface region of the first sensor may travel through the third lens, and a fourth fraction of the electromagnetic radiation incident upon the first surface region of the first sensor may travel through the fourth lens. Again, if only two lenses (or two lens rows) are vertically stacked, the electromagnetic radiation incident upon the first surface region of the first sensor may only travel through the first lens and the third lens.

[0041] A third optical axis of the third lens and a fourth optical axis of the fourth lens may be parallel.

[0042] A vertical distance between the third optical axis and the fourth optical axis may be equal to or larger than two times a height of the third surface region.

[0043] The method comprises segmenting the area into a pattern of non-overlapping portions, imaging a first subset of said portions onto a first surface region of a first sensor which is configured to output a first signal and imaging a second subset of said portions onto a second surface region of a second sensor which is configured to output a second signal, wherein any pair of portions of said first subset is separated by at least one portion of said second subset and, wherein any pair of portions of said second subset is separated by at least one portion of said first subset, and evaluating the first signal and evaluating the second signal, or evaluating a combined signal, wherein the combined signal is indicative of each change of either the first signal, the second signal, or both.

[0044] In this regard, the formulation that "the combined signal is indicative of each change of either the first signal, the second signal, or both", as used throughout the description and the claims, particularly refers to signals which are not formed by merely summing the first signal and the second signal. For example, the first sensor and the second sensor may not be merely serially (or anti-serially) connected.

[0045] The portions of the first and second subsets may be imaged onto the first surface region and the second surface region, respectively, by a first lens and a second lens, wherein a first optical axis of the first lens and a second optical axis of the second lens are parallel, and the first surface region and the second surface region are coplanar.

[0046] There may be a horizontal gap and/or a vertical gap between the first surface region and the second surface region.

[0047] The horizontal gap between the first surface region and the second surface region may be substantially zero or a multiple of a horizontal distance between the first optical axis and the second optical axis, and said horizontal distance between the first optical axis and the second optical axis may be equal to or larger than a combined width of the first surface region and the second surface region.

[0048] The vertical gap between the first surface region and the second surface region may be substantially zero or a multiple of a vertical distance between the first optical axis and the second optical axis, and said vertical distance between the first optical axis and the second optical axis may be equal to or larger than a combined height of the first surface region and the second surface region.

[0049] Notably, all other features of the device may also be features of the method and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] The foregoing aspects and many of the attendant advantages will become more readily appreciated as the same become better understood by reference to the following description of embodiments, when taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts throughout the various views, unless otherwise specified.

Fig. 1a schematically illustrates a top view and Fig. 1b schematically illustrates a side view of a device for detecting a movement of a body in an area which is to be monitored by the device.

Fig. 2a, Fig. 2b and Fig. 2c schematically illustrate the sensor signals caused by a body moving through the area.

Fig. 3a and Fig. 3b schematically illustrate a possible modification of the device which results in overlapping first and second portions.

Fig. 4 schematically illustrates an option for the horizontal placement of the sensors in the device.

Fig. 5 schematically illustrates another option for the horizontal placement of the sensors in the device.

Fig. 6 schematically illustrates a possible modification of the size of the sensors shown in Fig. 4.

Fig. 7 schematically illustrates a possible modification of the size of the sensors shown in Fig. 5.

Fig. 8a and Fig. 8b schematically illustrate another possible modification of the device which results in a vertical segmentation of the area.

Fig. 8c and Fig. 8d schematically illustrate further sensor signals caused by a body moving through the area.

Fig. 9 schematically illustrates a modification where two sensors are vertically stacked.

Fig. 10 schematically illustrates another option for the vertical placement of the sensors shown in Fig. 9.

Fig. 11 schematically illustrates a modification where three lenses are vertically stacked.

Fig. 12 schematically illustrates another option for the vertical placement of the sensors shown in Fig. 11.

Fig. 13 shows a flow chart of the method.

[0051] Notably, the drawings are not drawn to scale and unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

DESCRIPTION OF EMBODIMENTS

[0052] Fig. 1a schematically illustrates a top view and Fig. 1b schematically illustrates a side view of device 10 which is configured to detect a movement of body 12 in area 14. Area 14 is segmented along a horizontal curve H into a sequence of alternating, non-overlapping discrete first portions 16 and discrete second portions 18 by arrangement 20 which images discrete first portions 16 onto first surface region 22a (of first pyroelectric sensor 22) and discrete second portions 18 onto second surface region 24a (of second pyroelectric sensor 24). Hence, discrete first portions 16 may be monitored by first pyroelectric sensor 22 and discrete second portions 18 may be monitored by second pyroelectric sensor 24. As stated above, first pyroelectric sensor 22 and second pyroelectric sensor 24 may be replaced by thermopile sensors or bolometer sensors.

[0053] As indicated by the arrow in Fig. 1a and the circles in Fig. 2a, body 12 may move through area 14 from one side to the other. If the surface temperature of body 12 differs from the surface temperature of the structures which it occludes from view, signal I1 (which depends on the intensity of electromagnetic radiation incident upon first surface region 22a) may undergo a change whenever body 12 enters into one of discrete first portions 16 and signal I2 (which depends on the intensity of electromagnetic radiation incident upon second surface region 24a) may undergo a change whenever body 12 enters into one of discrete second portions 18, as schematically indicated in Fig. 2b and Fig. 2c. Likewise, signal I1 may undergo a change whenever body 12 leaves one of discrete first portions 16 and signal I2 may undergo a change whenever body 12 leaves one of discrete second portions 18, as schematically indicated in Fig. 2b and Fig. 2c.

[0054] To detect the movement of body 12, signal I1 output by first sensor 22 and signal I2 output by second sensor 24 may be analyzed individually. For example, if either I1 or 12 undergoes a change (within a specific time) that is larger than a threshold, device 10 may output a signal indicating that body 12 (is present in area 14 and/or) moves. This signal may be used to activate another device (not shown). Furthermore, signal I1 output by first sensor 22 and signal 12 output by second sensor 24 may be combined (by circuitry in device 10). The combined signal may ensure that a change having an impact on signal I1 output by first sensor 22, that could otherwise be observed in the combined signal, is not (easily) compensated by a change having an impact on signal 12 output by second sensor 24. For example, a combined signal may be formed by summing $\pm I1^2$ and $\pm I2^2$. Signal I1 and I2 may also be output separately by device 10 and may be processed by an apparatus connected to device 10 (e.g., by electric wires).

[0055] As schematically illustrated in Fig. 3a and Fig. 3b, area 14 may also be segmented along H into a sequence comprising alternating overlapping discrete first and second portions 16 and 18. For example, a width of first surface region 22a and a width of second surface region 24a may be increased to provide for a buffer to prevent gaps between neighboring ones of discrete first and second portions 16 and 18. Alternatively, a width of first surface region 22a and a width of second surface region 24a may be decreased to provide for gaps between neighboring ones of discrete first and second portions 16 and 18 (not shown).

[0056] Fig. 4 shows a top view of arrangement 20 which comprises a plurality of lenses 26 (of substantially the same size and shape). Lenses 26 are positioned along a horizontal (straight) line and have equidistantly spaced parallel optical axes A1, A2, and A3. First surface region 22a and second surface region 24a are coplanar and have a combined width which equals a distance D of the optical axes of neighboring ones of lenses 26. Alternatively, or in addition, arrangement 20 may comprise a plurality of mirrors (not shown). Moreover, as illustrated in Fig. 5, there may be a (horizontal) gap/distance between first sensor 22 and second sensor 24 which may be a multiple of D (i.e., the width of the gap may be n·D with n being a non-negative integer).

[0057] Although Fig. 5 and Fig. 6 show first and second surface regions 22a and 24a having a same width (i.e., a width of 0.5·D each), a width of first surface region 22a and a width of second surface region 24a may differ, as illustrated in Fig. 6 and Fig. 7. This may cause discrete first portions 16 to shrink in width and discrete second portions 18 to gain in width.

[0058] As illustrated in Fig. 8a and Fig. 8b, area 14 may also be segmented (by arrangement 20) along a vertical curve V into a sequence of alternating non-overlapping discrete third and fourth portions 28 and 30. Discrete third portions 28 may be imaged onto third surface region 32a of third sensor 32 which may be configured to output signal I3 that is indicative of an intensity of electromagnetic radiation incident upon third surface region 32a. Discrete fourth portions 30 may be imaged onto first surface region 22a of first sensor 22 (or onto a surface region of an additional sensor, e.g., a fourth sensor). As indicated by the circles in Fig. 8b, body 12 may move through area 14 from one side to the other.

[0059] If the surface temperature of body 12 differs from the surface temperature of the structures which it occludes from view, signal I3 (which depends on the intensity of electromagnetic radiation incident upon third surface region 32a) may undergo a change whenever body 12 enters into one of discrete third portions 28 and signal I1 (which depends on the intensity of electromagnetic radiation incident upon first surface region 22a) may undergo a change whenever body 12 enters into one of discrete fourth portions 30, as schematically indicated in Fig. 8c and Fig. 8d. Likewise, signal I3 may undergo a change whenever body 12 leaves one of discrete third portions 28 and signal I1 may undergo a change whenever body 12 leaves one of discrete fourth portions 30, as schematically indicated in Fig. 8c and Fig. 8d.

[0060] As illustrated in Fig. 9 which depicts a side view of arrangement 20, arrangement 20 may comprise two lenses 26 which are equidistantly spaced apart along a vertical (straight) line and have parallel optical axes A1 and A4. Alternatively, or in addition, arrangement 20 may comprise a plurality of mirrors (not shown). Moreover, first surface region 22a and third surface region 32a may be coplanar and have a combined height which equals a distance D of the optical axes A1 and A4. Furthermore, as illustrated in Fig. 10, there may be a (vertical) gap between first sensor 22 and third sensor 32 which may be a multiple of D (i.e., the height of the gap may be n·D with n being a non-negative integer).

[0061] Although Fig. 9 and Fig. 10 show first and third surface regions 22a and 32a having a same height (i.e., a height of 0.5·D each), a height of first surface region 22a and a height of third surface region 32a may differ, which may cause discrete fourth portions 30 to shrink in height and discrete third portions 28 to gain in height and vice versa. Moreover, area 14 may also be segmented along V into a sequence comprising alternating overlapping discrete third and fourth portions 28 and 30 (not shown). For example, a height of first surface region 22a and a height of third surface region 32a may be increased to provide for a buffer to prevent gaps between neighboring ones of discrete third and fourth portions 28 and 30. Alternatively, a height of first surface region 22a and a height of third surface region 32a may be decreased to provide for gaps between neighboring ones of discrete third and fourth portions 28 and 30.

[0062] As illustrated in Fig. 11 and Fig. 12 which depict side views of arrangement 20, one or more further lenses may be added to arrangement 20. As a result, arrangement 20 comprises three lenses 26 which are equidistantly spaced apart along a vertical (straight) line and have parallel optical axes A1, A4, and A5. As an additional lens 26 has been added, additional discrete third and fourth portions 28 and 30 emerge. Furthermore, the electromagnetic radiation incident upon first surface region 22a and third surface region 32a travels through the vertically stacked lenses 26.

[0063] Fig. 13 shows a flow chart of the method. The method starts at step 34 with segmenting area 14 into a pattern (horizontal, vertical, diagonal, or a combination thereof) of non-overlapping portions 16, 18, 28, and 30. At step 36, the method is continued with imaging a first subset of portions 16, 18, 28, and 30 onto one of surface regions 22a, 24a, and 32a, and imaging a second subset of portions 16, 18, 28, and 30 onto another one of surface regions 22a, 24a, and 32a. When body 12 moves in area 14, the imaging causes different sensors to detect body 12, depending on which portions 16, 18, 28, and 30 body 12 enters or leaves. The method may thus be continued at step 38 with evaluating signal I1 and evaluating signal 12, or at step 40 with evaluating a combined signal, wherein the combined signal may be indicative of each change of either the first signal Ii, the second signal I2, or both.

REFERENCE SIGNS LIST

[0064]

10	device
12	body
14	area
16	portion
18	portion
20	arrangement
22	sensor
22a	surface region
24	sensor
24a	surface region
26	lens
28	portion
30	portion
32	sensor
32a	surface region
34	step
36	step
38	step
40	step
A1	optical axis
A2	optical axis
A3	optical axis
A4	optical axis
A5	optical axis
D	gap
H	horizontal curve
I1	signal
I2	signal
I3	signal
V	vertical curve

Claims

1. A device (10) for detecting a movement of a body (12) in an area (14) which is to be monitored by the device (10), the device (10) comprising:

   a first sensor (22) which is configured to output a first signal (Ii) that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region (22a) of said first sensor (22);
   a second sensor (24) which is configured to output a second signal (I2) that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region (24a) of said second sensor (24); and
   an arrangement (20) which images discrete first portions (16) of the area (14) onto the first surface region (22a) and discrete second portions (18) of the area (14) onto the second surface region (24a), thereby segmenting the area (14) along a first curve (H, V) traversing the area (14) from a first side of the area (14) to a second side of the area (14), into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions (16, 18).

2. The device (10) of claim 1, wherein the first sensor (22) comprises a first pyroelectric element and the second sensor (24) comprises a second pyroelectric element, the first surface region (22a) being a surface region of the first pyroelectric element and the second surface region (24a) being a surface region of the second pyroelectric element.

3. The device (10) of claim 2, wherein the arrangement (20) comprises a plurality of optical elements.

4. The device (10) of claim 3, wherein the arrangement (20) comprises a first lens (26) and a second lens (26) and wherein:

   a first fraction of the electromagnetic radiation incident upon the first surface region (22a) of the first sensor (22) travels through the first lens (26) and a second fraction of the electromagnetic radiation incident upon the first surface region (22a) of the first sensor (22) travels through the second lens (26); and
   a first fraction of the electromagnetic radiation incident upon the second surface region (24a) of the second sensor (24) travels through the first lens (26) and a second fraction of the electromagnetic radiation incident upon the second surface region (24a) of the second sensor (24) travels through the second lens (26).

5. The device (10) of claim 4, wherein a first optical axis (A1) of the first lens (26) and a second optical axis (A2) of the second lens (26) are parallel and/or the first surface region (22a) and the second surface region (24a) are coplanar.

6. The device (10) of claim 5, wherein a horizontal gap between the first surface region (22a) and the second surface region (24a) is substantially zero or a multiple of a horizontal distance (D) between the first optical axis (A1) and the second optical axis (A2).

7. The device (10) of claim 6, wherein the horizontal distance (D) between the first optical axis (A1) and the second optical axis (A2) is equal to or larger than a combined width of the first surface region (22a) and the second surface region (24a).

8. The device (10) of claim 7, wherein the width of the first surface region (22a) is equal to the width of the second surface region (24a).

9. The device of any one of claims 1 to 8, further comprising:

a first output for outputting the first signal (Ii) and a second output for outputting the second signal (I2); or
circuitry which is configured to combine the first signal (Ii) and the second signal (I2), wherein, preferably, said circuitry is further configured to ensure that an effect of a decreasing first intensity on the combined signal is not compensated by an effect of an increasing second intensity on the combined signal, and vice versa.

10. The device (10) of any one of claims 1 to 9, further comprising:

a third sensor (32) which is configured to output a third signal (I_3) that is indicative of a third intensity of electromagnetic radiation incident upon a third surface region (32a) of said third sensor (32);
wherein the arrangement (20) images discrete third portions (28) of the area (14) onto the third surface region (32a), thereby segmenting the area (14) along a second curve (H, V), the first curve (H, V) and the second curve (H, V) being lines that are perpendicular to each other, into a sequence comprising alternating, overlapping or non-overlapping, discrete third and discrete fourth portions (28, 30).

11. The device (10) of claim 10, wherein the arrangement (20) comprises a third lens (26) and a fourth lens (26) and wherein:
a first fraction of the electromagnetic radiation incident upon the third surface region (32a) of the third sensor (32) travels through the third lens (26) and a second fraction of the electromagnetic radiation incident upon the third surface region (32a) of the third sensor (32) travels through the fourth lens (26).

12. The device (10) of claim 11, wherein a third optical axis (A4) of the third lens (26) and a fourth optical axis (A5) of the fourth lens (26) are parallel.

13. The device (10) of claim 12, wherein the vertical distance between the third optical axis (A4) and the fourth optical axis (A5) is equal to or larger than two times a height of the third surface region.

14. A method of detecting a movement of a body (12) in an area (14), comprising:

segmenting the area (14) into a pattern of non-overlapping portions (16, 18, 28, 30);
imaging a first subset of said portions (16, 18, 28, 30) onto a first surface region (22a) of a first sensor (22) which is configured to output a first signal (Ii) and imaging a second subset of said discrete portions (16, 18, 28, 30) onto a second surface region (24a) of a second sensor (24) which is configured to output a second signal (I2), wherein any pair of portions (16, 18, 28, 30) of said first subset is separated by at least one portion (16, 18, 28, 30) of said second subset and any pair of portions (16, 18, 28, 30) of said second subset is separated by at least one portion (16, 18, 28, 30) of said first subset; and
evaluating the first signal (Ii) and evaluating the second signal (I2); or
evaluating a combined signal, wherein the combined signal is indicative of each change of either the first signal (Ii), the second signal (I2), or both.

15. The method of claim 14, wherein:

the portions (16, 18, 28, 30) of the first and second subsets are imaged onto the first and second surface region (22a, 24a), respectively, by a first lens (26) and a second lens (26);
a first optical axis (A1) of the first lens (26) and a second optical axis (A2) of the second lens (26) are parallel;
the first surface region (22a) and the second surface region (24a) are coplanar;
a horizontal gap between the first surface region (22a) and the second surface region (24a) is substantially zero or a multiple of a horizontal distance (D) between the first optical axis (A1) and the second optical axis (A2); and
said horizontal distance (D) between the first optical axis (A1) and the second optical axis (A2) is equal to or larger than a combined width of the first surface region (22a) and the second surface region (24a).

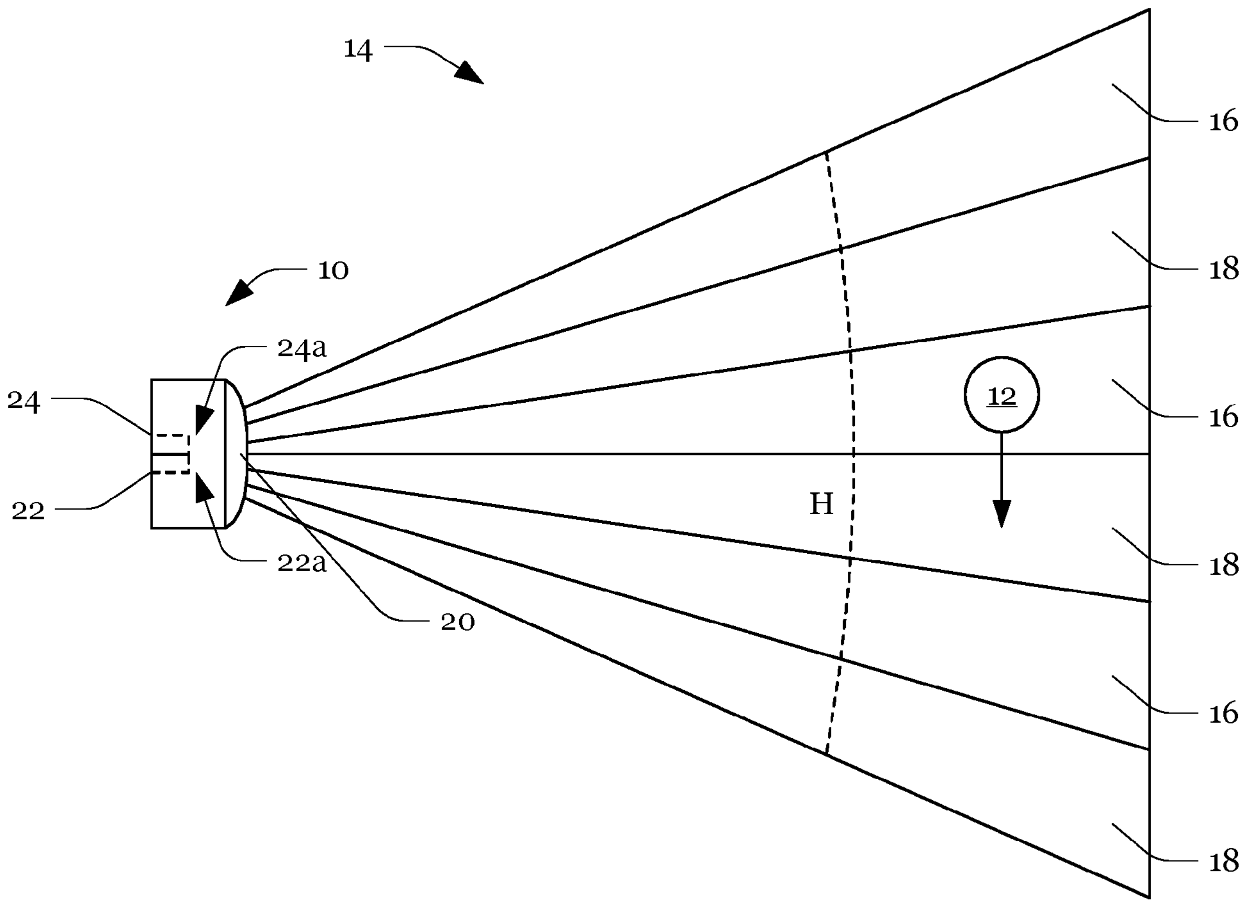


Fig. 1a

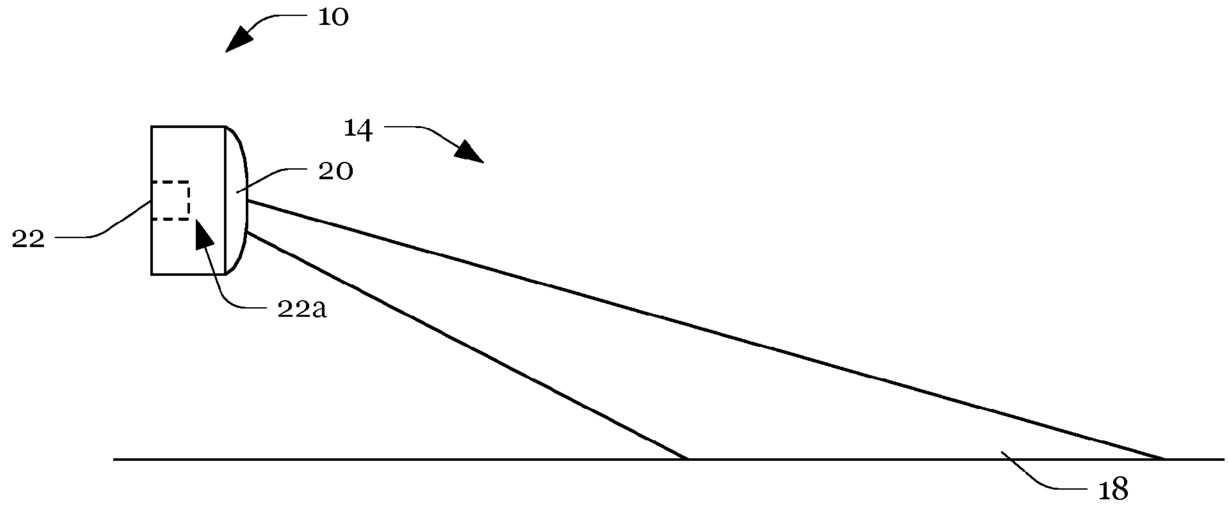


Fig. 1b

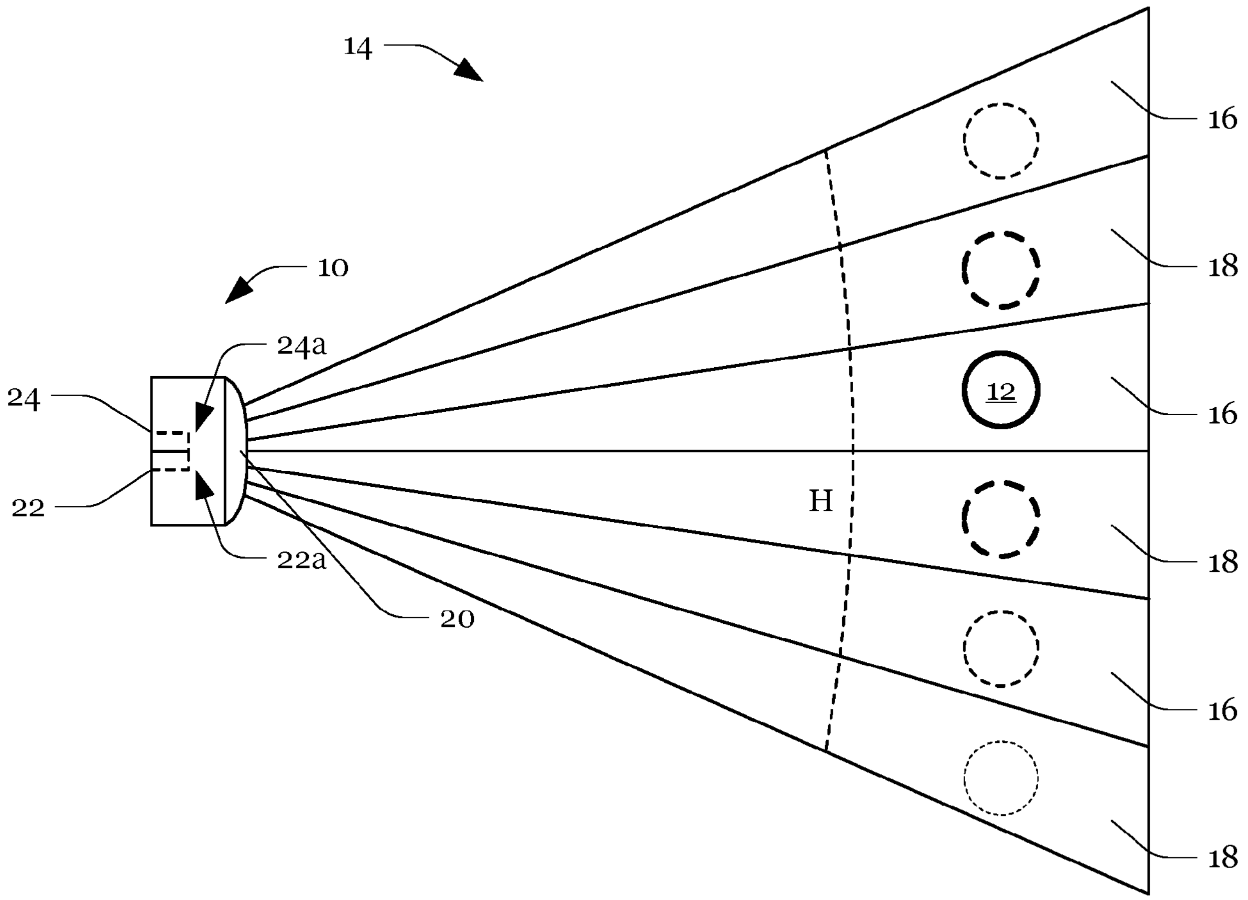


Fig. 2a

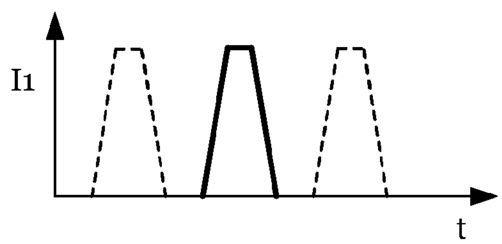


Fig. 2b

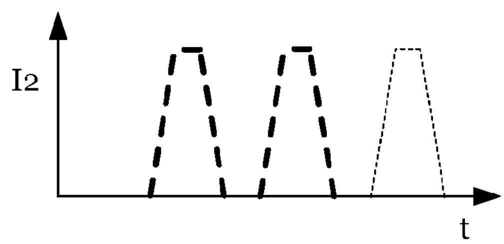


Fig. 2c

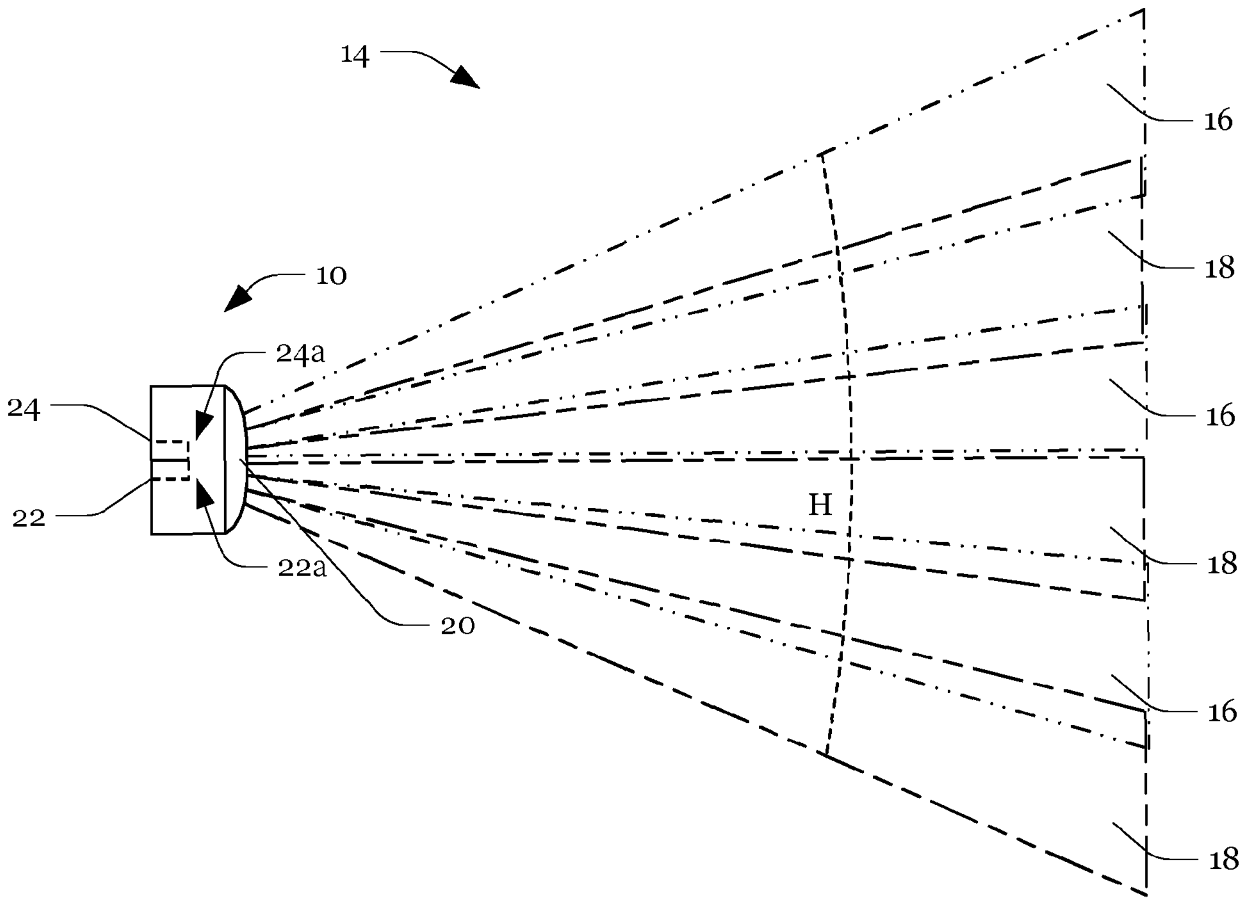


Fig. 3a

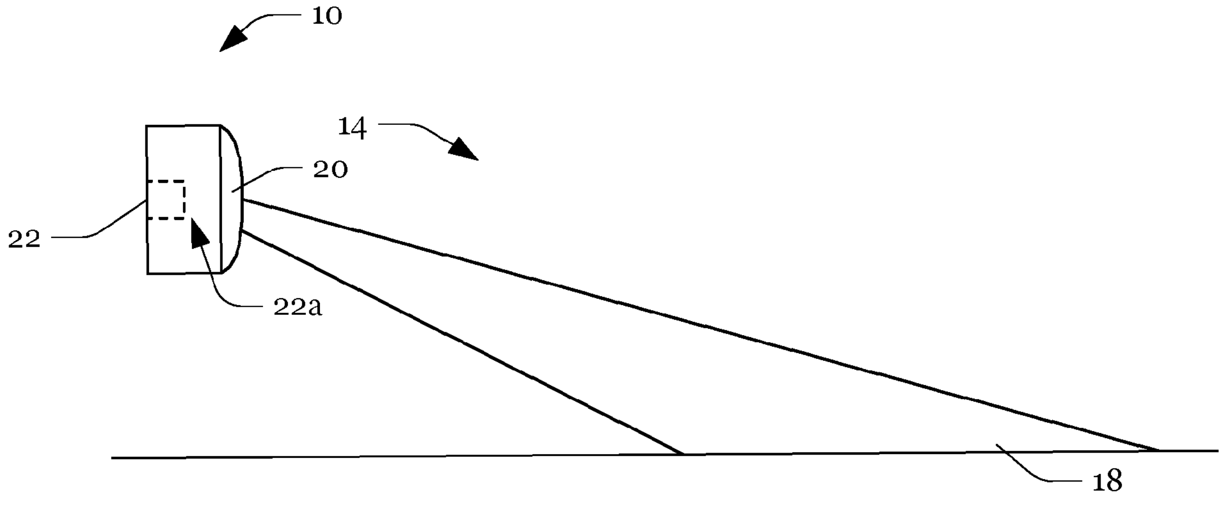


Fig. 3b

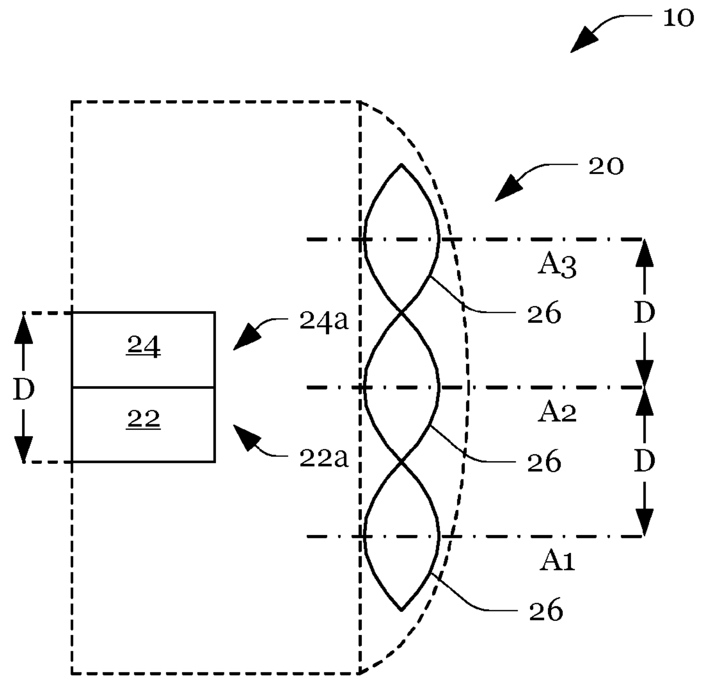

10
20
A3
26
D
24
24a
D
22
A2
22a
26
D
A1
26

Fig. 4

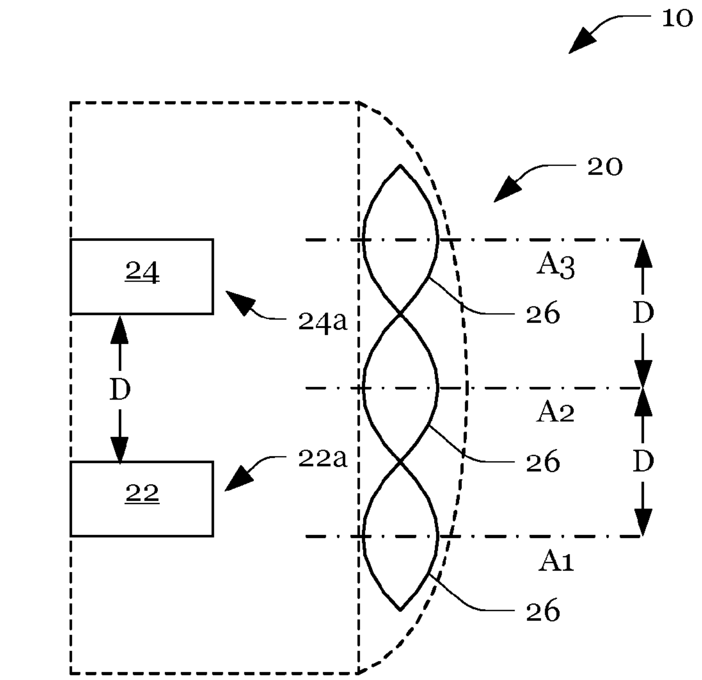

10
20
A3
24
24a
26
D
D
A2
22a
26
D
22
A1
26

Fig. 5

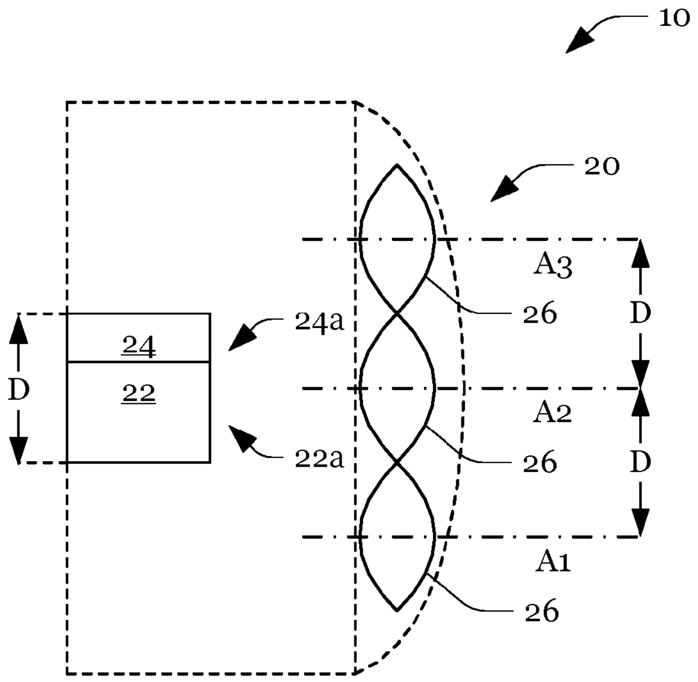

10
20
24
22
24a
22a
D
A3
A2
A1
26
26
26
D
D

Fig. 6

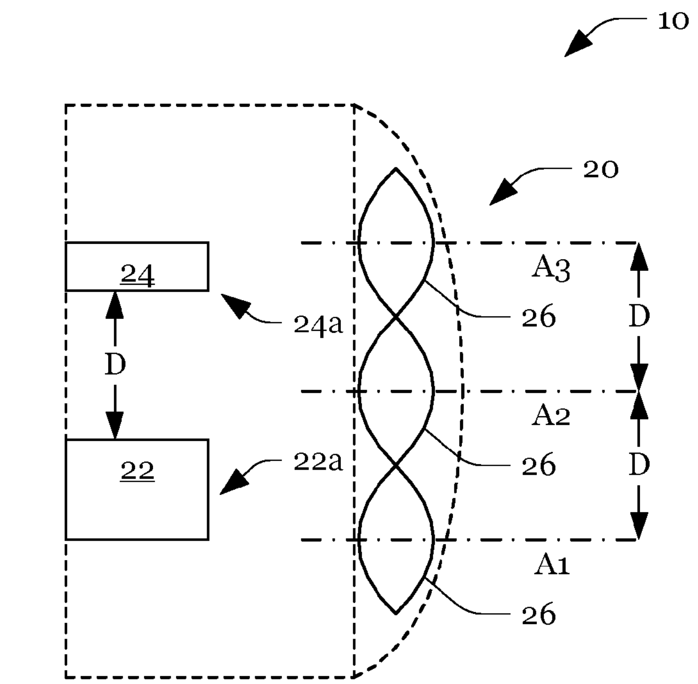

10
20
24
22
24a
22a
D
A3
A2
A1
26
26
26
D
D

Fig. 7

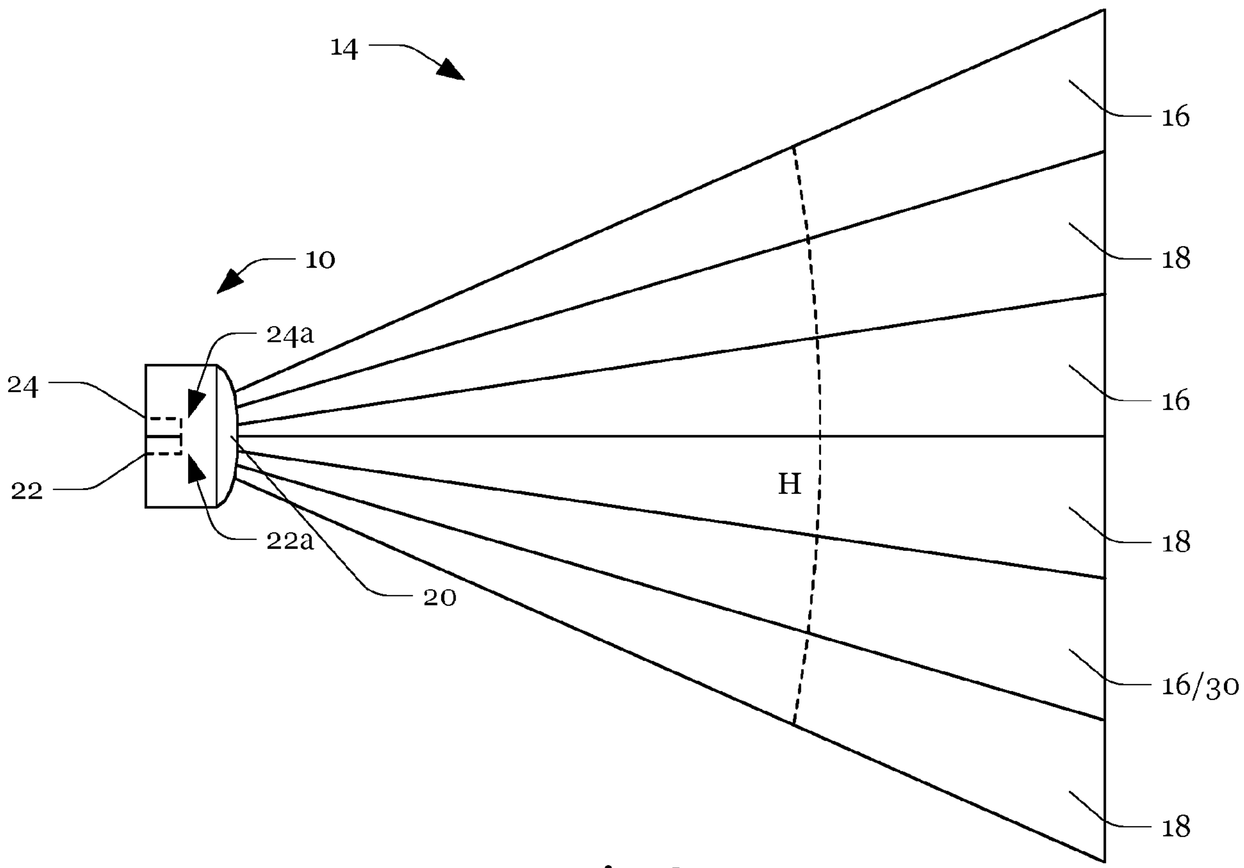


Fig. 8a

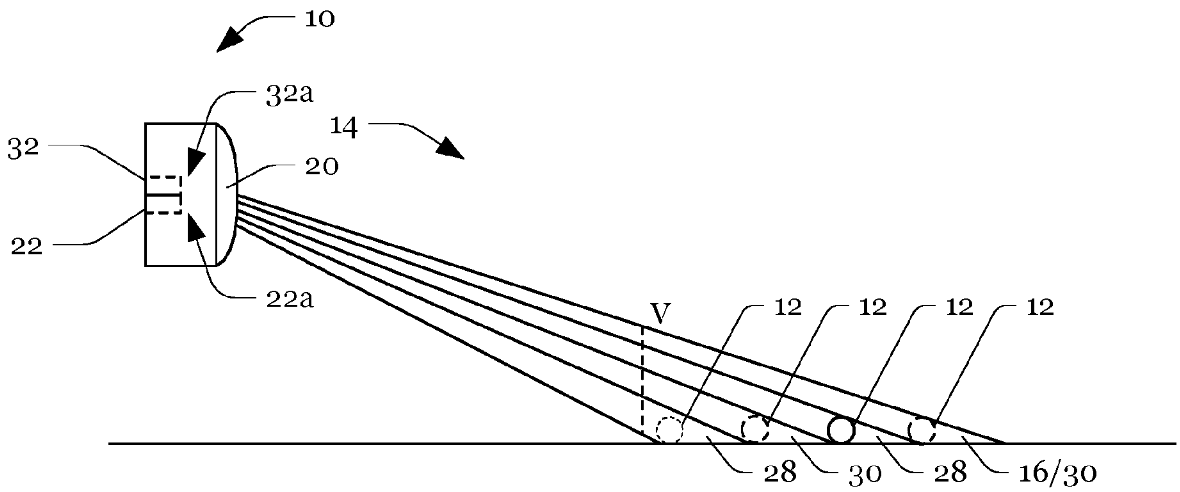


Fig. 8b

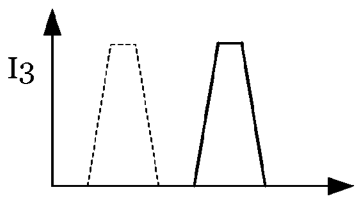


Fig. 8c

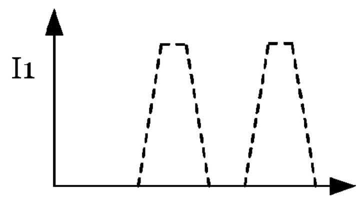


Fig. 8d

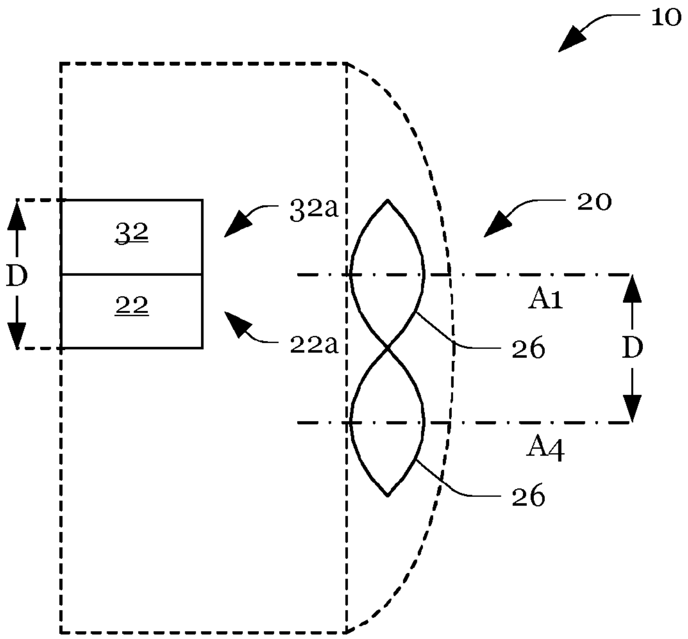


Fig. 9

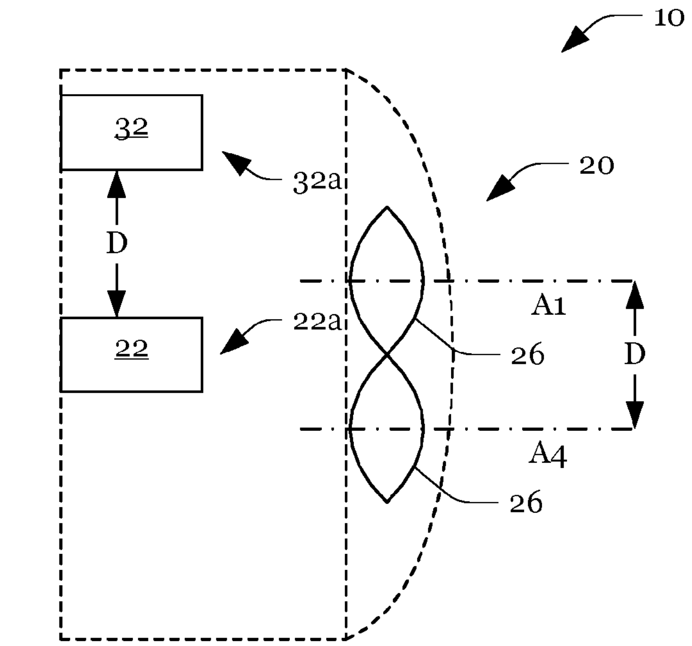


Fig. 10

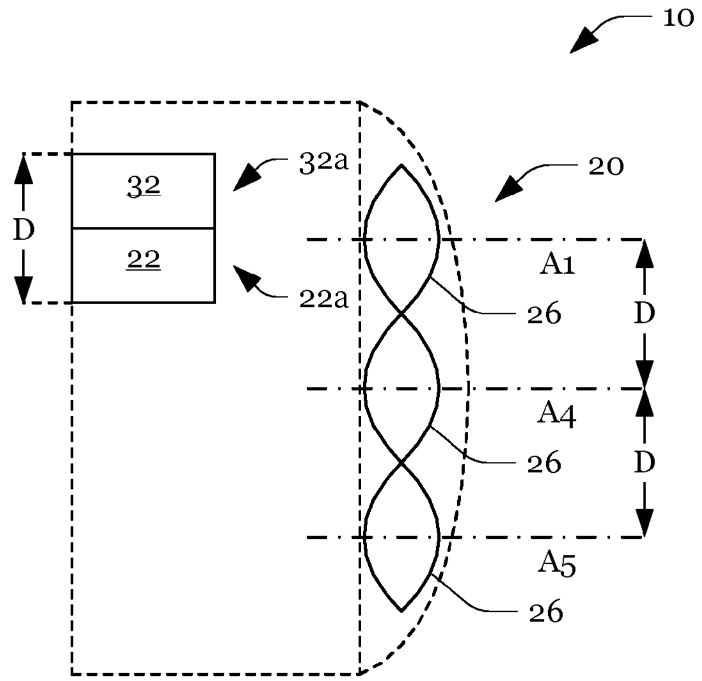
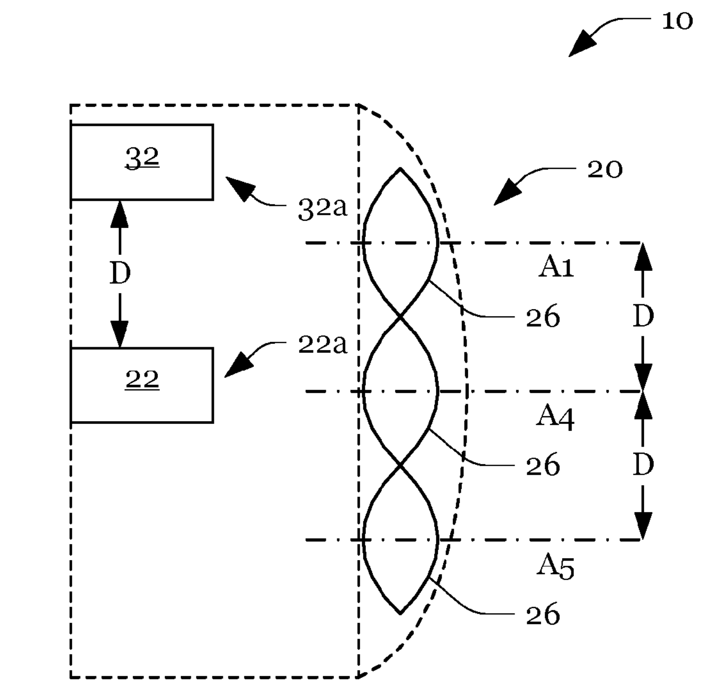

10
32
22
D
32a
22a
20
A1
A4
A5
26
26
26
D
D

Fig. 11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D
32a
22a
20
A1
A4
A5
26
26
26
D
D

Fig. 12

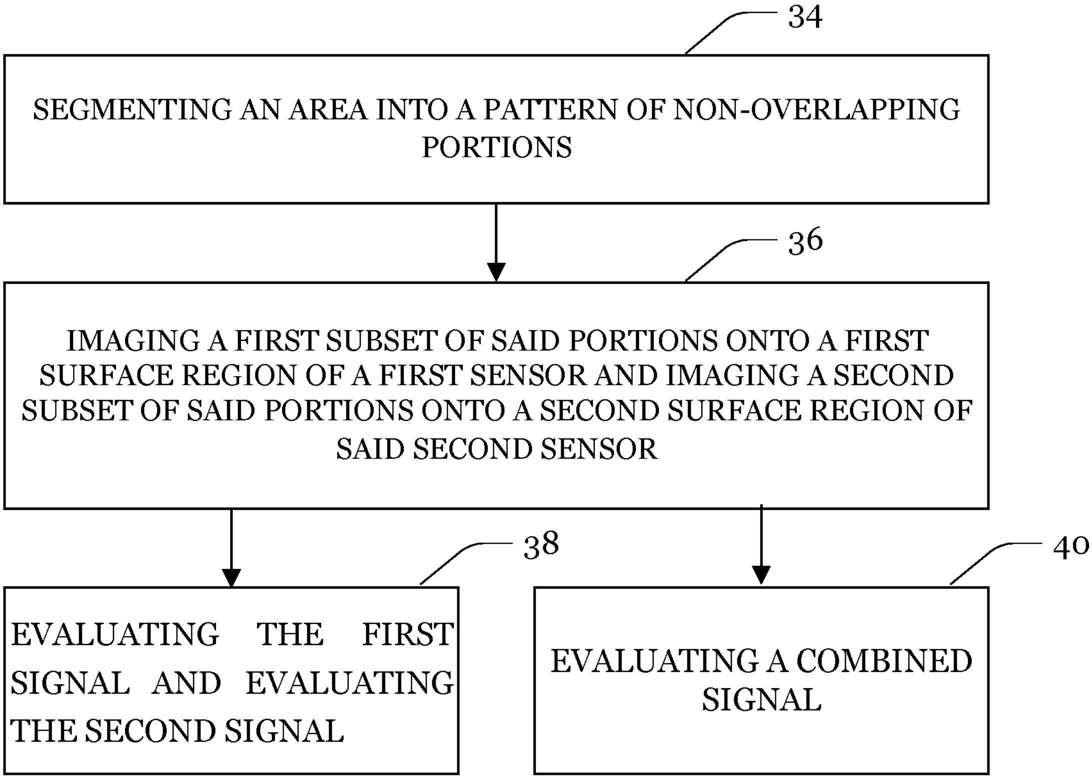
34
SEGMENTING AN AREA INTO A PATTERN OF NON-OVERLAPPING PORTIONS
36
IMAGING A FIRST SUBSET OF SAID PORTIONS ONTO A FIRST SURFACE REGION OF A FIRST SENSOR AND IMAGING A SECOND SUBSET OF SAID PORTIONS ONTO A SECOND SURFACE REGION OF SAID SECOND SENSOR
38
EVALUATING THE FIRST SIGNAL AND EVALUATING THE SECOND SIGNAL
40
EVALUATING A COMBINED SIGNAL

Fig. 13

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EUROPEAN SEARCH REPORT

Application Number
EP 21 15 3893

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2016/138976 A1 (SCHILZ JUERGEN [DE] ET AL) 19 May 2016 (2016-05-19) * paragraph [0024] * * paragraphs [0031], [0032] * * paragraphs [0049] - [0051] * * paragraphs [0068], [0069] * * paragraph [0073] * * paragraphs [0075], [0076] * * paragraph [0082] * * paragraphs [0093], [0094] * * figures 1,2,4,5,10,12,13 * -----	1-3,9,14	INV. G08B13/193
X	US 6 037 594 A (CLAYTOR RICHARD N [US] ET AL) 14 March 2000 (2000-03-14) * column 2, lines 17-47 * * column 3, lines 29-33 * * column 3, line 62 - column 4, line 36 * * column 6, lines 16-34 * * column 7, line 28 - column 8, line 16 * * figures 3,4,5A,9 * -----	1-9,14, 15	
			TECHNICAL FIELDS SEARCHED (IPC)
			G08B

~~The present search report has been drawn up for all claims~~

1

Place of search	Date of completion of the search	Examiner
Munich	28 June 2021	Meister, Mark

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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European Patent Office
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Application Number
EP 21 15 3893

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-8, 14, 15(completely); 9(partially)

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 21 15 3893

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-8, 14, 15(completely); 9(partially)

A device for detecting a movement of a body in an area which is to be monitored by the device, the device comprising: a first sensor which is configured to output a first signal that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region of said first sensor;a second sensor which is configured to output a second signal that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region of said second sensor; and an arrangement which images discrete first portions of the area onto the first surface region and discrete second portions of the area onto the second surface region, thereby segmenting the area along a first curve traversing the area from a first side of the area to a second side of the area, into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions, wherein the first sensor comprises a first pyroelectric element and the second sensor comprises a second pyroelectric element, the first surface region being a surface region of the first pyroelectric element and the second surface region being a surface region of the second pyroelectric element, wherein the arrangement comprises a plurality of optical elements, wherein the arrangement comprises a first lens and a second lens and wherein:a first fraction of the electromagnetic radiation incident upon the first surface region of the first sensor travels through the first lens and a second fraction of the electromagnetic radiation incident upon the first surface region of the first sensor travels through the second lens; anda first fraction of the electromagnetic radiation incident upon the second surface region of the second sensor travels through the first lens and a second fraction of the electromagnetic radiation incident upon the second surface region of the second sensor travels through the second lens.

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2. claim: 9(partially)

A device for detecting a movement of a body in an area which is to be monitored by the device, the device comprising: a first sensor which is configured to output a first signal that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region of said first sensor;a second sensor which is configured to output a second signal that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region of said second sensor; and an arrangement which images discrete first portions of the area onto the first surface region and discrete second portions of the area onto

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LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 21 15 3893

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

the second surface region, thereby segmenting the area along a first curve traversing the area from a first side of the area to a second side of the area, into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions, wherein the device further comprises circuitry which is configured to combine the first signal and the second signal, wherein, said circuitry is further configured to ensure that an effect of a decreasing first intensity on the combined signal is not compensated by an effect of an increasing second intensity on the combined signal, and vice versa.

---

3. claims: 10-13

A device for detecting a movement of a body in an area which is to be monitored by the device, the device comprising: a first sensor which is configured to output a first signal that is indicative of a first intensity of electromagnetic radiation incident upon a first surface region of said first sensor;a second sensor which is configured to output a second signal that is indicative of a second intensity of electromagnetic radiation incident upon a second surface region of said second sensor; and an arrangement which images discrete first portions of the area onto the first surface region and discrete second portions of the area onto the second surface region, thereby segmenting the area along a first curve traversing the area from a first side of the area to a second side of the area, into a sequence comprising alternating, overlapping or non-overlapping, discrete first and discrete second portions, wherein the device further comprises: a third sensor which is configured to output a third signal that is indicative of a third intensity of electromagnetic radiation incident upon a third surface region of said third sensor; wherein the arrangement images discrete third portions of the area onto the third surface region, thereby segmenting the area along a second curve, the first curve and the second curve being lines that are perpendicular to each other, into a sequence comprising alternating, overlapping or non-overlapping, discrete third and discrete fourth portions.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 21 15 3893

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28-06-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016138976 A1	19-05-2016	NONE	
US 6037594 A	14-03-2000	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 4218151 C2 **[0002]**