(54) Titre : DISPOSITIF DE MESURE DE DISTANCE POUR DES APPLICATIONS DE MISE AU POINT POUR CAMERA CINEMATOGRAPHIQUE
(54) Title: DISTANCE MEASUREMENT DEVICE FOR MOTION PICTURE CAMERA FOCUS APPLICATIONS
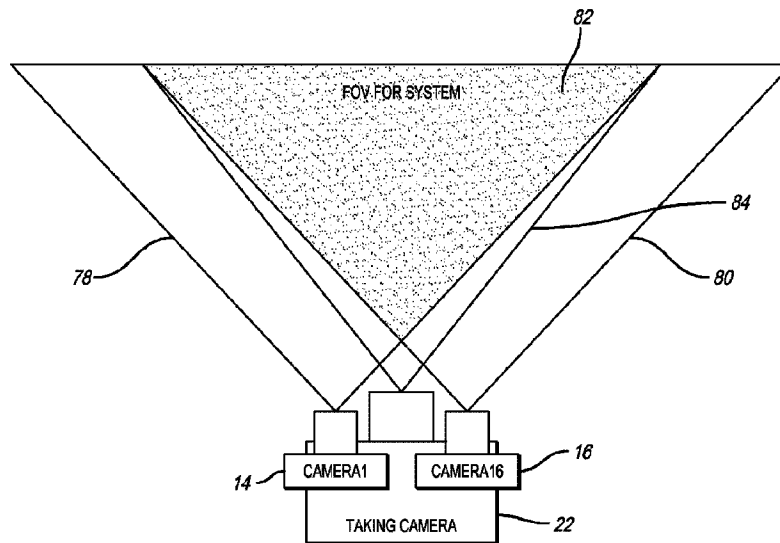
(57) Abrégé/Abstract:
A system for determining a distance to a region of interest. The system may be used to adjust focus of a motion picture camera. The system may include a first camera configured to have a first field of view, and a second camera configured to have a second field of view that overlaps at least a portion of the first field of view. The system may include a processor configured to calculate a distance of the selected region of interest relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view.

(54) Title: DISTANCE MEASUREMENT DEVICE FOR MOTION PICTURE CAMERA FOCUS APPLICATIONS

FIG. 7

(57) Abstract: A system for determining a distance to a region of interest. The system may be used to adjust focus of a motion picture camera. The system may include a first camera configured to have a first field of view, and a second camera configured to have a second field of view that overlaps at least a portion of the first field of view. The system may include a processor configured to calculate a distance of the selected region of interest relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view.

DISTANCE MEASUREMENT DEVICE FOR MOTION PICTURE CAMERA FOCUS APPLICATIONS

FIELD

[0001]   The present disclosure relates to systems, apparatuses, and methods for determining distances to regions of interest.

BACKGROUND

[0002]   Determining distance to a region of interest is pertinent for proper camera operation, including properly setting focus of a taking camera.   For professional level filming, including filming for motion pictures and television, it is particularly pertinent to properly determine the distance to regions of interest.   A camera assistant may be tasked with determining the distance to regions of interest and then setting the focus of a taking camera based on that distance.

[0003]   Prior systems, apparatuses, and methods of determining distance to a region of interest suffer from a series of drawbacks.   Systems such as acoustic or infrared measurement devices may not properly identify a desired region of interest, and may not properly track movement of a region of interest.   In addition, prior systems may not allow the desired region of interest to be readily visualized.

SUMMARY

[0004]   The systems, apparatuses, and methods disclosed herein are intended to provide for improved determination of distance to a region of interest.   The determination of

distance may be used to properly set the focus of a taking camera.

[0005]   Embodiments of the present disclosure may include determination of the distance to a region of interest through
5   use of cameras positioned in a stereoscopic orientation. The disparity of the region of interest through the view of the two cameras is inversely proportional to the distance of the region of interest from the cameras. The distance to the region of interest may be determined based on this disparity.

10   [0006]   Embodiments of the present disclosure may allow for tracking movement of the region of interest. Embodiments of the present disclosure may allow for real time calculation of the distance to the region of interest. Embodiments of the present disclosure may allow for multiple regions of interest
15   to be tracked simultaneously, and the field of view of either camera to be produced on a display.

[0007]   The systems, apparatuses, and methods disclosed herein enhance the ease of determination of distance to a region of interest, and produce improved information regarding
20   the distance to the region of interest.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]   Features and advantages of the systems, apparatuses, and methods as disclosed herein will become appreciated as the same become better understood with reference to the
5 specification, claims, and appended drawings wherein:

[0009]   FIG. 1 illustrates a schematic view of a system according to an embodiment of the present disclosure.

[0010]   FIG. 2 illustrates a top view of an apparatus according to an embodiment of the present disclosure.

10 [0011]   FIG. 3 illustrates a side view of the apparatus shown in FIG. 2 according to an embodiment of the present disclosure.

[0012]   FIG. 4 illustrates a front view of the apparatus shown in FIG. 2 according to an embodiment of the present
15 disclosure.

[0013]   FIG. 5 illustrates a top perspective view of the apparatus shown in FIG. 2 with components separate, according to an embodiment of the present disclosure.

[0014]   FIG. 6 illustrates a top perspective view of the
20 apparatus shown in FIG. 2 with a lid of a housing removed, according to an embodiment of the present disclosure.

[0015]   FIG. 7 illustrates a schematic view of fields of view according to an embodiment of the present disclosure.

[0016]   FIG. 8 illustrates an image of fields of view
25 according to an embodiment of the present disclosure.

[0017]   FIG. 9 illustrates an algorithm according to an embodiment of the present disclosure.

[0018]   FIG. 10 illustrates a region of interest according to an embodiment of the present disclosure.

[0019]   FIG. 11 illustrates a calibration table according to an embodiment of the present disclosure.

[0020]   FIG. 12 illustrates a resolution table according to an embodiment of the present disclosure.

[0021]   FIG. 13 illustrates a resolution graph according to an embodiment of the present disclosure.

[0022]   FIG. 14 illustrates an image of an apparatus according to an embodiment of the present disclosure.

[0023]   FIG. 15 illustrates an image of an apparatus according to an embodiment of the present disclosure.

[0024]   FIG. 16 illustrates an image of an apparatus according to an embodiment of the present disclosure.

[0025]   FIG. 17 illustrates a top perspective view of an apparatus with components separate, according to an embodiment of the present disclosure.

[0026]   FIG. 18 illustrates a top view of the apparatus shown in FIG. 17, according to an embodiment of the present disclosure.

[0027]   FIG. 19 illustrates a side view of the apparatus shown in FIG. 18, according to an embodiment of the present disclosure.

[0028]   FIG. 20 illustrates a schematic view of a hardware configuration, according to an embodiment of the present disclosure.

[0029]   FIG. 21 illustrates a schematic view of wired connections of a system, according to an embodiment of the present disclosure.

[0030]   FIG. 22 illustrates a process map, according to an embodiment of the present disclosure.

[0031]   FIG. 23 illustrates a process to transfer data to and from a camera controller, according to an embodiment of the present disclosure.

[0032]   FIG. 24 illustrates a process to transfer distance data to a camera controller, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0033]   FIG. 1 illustrates an embodiment of a system **10** for determining a distance to a region of interest. The system **10** may be used in motion picture camera applications, to more easily allow a taking camera to be focused on a desired region of interest.

[0034]   The system **10** may include a camera device **12**. The camera device **12** may include two cameras **14, 16** each having a respective field of view. The system **10** may include a control device **18** for selecting a region of interest in the field of view of one of the cameras **14, 16**. The system **10** may include a display device **20** configured to display a distance to a region of interest calculated by a processor of the system **10**.

[0035]   The system **10** may include a taking camera **22**, a display device **24**, a camera controller **26**, and a display device **28**. The taking camera **22** may be configured to produce an image in a field of view that overlaps the fields of view of the cameras **14, 16**. The display device **24** may be in the form of an overlay device, for overlaying a distance calculated by a processor of the system **10** on an image from a taking camera **24**. The camera controller **26** may be configured to control the operation of the cameras **14, 16**. The display device **28** may display an image from the taking device **22** including an overlay from the overlay device. Elements of the system **10** may be excluded, or additional elements may be included to produce a desired result.

[0036]   The camera device **12** may include two cameras **14, 16**. The two cameras **14, 16** may be positioned in a stereoscopic orientation. The field of view of one camera **14** may overlap the entirety of the field of view of the other camera **16**, or only a portion of the field of view of the other camera **16**, such that at least a portion of the respective fields of view are overlapped.

[0037]   Referring to FIG. 2, each camera **14, 16** may be coupled to a housing **30**.   The housing **30** may retain the cameras **14, 16** at a distance **32** from each other.   The housing **30** may set the cameras **14, 16** in position and define the distance **32** between the two cameras **14, 16**.

[0038]   Each camera **14, 16** may be aligned along a respective axis **34, 36**.   The axes **34, 36** may be substantially parallel to each other.   The cameras **14, 16** may be oriented substantially co-planar with each other, being aligned in a substantially similar horizontal, or x-dimension, plane **38** extending out of the page in FIG. 3.   The camera image sensors **40, 42** shown in FIG. 5 may be oriented substantially co-planar with each other, being aligned in a substantially similar vertical, or y-dimension, plane **44** extending out of the page in FIG. 3. The cameras **14, 16** may be oriented such that they face towards the same direction.   The cameras **14, 16** may be retained by the housing **30** such that the orientation of each camera **14, 16** is fixed.   In one embodiment, either camera **14, 16** may be configured to be movable relative to the housing **30** and/or other camera **14, 16**.   In one embodiment, either camera **14, 16** may not be coupled to a housing **30**.   The cameras may be separable cameras able to be set up in a desired orientation, including an orientation described in regard to the cameras coupled to the housing **30**.

[0039]   The focal length of each camera may be set as desired, and is preferably set such that the fields of view of the two cameras **14, 16** overlap.   In one embodiment, the focal length of each camera **14, 16** may be between approximately 12 mm and 16 mm, inclusive.   In one embodiment, the focal length of each camera **14, 16** may be set to be the same or substantially similar.   In such an embodiment, the similar or identical focal length may reduce the amount of processing

that is used to determine distance. In one embodiment, different focal lengths of the cameras may be used as desired.

[0040]   The camera unit **12** may be configured to be lightweight and portable. As shown in FIG. 2, the length of the camera unit **12** may be approximately 7.29 inches, and the width may be approximately 10.5 inches. The height as shown in FIG. 3 may be approximately 2.65 inches. The dimensions shown in FIGS. 2 and 3 are exemplary, as varied dimensions may be utilized, including a length of between approximately 5 and 10 inches, a width of between approximately 7 and 13 inches, and a height of between approximately 1 and 5 inches. In one embodiment, dimensions different from those stated herein may be utilized. The housing **30** may include attachment devices **46, 48** configured to allow the camera unit **12** to connect to other structures or elements of the system **10**. Either of the attachment devices **46, 48** may allow the camera unit **12** to be retained in a desired orientation. Either of the attachment devices **46, 48** may allow the camera unit **12** to couple to the taking camera **22**. The attachment devices **46, 48** may be dovetail devices as shown in FIG. 2, or may have other forms as desired.

[0041]   FIG. 4 illustrates a front view of the camera unit **12**. FIG. 5 illustrates the housing **30** with a lid **50** removed. The cameras **14, 16** are shown separated into components. The internal hardware of the camera unit **12** is visible. The cameras **14, 16** may include a respective front window **54, 56**, a respective lens assembly **58, 60**, and a respective image sensor **40, 42**. A respective front bezel **62, 64** may secure the lens assembly **58, 60** to the housing **30**. Each lens assembly **58, 60** may include a single lens, or multiple lenses. In one embodiment, the lens assembly **58, 60** may include a zoom lens. In one embodiment, the lens assembly **58, 60** may be configured to control the focus, zoom, and/or iris of the respective

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camera **14, 16**.   The image sensors **40, 42** may each be
configured to capture an image of the respective field of view
and digitize it for processing.   The image sensors **40, 42** may
be CCD sensors, CMOS sensors, or other forms of image sensor.
5   The image sensors **40, 42** may be capable of producing
resolutions of 720p, 1080i, 1080PsF, 1080p, although other
resolutions may be used if desired.   The image sensors are
preferably configured to capture video images.   Frame rates of
23.98, 24, 25, 29.97, 30, 48, 50, 59.94 and 60 may be
10   utilized, although other frame rates may be used if desired.
In one embodiment, the cameras **14, 16** may be configured to
capture static images.

[0042]   The cameras **14, 16** may be configured to each have a
field of view of between approximately 80 to 90 degrees,
15   inclusive, in the horizontal, or x-dimension.   Preferably,
each camera **14, 16** has a field of view of approximately 90
degrees in the horizontal, or x-dimension.   In one embodiment,
a lesser or greater angle for each camera **14, 16** may be
utilized if desired.

20   [0043]   In one embodiment, the features of the camera **14, 16**
may be set to be the same or substantially similar.   In such
an embodiment, the similar or identical features of the
cameras **14, 16** may reduce the amount of processing used to
determine distance.

25   [0044]   Referring to FIG. 2, the distance **32** between the two
cameras **14, 16** may be between approximately 5 to 14 inches,
inclusive.   The distance **32** is preferably approximately 8
inches.   In one embodiment, a lesser or greater distance **32**
between the cameras **14, 16** may be utilized if desired.

30   [0045]   Referring back to FIG. 5, the camera device **12** may
include an input device, and may include an output device.   In
the embodiment shown in FIG. 5, the input device and the
output device are a wireless communication device in the form

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of an antenna **66**. In one embodiment, the input device and the output device may comprise connectors such as the connectors **68** shown in FIG. 5. In one embodiment, the input device and output device may comprise different structures. The input

5   device may be configured to receive data, and the output device may be configured to output data. The camera device **12** may also include power connectors **68** that receive power for operating the camera device **12**. The voltage utilized by the camera device **12** may range between approximately 12V and 24V,

10 inclusive, or approximately 10V and 35V, inclusive. In one embodiment, a lesser or greater amount of voltage may be utilized if desired. Power connectors **68** and other forms of connectors may be grouped together in proximity on the housing **30**.

15 **[0046]**   The camera device **12** may include a wireless communication card **70**. The wireless communication card **70** may operate to transmit data to and from the antenna **66**. The wireless communication card **70** may be in the form of a router and may operate as a network hub for wireless communication

20 with other devices that may be used in the system **10**. The camera device **12** may include an interface device **72** for communication with the first camera **14** and/or the second camera **16**. The interface device **72** may be in the form of a USB card. The camera device **12** may include a power supply **74**

25 for processing and supplying power to the components of the camera device **12**. The power may be input to the power supply **74** from the power connectors **68**. In one embodiment, the power supply **74** may be in the form of a DC-DC converter, although other forms of power supplies **74** may be used in embodiments as

30 desired.

[0047]   The camera device **12** may include a processor card **76**. The processor card **76** may include a processor **77** that is configured to process images that are received from the first

camera **14** and the second camera **16**.   The processor **77** may be used to calculate distance to a region of interest.

[0048]   FIG. 6 illustrates components of the camera device **12** in position in the housing **30**, with a lid **50** of the housing **30** removed.

[0049]   Referring to FIG. 7, the field of view **78** of the first camera **14**, and the field of view **80** of the second camera **16**, may have a portion of overlapping field of view **82**.   In one embodiment, the field of view **84** of the taking camera **22** may overlap at least a portion of either field of view **78, 80**. A region of interest may be selected within the field of view **78** and/or field of view **80**.   The region of interest may be any image shown in either field of view **78, 80,** such as an object or area.   The region of interest may be a point or collection of points.   In one embodiment, the region of interest may have a defined size, such as a size of 80 x 80 pixels.   In one embodiment, the region of interest may have a different size, or may not have a defined size, as desired.

[0050]   FIG. 8 shows an example image of a field of view **78** produced by a camera **14,** on the left side of FIG. 8.   FIG. 8 shows an example image of a field of view **80** produced by a camera **16,** on the right side of FIG. 8.   The fields of view **78, 80** overlap, as shown by the portions of the images of the fields of view **78, 80** that are similar in both images.   The fields of view **78, 80** are offset, as shown by the portions of the field of view **78** that is not shown in the field of view **80**.   A region of interest **86** has been selected.   In one embodiment, the region of interest **86** may be selected automatically by the processor **77**, or other automatic process. In one embodiment, the region of interest **86** may be selected by a user's input.

[0051]   In one embodiment, the region of interest **86** may be selected in one of the fields of view **78, 80**.   For example,

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the region of interest **86** may be selected in the field of view **78**, which may be referred to as a first field of view **78**. The processor **77** may be configured to identify features of the region of interest **86**, for example, the appearance of the

5 selected region of interest **86**, and may use an algorithm to match the appearance of the selected region of interest **86** in the other field of view **80**, which may be referred to as a second field of view **80**. The algorithm may correlate the appearance of the selected region of interest **86** in the first

10 field of view **78** with the appearance of the selected region of interest **86** in the second field of view **80**.

[0052] FIG. 9 illustrates an embodiment of an algorithm that may be used to correlate the appearance of the selected region of interest **86** in the first field of view **78** with the

15 appearance of the selected region of interest **86** in the second field of view **80**. The element "T" represents the appearance of the image of the selected region of interest **86**. The element "I" represents the image of the second field of view **80**. The "x" and "y" elements correspond to the respective "x"

20 and "y" dimensions of the fields of view as marked in FIG. 8. The "w" and "h" elements correspond to the width and height of the fields of view. The element "R" represents the correlation between the appearance of the selected region of interest **86** in the first field of view **78** with the appearance

25 of the selected region of interest **86** in the second field of view **80**. The processor **77** may use the algorithm, scanning through the image of the second field of view **80**, to find a peak correlation. In one embodiment, an algorithm that differs from the algorithm shown in FIG. 9 may be used by the

30 processor **77**.

[0053] In one embodiment, a matching algorithm may not be used, and a user may identify the selected region of interest

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86 in both the first field of view **78** and the second field of view **80**.

[0054] The processor **77** may be configured to calculate a distance of the region of interest **86** relative to a location
5   by comparing a position of the region of interest **86** in the first field of view **78** to the position of the region of interest **86** in the second field of view **80**. FIG. 10, for example, displays the relative position of the region of interest **86** as shown through the first camera **14** (top image)
10   as compared to the position of the region of interest **86** as shown through the second camera **16** (bottom image). The processor **77** may identify the position of the region of interest in the second field of view **80** through the matching algorithm discussed above, or through an alternative process
15   if desired. The difference in the location of the region of interest **86** in the first field of view **78** and the second field of view **80** is the disparity between the locations. The difference in the location of the region of interest **86** may be the difference in location of the peak correlation calculated
20   using a matching algorithm.

[0055] The disparity may be calculated as a difference in position in the horizontal, or x-dimension, of the region of interest **86** in the first field of view **78** relative to the position of the region of interest **86** in the second field of
25   view **80** in the horizontal, or x-dimension. The disparity may be calculated based on a difference of the pixel location of the region of interest **86** in the first field of view **78** and the second field of view **80**. In one embodiment, the disparity may be calculated based on a location of the region of
30   interest **86** in the first field of view **78** and the second field of view **80** relative to a centerline.

[0056] The processor **77** may be configured to calculate the distance of the region of interest **86** based on the distance

between the cameras **14, 16** and the disparity of the region of interest **86.** As the disparity increases, the relative distance of the region of interest **86** from the cameras **14, 16** decreases. As the distance between the cameras **14, 16** increases, the apparent disparity will increase. The distance measurement may be based on a relationship given below, with the camera baseline being the distance between the two cameras **14, 16** lenses, which may be the interocular spacing of the center of the two camera **14, 16** lenses:

Distance $\propto$ ((camera focal length)(camera baseline))/(disparity)

[0057] A constant element of the relationship shown above may be automatically determined by the processor **77,** or may be input into the processor **77.** The camera focal length, and camera baseline, for example, or any other constant elements, may be input into the processor **77** for use in its distance calculation. In one embodiment, the processor **77** may automatically detect constant elements of the relationship above, based, for example, on a particular kind of camera being utilized with the camera device **12.** In one embodiment, the processor **77** may automatically detect an orientation of the cameras **14, 16** and/or the distance of the cameras **14, 16** from each other. In one embodiment, the processor **77** may include look-up table stored in memory, which may be used to match stored constants with an input provided by a user. The input may be the type of camera being utilized. In one embodiment, a memory may be used to store any constants or other information used by the processor **77.** In one embodiment, a distance relationship may be utilized that includes different constants or variables than identified above.

[0058] In one embodiment, the camera device **12** may be configured to be calibrated to allow the processor **77** to

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calculate the distance relative to a location. FIG. 11, for example, illustrates a table **88** that may be used to calibrate the processor **77**. In a process of calibration, a user may set a region of interest at a defined distance. The processor **77**

5   may determine the disparity of the region of interest at that distance. The user may input the distance that corresponds to that disparity into the processor **77**, or the processor's memory. The user may repeat this process at varying distances. After calibration, upon the processor **77**

10   calculating a disparity, it may match this disparity to the distance stored in the memory during calibration, to be able to output a distance. A calibration process may allow the processor **77** to more easily account for variations in any constants used to calculate distance. Calibration data may be

15   stored in the memory for different constants, such as the type of camera, camera focal length, camera orientation or distance between the cameras, or other factors. The calibration data may be retrieved by the processor **77** to output a distance based on the calculated disparity.

20   **[0059]**   The location that the processor **77** calculates the distance relative to may be set by default or may be input into the processor **77**, or automatically determined by the processor **77**. The location may be set during a calibration process. In one embodiment, the location may be set as the

25   position of the taking camera **22**. The position of the taking camera **22** may be further defined as either the lens or the sensor plane of the taking camera **22**. In one embodiment, the camera device **12** may be configured to couple to the taking camera **22** at a defined position, and the location may be set

30   to be the taking camera **22** based on the defined position. In one embodiment, the location may be input into the processor **77** by inputting a type of taking camera into the processor **77**. The processor **77** may include a look-up table providing the position of the taking camera **22**, or a component of the camera

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such as a lens or sensor plane, based on the type of taking
camera **22** used. In one embodiment, the location may be set at
a different position as desired, for example a user may input
the location into the processor **77**.

5   [0060]   In one embodiment, the camera device **12** may be
configured to calculate the distance of a region of interest
86 relative to a location while the region of interest **86**
moves.   The processor **77** may be configured to track the
position of the selected region of interest **86**.   Referring to

10   FIG. 8, upon the region of interest **86** being selected, the
processor **77** may be configured to determine if the region of
interest **86** moves.   The processor **77** may determine the
appearance of the region of interest **86** and then identify the
appearance of the region of interest **86** in successive frames

15   to track movement of the region of interest **86**.   In one
embodiment, the processor **77** may track the region of interest
86 by calculating if pixel data has been translated to
different pixels than the original pixels. In one embodiment,
a different process of tracking the region of interest **86** may

20   be used.   The processor **77** may track the region of interest **86**
in each frame.   In one embodiment, the processor **77** may track
the region of interest **86** for a defined interval of frames.

[0061]   In one embodiment, a separate device, such as a
control device, may assist the processor **77** to track the

25   region of interest **86**.   The separate device may identify
movement of the region of interest **86**, and the processor **77**
may use image data from the subset of pixels representing the
region of interest **86** as the region of interest **86** moves, to
track the movement of the region of interest **86**.   The image

30   data from the subset of pixels may be used for comparison with
the image from the second field of view **80**.

[0062]   The processor **77** may be configured to track the
position of the region of interest **86** in the second field of

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view **80**.   The processor **77** may track the position in the second field of view **80** by matching the appearance of the region of interest **86** in the first field of view **78** to the second field of view **80** in a process as discussed above in
5   this application.   For example, the processor **77** may use an algorithm to match the appearance of the selected region of interest **86** in the other field of view **82**.   The algorithm may correlate the appearance of the selected region of interest **86** in the first field of view **78** with the appearance of the
10   selected region of interest **86** in the second field of view **80**. The algorithm may be the algorithm shown in FIG. 9, or may be a different algorithm.   In one embodiment, the processor **77** may track the region of interest **86** in the second field of view **80** in a process in which data representing the movement
15   of the region of interest **86** in the first field of view **78** is applied to calculate the movement of the region of interest **86** in the second field of view **78**.   In one embodiment, a different process of tracking the region of interest **86** in the second field of view **78** may be used.

20   **[0063]**   The processor **77** may be configured to calculate a distance of the region of interest **86** relative to a location while the region of interest **86** moves, by comparing a position of the region of interest **86** in the first field of view **78** to the position of the region of interest **86** in the second field
25   of view **80**.   The distance may be calculated in a process as discussed above in this application.   The distance may be calculated in real-time, as the region of interest **86** moves in the first field of view **78** for example.   A distance may be calculated for each frame.   In one embodiment, a distance may
30   be calculated for a defined interval of frames.

[0064]   In one embodiment, the camera device **12** may be configured to calculate the distance for a plurality of regions of interest **86**.   In one embodiment, the processor **77**

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may be configured to track a plurality of regions of interest
86 and to calculate the distance for a plurality of regions of
interest **86**.   In one embodiment, up to twelve different
regions of interest may be tracked and/or have their

5   respective distances calculated.   In one embodiment, a greater
or lesser number of regions of interest may be tracked and/or
have their respective distances calculated.   The distances
and/or tracking of the plurality of regions of interest may
occur simultaneously.   The tracking, matching, and distance

10 processes may occur for each region of interest · **86** through
similar processes as discussed above for the individual
regions of interest **86**.   A distance may be calculated for each
region of interest for each frame.   In one embodiment, a
distance may be calculated for each region of interest for

15 defined interval of frames.   In one embodiment, the processor
77 may be configured to produce a disparity map of the
disparities for various regions of interest **86**.

[0065]   The camera device **12** may be configured to output the
distance data that the processor **77** has calculated.

20 [0066]   In one embodiment, the processor **77** may be
positioned external to housing **30**.

[0067]   In one embodiment, the distance calculations may be
performed using cameras **12**, **14** that are not coupled to the
housing **30**, and/or are positioned in a different orientation

25 than shown in FIG. 2 or 7 for example.   The different
orientation of the cameras **12**, **14** may be utilized by the
processor **77** in its distance calculations, for example, a
different camera baseline value may be used.

[0068]   FIG. 12 illustrates a table representing the
30 resolution of the cameras **14**, **16** of the camera device **12** at
certain defined distances from the camera device **12**.   FIG. 13
illustrates a graph of the resolution of the cameras **14**, **16** of
the camera device **12** at certain defined distances from the

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camera device **12**.   The data shown in FIGS. 12 and 13 represents one embodiment of the camera device **12,** and other resolutions may occur in other embodiments of the camera device **12**.

5   **[0069]**   Referring back to FIG. 1, the system **10** may include a control device **18**.   The control device **18** may be configured to allow a user to select a region of interest.   The control data from the control device **18** may be input into the camera device **12** and received by the processor **77**.   The control

10   device **18** may be connected to the camera device **12** or may be configured   to   communicate   with   the   camera   device   **12** wirelessly.   The wireless communication device of the camera device **12** may be used to communicate with the control device **18**.   The   control   device   **18**   may   include   a   wireless

15   communication device to communicate with any component of the system **10**.

[0070]   FIG. 14 illustrates a close-up view of the control device **18**.   The control device **18** may be configured as a handheld device, or may be configured as any device configured

20   to   control   operation   of   the   camera   device   **12**.   In   the embodiment shown in FIG. 14, the control device **18** is a tablet computer, although other forms of computers may be used if desired, such as a laptop computer.   The control device **18** may include a display **90**.   The display **90** may be configured to

25   display an image of the fields of view **78, 80** from either of the respective cameras **14, 16,** and/or a field of view **82** of the taking camera **22**.   In one embodiment, the display **90** may be configured to display an overlapping portion of the fields of view **78, 80,** and/or an overlapping portion of the field of

30   view **82** of the taking camera **22**.

[0071]   In one embodiment, the control device **18** may be configured   to   produce   an   indicator   **92**   that   indicates   an overlap of any of the fields of views **78, 80, 84.**   In the

embodiment shown in FIG. 14, for example, the indicator **92** indicates the overlap of the taking camera **22** field of view **84** and the first field of view **78**. In one embodiment, an overlap between the first field of view **78** and the second field of

5   view **80**, and/or an overlap between the taking camera **22** field of view **84** and the second field of view **80** may be indicated. The indicator **92** may take the form of a box on the display **90** as shown in FIG. 14, although in other embodiments other forms of indicators **92** may be used as desired.

10 [0072]   The control device **18** may include a touch screen **94** configured for a user to select a region of interest **86**. A user may touch a portion of the image from any of the fields of views **78**, **80**, **84** that displays the desired region of interest **86** to select the region of interest **86**. The user may

15 unselect the desired region of interest **86** by touching the image of the region of interest again. In one embodiment, the control device **18** may include facial recognition processes to automatically identify facial features in any of the fields of views **78**, **80**, **84**. The control device **18** may be configured to

20 automatically select regions of interest **86** corresponding to those facial features, or may be configured to suggest regions of interest **86** to the user that correspond to those facial features. In one embodiment, the control device **18** may utilize an alternative method of selecting regions of interest

25 **86**, for example, the control device **18** may be configured to respond to a marker used to indicate the region of interest **86**. The marker may be a physical structure positioned at the region of interest **86**, or may be a light device such as a laser beam aimed at the region of interest **86**, or may have

30 another form.

[0073]   The control device **18** may select multiple regions of interest **86**, either automatically or based on user selection. In an embodiment in which the control device **18** includes a

touch screen **94**, the user may touch multiple portions of the image from any of the fields of views **78**, **80**, **84** to select the region of interest **86**. In one embodiment, up to twelve different regions of interest may be selected. In one

5   embodiment, a greater or lesser number of regions of interest may be selected.

[0074] The control device **18** may be configured to produce an indicator **96** that indicates the regions of interest **86** that have been selected. The indicator **96** may take the form of a

10   box on the display **90** as shown in FIG. 14, although in other embodiments other forms of indicators **96** may be used as desired. Additional indicators **98**, **100** may be used to indicate the multiple regions of interest **86** that have been selected. In an embodiment in which the processor **77** tracks

15   the movement of a single or multiple regions of interests **86**, the corresponding indicators **96**, **98**, **100** may move with the regions of interest **86**.

[0075] The control device **18** may be configured to display a distance calculated by the processor **77**. The distance may be

20   provided on the display **90**. In an embodiment in which the processor **77** provides real time calculations of the distance, the distance displayed on the control device **18** may be updated in real time as well. Multiple distances may be displayed, each corresponding to multiple regions of interest. The

25   control device **18** may display a distance outside of an overlapping portion of the fields of view **78**, **80**, **84**. For example, in FIG. 14 a distance is shown for the indicator **100**, which is outside of the field of view **84** of the taking camera **22**. This distance may be displayed such that the distance to

30   this region of interest is already displayed, should the field of view **84** of the taking camera **22** be moved to cover this region of interest.

[0076]   The control device **18** may be configured to receive
an input of properties of the cameras **14**, **16**, or properties of
the taking camera **22**.   The properties may include the focal
length of any of the cameras, the field of view of any of the
5   cameras, the distance between the cameras **14**, **16**, the focus,
the iris, and/or the zoom of any of the cameras, and/or type
of camera or lens being used, among other properties.   The
control device **18** may be configured to receive input of the
location that the processer **77** calculates a distance relative
10   to.   The control device **18** may be configured for a user to
input this data into the control device **18**.

[0077]   In one embodiment, the control device **18** may be
configured to control properties of the cameras **14**, **16**,
including the focus, iris, and/or zoom of the cameras **14**, **16**.
15   The control device **18** may be configured such that a user has
touch screen control of the properties, including focus, iris,
and/or zoom.   The control device **18** may be configured to
display these properties.

[0078]   The control device **18** may be configured to display
20   multiple screens of images providing information about the
system **10**.   For instance, one screen as shown in FIG. 14 may
display video images of the field of view **78** from the camera
14.   The control device **18** may display another screen that
provides information regarding the focus, iris, and/or zoom of
25   the cameras **14**, **16**.   The control device **18** may be configured
such that a user may change the screen that is displayed on
the control device **18**.

[0079]   In one embodiment, the processes of the control
device **18** may be embodied in a program that is operated by a
30   processor of the control device **18**.   The program may be
embodied in a non-transitory machine readable medium.   The
program may be stored in a memory of the control device **18**.
The program may be configured to be downloadable by the

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control device **18**. The program may be an application or "app" operated by the control device **18**. The control device **18** for example may be a tablet computer such as an iPad sold by Apple, or a Galaxy sold by Samsung, and the processes of the

5   control device **18** discussed herein may be loaded onto the control device **18**. The program may cause the processer of the control device **18** to effect the processes discussed herein.

[0080] In one embodiment, the control device **18** may be coupled to the housing **30** of the camera device **12**. In one

10   embodiment, the control device **18** may be integrated within the camera device **12**. For example, in one embodiment, a control device **18** integrated within the camera device **12** may serve to automatically detect facial features or other desired features of the region of interest.

15   [0081] The control device **18** may be configured to communicate with the camera device **12** either wirelessly or through a wired connection. The control device **18** may output the selection of the region of interest, the properties of the cameras **14**, **16**, and/or properties of the taking camera **22** to

20   the camera device **12** or another element of the system **10**. The control device **18** may also output the control of the cameras **14**, **16** to the camera device **12**. The control device **18** may receive data from the control device **18** or other element of the system **10**.

25   [0082] In one embodiment, the control device **18** may assist the processor **77** in tracking movement of the region of interest, or multiple regions of interest in a field of view. The control device **12** may be configured to provide data to the processor **77** about the position of the selected region of

30   interest while it moves. For instance, facial recognition features identified by the control device **18** may be provided to the processor **77** to assist the processor **77** in tracking movement of the region of interest.

[0083]   The control device **18** may be configured to be lightweight and portable, to allow an operator of the control device **18** to more easily move about while operating the camera device **12**.

5   [0084]   Referring back to FIG. 1, the system **10** may include a display device **20** configured to display a distance to a region of interest calculated by the processor of the system **10**, or distances to multiple regions of interest. The display device **20** may be connected to the camera device **12** or may be

10 configured to communicate with the camera device **12** wirelessly. The wireless communication device of the camera device **12** may be used to communicate with the display device **20**.   The display device **20** may include a wireless communication device to communicate with any other component

15 of the system **10**.

[0085]   FIG. 15 illustrates a close-up view of the display device **20**. The display device **20** may be configured as a handheld device, or may be configured as any device configured to display a distance to a region of interest. In the

20 embodiment shown in FIG. 15, the control device **18** is a mobile communication device, although other forms of devices may be used if desired. The control device **18** may be a mobile communication device such as an iPhone, iPod, or other mobile devices. The display device **20** may include a display **104**.

25 The display **104** may be configured to display a distance to a region of interest.

[0086]   The display device **20** may be configured to display a single distance, or multiple distances calculated by the processor **77**. The display device **20** may be configured to

30 display the distance or distances as the processor 77 calculates the distances in real time, as the region or regions of interest move. In the embodiment shown in FIG. 15, a multiline display shows distances calculated to different

regions of interest. The distances may be divided into primary and secondary regions of interest. The distances may be shown as a numerical value. In one embodiment, another form of indicator of distance may be used, such as a table,
5 chart, or other representative diagram, among others.

[0087] The display device **20** may be configured to be lightweight and portable. In one embodiment, the display device **20** may be configured to be integrated within the camera device **12**. In one embodiment, the display device **20** may be
10 configured to be coupled to any element of the system **10**. FIG. 16, for example, illustrates an embodiment of a display device **106** coupled to a taking camera **22**. The distance to the region of interest is indicated on the right side of the display device as being ten feet.

15 [0088] Referring back to FIG. 1, the system may include a display device **24** in the form of an overlay device, for overlaying a distance calculated by the processor **77** on an image from a taking camera **22**, or distances to multiple regions of interest. The display device **24** may be connected
20 to the camera device **12** or may be configured to communicate with the camera device **12** wirelessly. The wireless communication device of the camera device **12** may be used to communicate with the display device **24**. The display device **24** may include a wireless communication device to communicate
25 with any other component of the system **10**.

[0089] FIG. 17 illustrates a close-up view of the display device **24**, with a lid **108** of a housing **110** separated from the remainder of the housing **110**, and other components of the display device **24** separated. The display device **24** may
30 include power connectors **112** that receive power for operating the display device **24**. The display device **24** may include data connectors **114** for receiving cabled data from elements of the system **10**, including images from the taking camera **22**. The

display device **24** may include an input device, and may include
an output device.   In the embodiment shown in FIG. 17, the
input   device   and   the   output   device   are   a   wireless
communication device in the form of an antenna **116**.   In one

5   embodiment,   the   input   device   and   the   output   device   may
comprise   connectors   such   as   the   connectors   **114**.   In   one
embodiment, the input device and output device may comprise
different structures.

[0090]   The   display   device   **24**   may   include   an   overlay
10   processor   card   **118**.   The   processor   card   **118**   may   include a
processor   **120**   that   is   configured   to   overlay   the   distances
calculated from the processor **77** on other images from other
cameras.   The processor **120** may receive the distance data from
the camera device **12** and receive the image from the taking

15   camera   **22**   for   example,   and   match   the   distance   data   to   the
image.   Referring to FIG. 1, the display device **24** may produce
indicators that indicate the regions of interest **86** that have
been selected.   The indicator may take the form of a box as
shown in FIG. 1, although in other embodiments other forms of

20   indicators may be used as desired.   In an embodiment in which
the processor **77** tracks the movement of a single or multiple
regions of interests **86**, the corresponding indicators may move
with the regions of interest **86**.

[0091]   The display device **24** may display the distance or
25   distances   calculated   by   the   processor   **77**   on   another   display
device   **28**.   The distance may be provided on a display of the
display device **28**.   In an embodiment in which the processor **77**
provides real time calculations of the distance, the distance
displayed on the display device **28** may be updated in real time

30   as   well.   Multiple   distances   may   be   displayed,   each
corresponding   to   multiple   regions   of   interest.   The   display
device **24** may be configured to display only the image in the
field of view of the taking camera **22**.   As shown in FIG. 1,

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the image on the display device **28** matches the image shown within the indicator **92** shown in FIG. 14.

[0092]   The display device **24** may be configured to be lightweight and portable.   FIGS. 18 and 19 illustrate the

5   length of the display device **24** may be approximately 7.37 inches, with a length of the housing **110** being approximately 6.75 inches.   The width may be approximately 4.75 inches.   The height as shown in FIG. 19 may be approximately 1.35 inches. The dimensions shown in FIGS. 18 and 19 are exemplary, as

10   varied dimensions may be utilized, including a total length of between approximately 5 and 10 inches, a width of between approximately 2 and 7 inches, and a height of between approximately 1 and 3 inches.   In one embodiment, dimensions different from those stated herein may be utilized.

15   [0093]   Any of the display devices discussed herein may display data associated with taking camera **22** and/or cameras **14, 16** of the camera device **12**, such as the make, zoom, iris, and focus of the cameras.

[0094]   Referring back to FIG. 1, the system may include a

20   camera controller **26** configured to control operation of the cameras **14, 16.** The camera controller **26** may be configured to operate features of the cameras **14, 16** including lens control such as iris, focus, and/or zoom.   The camera controller **26** may be configured to operate both cameras **14, 16**

25   simultaneously such that the features of the cameras **14, 16** are similar.   In one embodiment, the camera controller **26** may be operated via the control device **18**.

[0095]   In one embodiment, the camera controller **26** may be configured to control the taking camera **22** and/or the cameras

30   **14, 16.**   The camera controller **26** may be configured to operate features of the taking camera **22** including lens control such as iris, focus, and/or zoom, such that these features of the taking camera **22** match the features of the cameras **14, 16.**   In

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one embodiment, the camera controller **26** may be configured to automatically adjust the focus of the taking camera **22** based on the distance measurements provided by the camera device **12**.

[0096]   The camera controller **26** may be connected to the camera device **12** or may be configured to communicate with the camera device **12** wirelessly.   The wireless communication device of the camera device **12** may be used to communicate with the camera controller **26**.   The camera controller **26** may include a wireless communication device to communicate with any other component of the system **10**.   The camera controller **26** may include a wired or wireless connection to the taking camera **22**.

[0097]   In one embodiment, the camera controller **26** may be a motor driver.   The motor driver may be a Preston MDR, or other kinds of motor drivers.

[0098]   The system **10** may include a taking camera **22** that is configured to produce an image in a field of view that overlaps the fields of view of the cameras **14, 16**.   The image may be a static image, or may be a video image.   The taking camera **22** may be of a style that is typically used to film television or motion pictures, and may be a digital or film camera.   The taking camera **22** may be configured to output an HD image.   The taking camera may include, but is not limited to, an Arri Alexa, a Red Epic, a Sony F55, a Sony F65, a Genesis, and a Panavision film camera, among other kinds of taking cameras.

[0099]   In one embodiment, the taking camera **22** may be utilized in a defined orientation relative to the camera device **12**.   For example, the taking camera **22** may be oriented such that the lens of the taking camera **22** is oriented substantially parallel to the respective axes **34, 36** of one or both of the cameras **14, 16**.   The taking camera **22** may be oriented substantially co-planar with one or both of the

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cameras **14**, **16**, being aligned in a substantially similar horizontal, or x-dimension, plane **38** extending out of the page in FIG. 3. The camera sensor of the taking camera **22** may be oriented substantially co-planar with the sensors of one or

5   both of the cameras **14**, **16**, being aligned in a substantially similar vertical, or y-dimension, plane **44** extending out of the page in FIG. 3. The taking camera **22** may be oriented such that it faces towards the same direction of one or both cameras **14**, **16**. In one embodiment, the taking camera **22** may

10 be oriented in the manner shown in FIG. 7, with the taking camera **22** positioned between the two cameras **14**, **16**. The field of view **84** of the taking camera **22** may be positioned centrally and overlap the respective fields of view **78**, **80** of the cameras **14**, **16**.

15 **[0100]** The taking camera **22** may be coupled to the camera device **12** to retain the desired orientation of the taking camera **22** relative to the camera device **12**. In one embodiment, the taking camera **22** may be separate from the camera device **12**. Any of the display devices **20**, **24**, **28**, **106**

20 or the control device **18** discussed herein may be coupled to the taking camera **22** as desired.

[0101] The calculation of distance performed by the system **10** and/or devices of the system may be used to set the focus of the taking camera **22**. During filming, it is pertinent to

25 readily ascertain the distance to regions of interest, to determine how to efficiently set focus of a taking camera **22** to those regions. The system, devices, and processes discussed herein improve the ability to readily ascertain distance, and thus improve the ability to set the focus of a

30 taking camera **22**. In one embodiment, the focus of the taking camera **22** may be set by a user, based on the distance calculations provided by the camera device **12**. The user may determine the distance calculations by reviewing the output

from one of the display devices, or the control device, or
another device associated with the system **10**. For example,
the user may view the distance on display device **28**, which
shows an overlay of the calculated distance and the image from
5   the taking camera **22**. The user may be an individual such as a
camera assistant. In one embodiment, the focus of the taking
camera **22** may be set automatically based on the distance
calculations provided by the camera device **12**. For example,
the camera controller **26**, or other device of the system **10**,
10   may automatically adjust the focus.

[0102]   Additional benefits of the system **10**, devices, and
processes discussed herein include the ability to select
regions of interest based on their appearance, including
facial recognition. Additional benefits include the ability
15   to track location of a region or regions of interest as they
move. Additional benefits include real time calculations of
the distance to a region or regions of interest, which may
occur during movement.

[0103]   The system **10**, devices, and processes discussed
20   herein, represent a marked improvement over prior methods of
determining distance, including use of acoustic or infrared
measurement devices.

[0104]   Elements of the system **10** may beneficially appear as
part of a normal camera system, enhancing the ease of use and
25   marketability of the system. For example, the camera device
12, control device **18**, and/or display devices may be coupled
to the taking camera **22** to reduce the total number of parts
used. Elements of the system **10** may be made portable and
preferably lightweight. In one embodiment, the camera device
30   **12** may have a weight of less than approximately four pounds.
In one embodiment, the display device **24** may have a weight of
less than two pounds.

[0105]   The system **10** may operate at a distance of between approximately 1 foot and 45 feet, although additional ranges may be utilized as well.   The system **10** may beneficially operate at a distance that is with the accuracy of the depth-
5   of-field of the taking camera **22**.   The system **10** may operate at a luminance level between very dark and bright light, approximately between 10 lux and 25,000 lux.   Other luminance levels may be utilized as well.

[0106]   FIG. 20 illustrates one embodiment of hardware
10   configuration of the camera device **12** and the display device **24**.   Other hardware configurations may be used in other embodiments.   The camera device **12** may use a processor card **76**.   In one embodiment, the processor card **76** may include up to 2 gigabytes of internal memory, and up to 16 gigabytes of
15   flash memory.   In other embodiments, other forms of processor cards **76** may be utilized.   In one embodiment, the interface device **72** may be in the form of a PCT USB3 card.   In other embodiments, other forms of interface devices may be utilized. The display device **24** may use an overlay processor card **118**.
20   In one embodiment, the overlay processor card **76** may include an HD-SDI input, and an HD-SDI output.   In other embodiments, other forms of processor cards **76** may be utilized.   The display device **24** may include a wireless communication card **122**, and a power supply **124**.

25   [0107]   In one embodiment, the cameras **14, 16** may be configured for binning, windowing and high-speed readout.   The cameras **14, 16** may include an image sensor having up to 5 mega-pixels.   The cameras **14, 16** may be configured to produce up to 33 images per second, or up to 15 images per second
30   depending on the resolution desired.   In other embodiments, the features of the cameras **14, 16** may be varied as desired.

[0108]   FIG. 21 illustrates one embodiment of wired connections between elements of system **10**.   Cables may be used

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to perform the wired connections. Cables for transferring image data may be in the form of HD-SDI cables, although other forms of cables may be used as desired. Power cables may supply power from a battery pack **126,** although other forms of 5   power supply may be used as desired.

[0109]   FIG. 22 illustrates one embodiment of a process map for determining a distance to a region of interest. The process **128** may occur with the selection of one or more regions of interest. Process **128** may occur through use of the 10   control device **18**. The process **128** may include a process of facial feature detection, or detection of track marks. The process **130** may occur through use of the camera device **12**. The camera device **12** may match the selected region or regions of interest in the first field of view with the second field 15   of view. The camera device **12** may perform disparity calculations. Process **132** may occur through parameters of the system **10** or the cameras of the camera device **12** being input to the camera device **12**. Such parameters may include features such as camera baseline, camera focal length, and other 20   features based herein. The process **134** may occur through the camera device **12** calculating the distance or distances to a region or region of interest based on the disparity calculations, and the parameters input in process **132**. The process **136** may occur through control device **18** or display 25   device **24** overlaying a distance on an image from one of the cameras **12, 14** or **22**. The process of FIG. 22 may be modified to include or exclude steps, and may include any process discussed herein.

[0110]   FIG. 23 illustrates one embodiment of a process to 30   transfer data to and from the camera controller **26**. An element of the system **10** may request focus, zoom, and/or iris data from the camera controller **26**. The data may represent the status of the camera device **12** and/or the taking camera

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22. The process shown in FIG. 23 may be modified or excluded as desired. FIG. 24 illustrates one embodiment of a process to transfer distance data to the camera controller **26**. The process shown in FIG. 23 may be modified or excluded as

5   desired.

[0111]   Embodiments disclosed herein may include the following processes. Additional processes disclosed herein may be incorporated into the steps listed below:

[0112]   A method of adjusting focus of a camera may

10   comprise: selecting, with a control device, a region of interest in a first field of view of a first camera; calculating, with a processor, a distance of the selected region of interest relative to a location by comparing a position of the selected region of interest in the first field

15   of view with a position of the selected region of interest in a second field of view of a second camera, the second field of view overlapping at least a portion of the first field of view; and adjusting a focus of a third camera on the selected region of interest based on the distance calculated with the

20   processor.

[0113]   The method may include a control device including a touch screen configured to display an image of the first field of view produced by the first camera, the region of interest being selected by a user touching a portion of the touch

25   screen that displays the region of interest in the image.

[0114]   The method may include the first camera and the second camera each being coupled to a housing that retains the first camera and the second camera at a distance from each other.

30   [0115]   The method may include a step of calculating that further comprises calculating the distance of the selected region of interest relative to the location based on the distance between the first camera and the second camera.

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[0116]   The method may further comprise a step of displaying the distance calculated with the processor on an overlay of an image produced by the third camera.

[0117]   The method may further comprise a step of tracking, with the processor, the position of the selected region of interest in the first field of view while the selected region of interest moves in the first field of view.

[0118]   The method may include a step of calculating that further comprises calculating the distance of the selected region of interest relative to the location in real time while the selected region of interest moves in the first field of view.

[0119]   The method may further comprise a step of displaying the distance calculated with the processor in real time while the selected region of interest moves in the first field of view.

[0120]   The method may include a step of displaying that further comprises overlaying the distance calculated with the processor in real time on an image produced by the third camera while the selected region of interest moves in the first field of view.

[0121]   The method may include the image produced by the third camera is a video image displaying the selected region of interest moving.

[0122]   Embodiments disclosed herein may include the following apparatus. Additional features disclosed herein may be incorporated into the apparatus listed below:

[0123]   An apparatus for determining a distance to a region of interest comprising: a housing; a first camera coupled to the housing and oriented to have a first field of view; a second camera coupled to the housing and oriented to have a second field of view that overlaps at least a portion of the

first field of view; and a processor coupled to the housing and configured to calculate a distance of a selected region of interest relative to a location by comparing a position of the selected region of interest in the first field of view with a

5   position of the selected region of interest in the second field of view.

[0124]   The apparatus may be configured wherein the first camera is aligned along a first longitudinal axis and the second camera is aligned along a second longitudinal axis that

10   is substantially parallel to the first longitudinal axis.

[0125]   The apparatus may be configured wherein the first camera has a first image sensor and the second camera has a second image sensor, the first image sensor being positioned substantially coplanar with the second image sensor.

15   [0126]   The apparatus may be configured wherein the first camera has a focal length of between approximately 12 millimeters and 16 millimeters, inclusive, and the second camera has a focal length of between approximately 12 millimeters and 16 millimeters, inclusive.

20   [0127]   The apparatus may be configured wherein the first field of view includes a horizontal dimension and a vertical dimension, and the second field of view includes a horizontal dimension and a vertical dimension; and the processor is further configured to calculate the distance of the selected

25   region of interest relative to the location by comparing the position of the selected region of interest in the horizontal dimension of the first field of view with the position of the selected region of interest in the horizontal dimension of the second field of view.

30   [0128]   The apparatus may be configured wherein the processor is further configured to track the position of the selected region of interest in the first field of view while

the selected region of interest moves in the first field of view.

[0129]   The apparatus may be configured wherein the processor is configured to calculate the distance of the selected region of interest relative to the location in real time while the selected region of interest moves in the first field of view.

[0130]   The apparatus may further comprise an input device coupled to the housing and configured for receiving data indicating the selected region of interest.

[0131]   The apparatus may be configured wherein the input device is a wireless communication device.

[0132]   The apparatus may further comprise an output device coupled to the housing and configured for outputting data indicating the distance calculated by the processor.

[0133]   In closing, it is to be understood that although aspects of the present specification are highlighted by referring to specific embodiments, one skilled in the art will readily appreciate that these disclosed embodiments are only illustrative of the principles of the subject matter disclosed herein. Therefore, it should be understood that the disclosed subject matter is in no way limited to a particular methodology, protocol, and/or reagent, etc., described herein. As such, various modifications or changes to or alternative configurations of the disclosed subject matter can be made in accordance with the teachings herein without departing from the spirit of the present specification. Lastly, the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of systems, apparatuses, and methods as disclosed herein, which is defined solely by the claims. Accordingly, the systems, apparatuses, and methods are not limited to that precisely as shown and described.

[0134]   Certain embodiments of systems, apparatuses, and methods are described herein, including the best mode known to the inventors for carrying out the same. Of course, variations on these described embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventors intend for the systems, apparatuses, and methods to be practiced otherwise than specifically described herein. Accordingly, the systems, apparatuses, and methods include all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described embodiments in all possible variations thereof is encompassed by the systems, apparatuses, and methods unless otherwise indicated herein or otherwise clearly contradicted by context.

[0135]   Groupings of alternative embodiments, elements, or steps of the systems, apparatuses, and methods are not to be construed as limitations. Each group member may be referred to and claimed individually or in any combination with other group members disclosed herein. It is anticipated that one or more members of a group may be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is deemed to contain the group as modified thus fulfilling the written description of all Markush groups used in the appended claims.

[0136]   Unless otherwise indicated, all numbers expressing a characteristic, item, quantity, parameter, property, term, and so forth used in the present specification and claims are to be understood as being modified in all instances by the term "about." As used herein, the term "about" means that the characteristic, item, quantity, parameter, property, or term

so qualified encompasses an approximation that may vary. The terms "approximate[ly]" and "substantial[ly]" represent an amount that may vary from the stated amount, yet is capable of performing the desired operation or process discussed herein.

[0137]   The terms "a," "an," "the" and similar referents used in the context of describing the systems, apparatuses, and methods (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein is intended merely to better illuminate the systems, apparatuses, and methods and does not pose a limitation on the scope of the systems, apparatuses, and methods otherwise claimed.   No language in the present specification should be construed as indicating any non-claimed element essential to the practice of the systems, apparatuses, and methods.

[0138] All patents, patent publications, and other publications referenced and identified in the present specification are provided solely for their disclosure prior to the filing date of the present application. Nothing in this regard should be construed as an admission that the inventors are not entitled to antedate such disclosure by virtue of prior invention or for any other reason. All statements as to the date or representation as to the contents

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of these documents is based on the information available to
the applicants and does not constitute any admission as to the
correctness of the dates or contents of these documents.

WHAT IS CLAIMED IS:

1.   A system for determining a distance to a region of interest comprising:

a first camera configured to have a first field of view;

a second camera configured to have a second field of view that overlaps at least a portion of the first field of view;

a control device configured to allow a user to select a region of interest in the at least a portion of the first field of view that overlaps the second field of view; and

a processor configured to calculate a distance of the selected region of interest relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view;

wherein the first field of view includes a horizontal dimension and a vertical dimension, and the second field of view includes a horizontal dimension and a vertical dimension; and

wherein the processor is further configured to calculate the distance of the selected region of interest relative to the location by comparing the position of the selected region of interest in the horizontal dimension of the first field of view with the position of the selected region of interest in the horizontal dimension of the second field of view.

2.   The system of claim 1, further comprising a housing retaining the first camera and the second camera at a distance from each other.

3.   The system of claim 2, wherein the processor is configured to calculate the distance of the selected region of interest based on the distance between the first camera and the second camera.

4.   The system of claim 2, wherein the housing retains the first camera and the second camera in an orientation such that the second field of view overlaps the at least a portion of the first field of view.

5.   The system of claim 1, wherein the processor is further configured to identify the position of the selected region of interest in the second field of view by using an algorithm that correlates an appearance of the selected region of interest in the first field of view with an appearance of the selected region of interest in the second field of view.

6.   The system of claim 1, wherein the processor is further configured to track the position of the selected region of interest in the first field of view while the selected region of interest moves in the

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first field of view.

7.   The system of claim 6, wherein the processor is further configured to track the position of the selected region of interest in the second field of view by using an algorithm that correlates an appearance of the selected region of interest in the first field of view with an appearance of the selected region of interest in the second field of view.

8.   The system of claim 7, wherein the processor is configured to calculate the distance of the selected region of interest relative to the location in real time while the selected region of interest moves in the first field of view.

9.   The system of claim 1, wherein:

        the control device is configured to allow a user to select a plurality of regions of interest in the at least a portion of the first field of view that overlaps the second field of view;

        the processor is configured to calculate a distance for each one of the plurality of selected regions of interest relative to a location by comparing a position of each one of the plurality of selected regions of interest in the first field of view with a position of a corresponding one of the plurality of selected regions of Interest in the second field of view.

10.   The system of claim 1, wherein the control device includes a touch screen configured to display an image and allow the user to select the region of interest by touching a portion of the touch screen that displays the region of interest in the image.

11.   A system for determining a distance to a region of interest comprising:

        a first camera having a first field of view;

        a second camera having a second field of view that overlaps a portion of the first field of view; and

        a processor that calculates a distance of a selected region of interest in the overlapping portion of the first and second fields of view relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view;

        wherein the processor identifies the position of the selected region of interest in the second field of view by correlating an appearance of the selected region of interest in the first field of view with an appearance of the selected region of interest in the second field of view.

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12.   The system of claim 11, further comprising a housing attached to the first camera and the second camera.

13.   The system of claim 11, wherein the first and second cameras are positioned a distance apart from one another, and wherein the processor is configured to calculate the distance of the selected region of interest using the distance between the first camera and the second camera.

14.   The system of claim 11, further comprising a device that provides the distance to a user.

15.   The system of claim 11, further comprising a third camera that produces an image in a field of view that overlaps the fields of view of one or both of the first and second cameras.

16.   The system of claim 15, wherein the image comprises a video image.

17.   The system of claim 11, wherein:
        each of the first and second fields of view include a horizontal dimension and a vertical dimension; and
        the processor calculates the distance of the selected region of interest relative to the location by comparing the position of the selected region of interest in the horizontal dimension of the first field of view with the position of the selected region of interest in the horizontal dimension of the second field of view.

18.   The system of claim 11, wherein the processor tracks the position of the selected region of interest in the first field of view while the selected region of interest moves in the first field of view.

19.   The system of claim 11, wherein the processor tracks the position of the selected region of interest in the second field of view by correlating an appearance of the selected region of interest in the first field of view with an appearance of the selected region of interest in the second field of view.

20.   The system of claim 11, wherein the processor calculates the distance of the selected region of interest relative to the location in real time while the selected region of interest moves in the first field of view.

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21.   The system of claim 11 further comprising a control device for selecting the region of interest in the overlapping portion of the first and second fields of view.

22.   The system of claim 11 further comprising a device for selecting a plurality of regions of interest in the overlapping first and second fields of view wherein the processor calculates a distance for each of the plurality of selected regions of interest relative to a location by comparing a position of each of the plurality of selected regions of interest in the first field of view with a position of a corresponding plurality of selected regions of interest in the second field of view.

23.   The system of claim 21, wherein the control device includes a touch screen to display an image of the first field of view produced by the first camera and enable a user to select the region of interest by touching a portion of the touch screen that displays the region of interest in the image.

24.   A method for determining a distance to a region of interest comprising the steps of:
        projecting a first field of view from a first camera and a second field of view from a second camera such that there is an overlapping portion of the first and second fields of view;
        selecting a region of interest in the overlapping portion; and
        determining a distance of the selected region of interest relative to a location by identifying a position of the selected region of interest in the second field of view by correlating an appearance of the selected region of interest in the first field of view with an appearance of the selected region of interest in the second field of view.

25.   The method as recited in claim 24 wherein during the step of projecting, the first camera is positioned a distance apart from the second camera.

26.   The method as recited in claim 24 wherein during the step of projecting, each of the first and second fields of view include a horizontal dimension and a vertical dimension.

27.   The method as recited in claim 24 wherein during the step of determining, comparing a position of the selected region of interest in the horizontal dimension of the first field of view with a position of the selected region of interest in the horizontal dimension of the second field of view.

28.   The method as recited in claim 24 wherein during the step of determining, a distance between the positions of the first and second cameras is used.

29. The method as recited in claim 24 wherein the region of interest moves in one of the first or second fields of view, and wherein during the step of determining, the distance of the selected region as it moves is determined.

30. A system for determining a distance to a region of interest comprising:

a first camera having a first field of view;

a second camera having a second field of view that overlaps a portion of the first field of view; and

processor that calculates a distance of a selected region of interest in the overlapping portion of the first and second fields of view relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view;

wherein the processor calculates the distance of the selected region of interest relative to the location in real time while the selected region of interest moves in the first field of view.

31. A system for determining a distance to a region of interest comprising:

a first camera configured to have a first field of view;

a second camera configured to have a second field of view that overlaps at least a portion of the first field of view;

a control device configured to allow a user to select a region of interest in the at least a portion of the first field of view that overlaps the second field of view, wherein the selected region of interest corresponds to a region of interest of a third camera that is positioned adjacent the first and second cameras; and

a processor configured to calculate a distance of the selected region of interest relative to a location by comparing a position of the selected region of interest in the first field of view with a position of the selected region of interest in the second field of view, wherein the location is related to the third camera.

32. The system of claim 31, wherein the control device comprises a display configured to show one or more of the field of view of the first camera, the field of the second camera, and a field of view of the third camera to select the region of interest.

33. The system of claim 31, wherein:

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the first field of view includes a horizontal dimension and a vertical dimension, and the second field of view includes a horizontal dimension and a vertical dimension; and

the processor is further configured to calculate the distance of the selected region of interest relative to the location by comparing the position of the selected region of interest in the horizontal dimension of the first field of view with the position of the selected region of interest in the horizontal dimension of the second field of view.

34.   The system of claim 31, wherein the location is a position of the third camera or a position of an element of the third camera.

35.   The system of claim 31, wherein the distance is used to manually or automatically adjust the focus of the third camera.

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FIG. 1

FIG. 4

FIG. 3

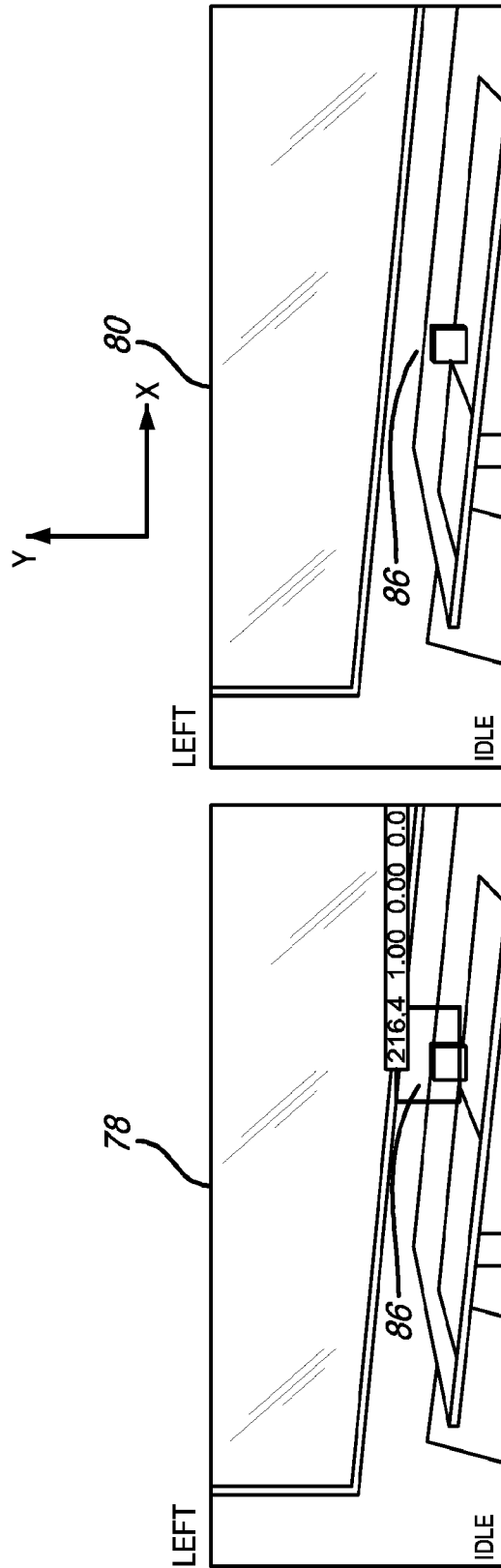**FIG. 2**

FIG. 5

FIG. 6

FIG. 7

CA 02962065 2017-03-21
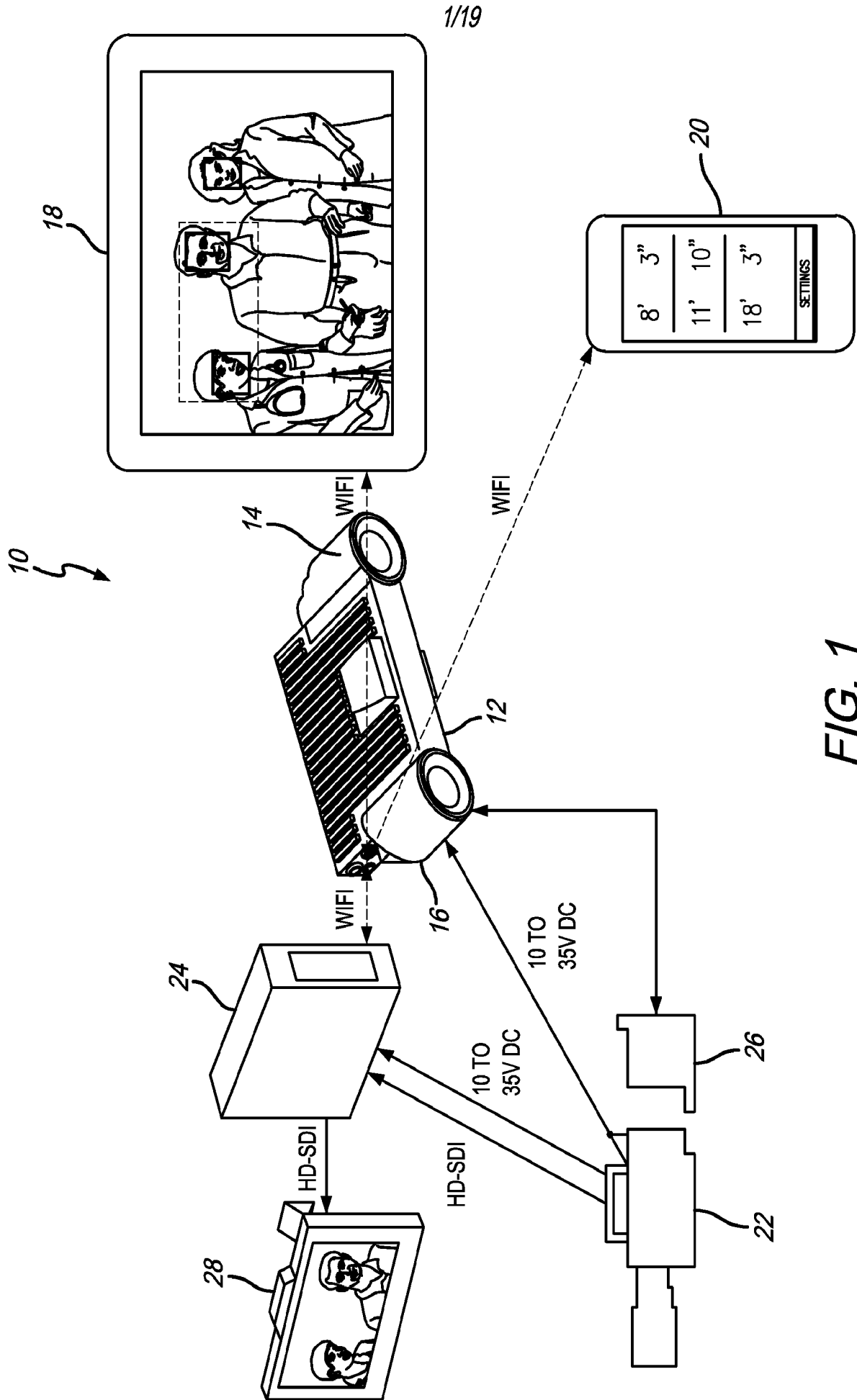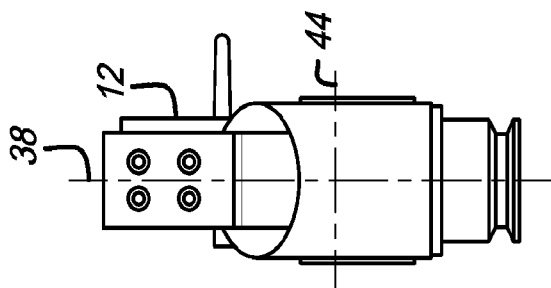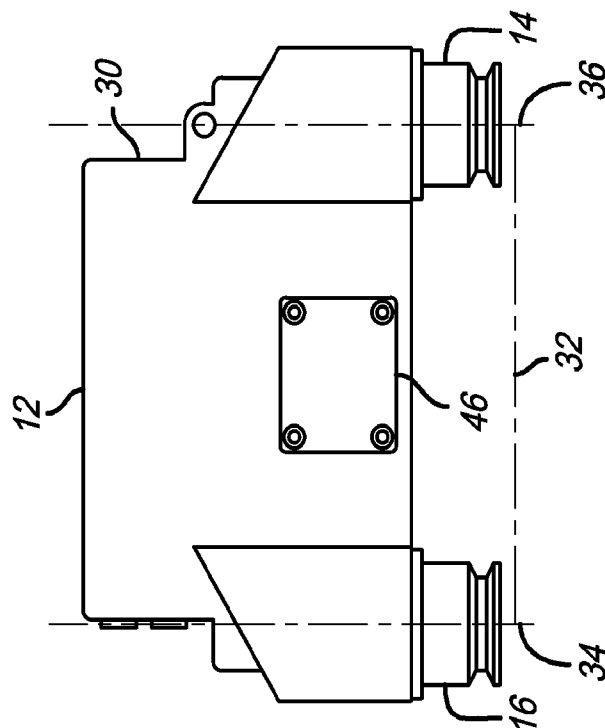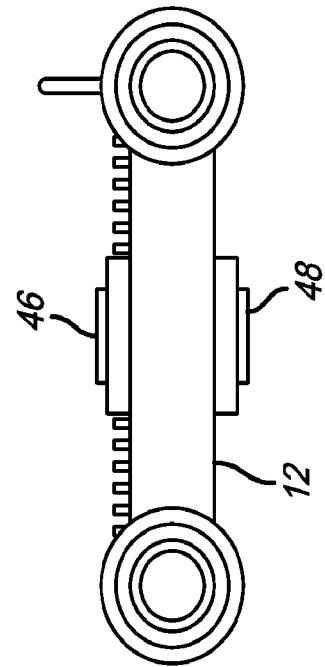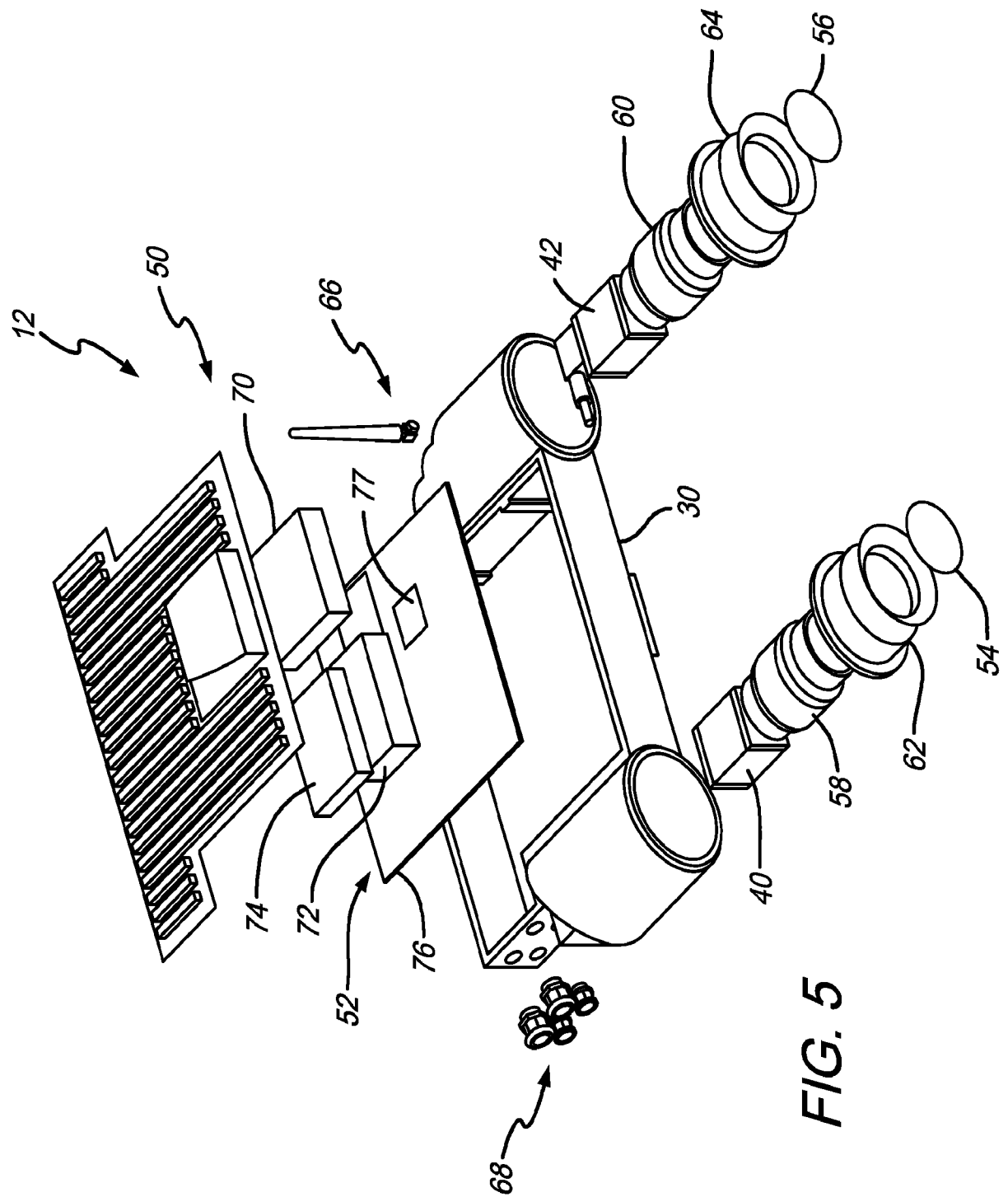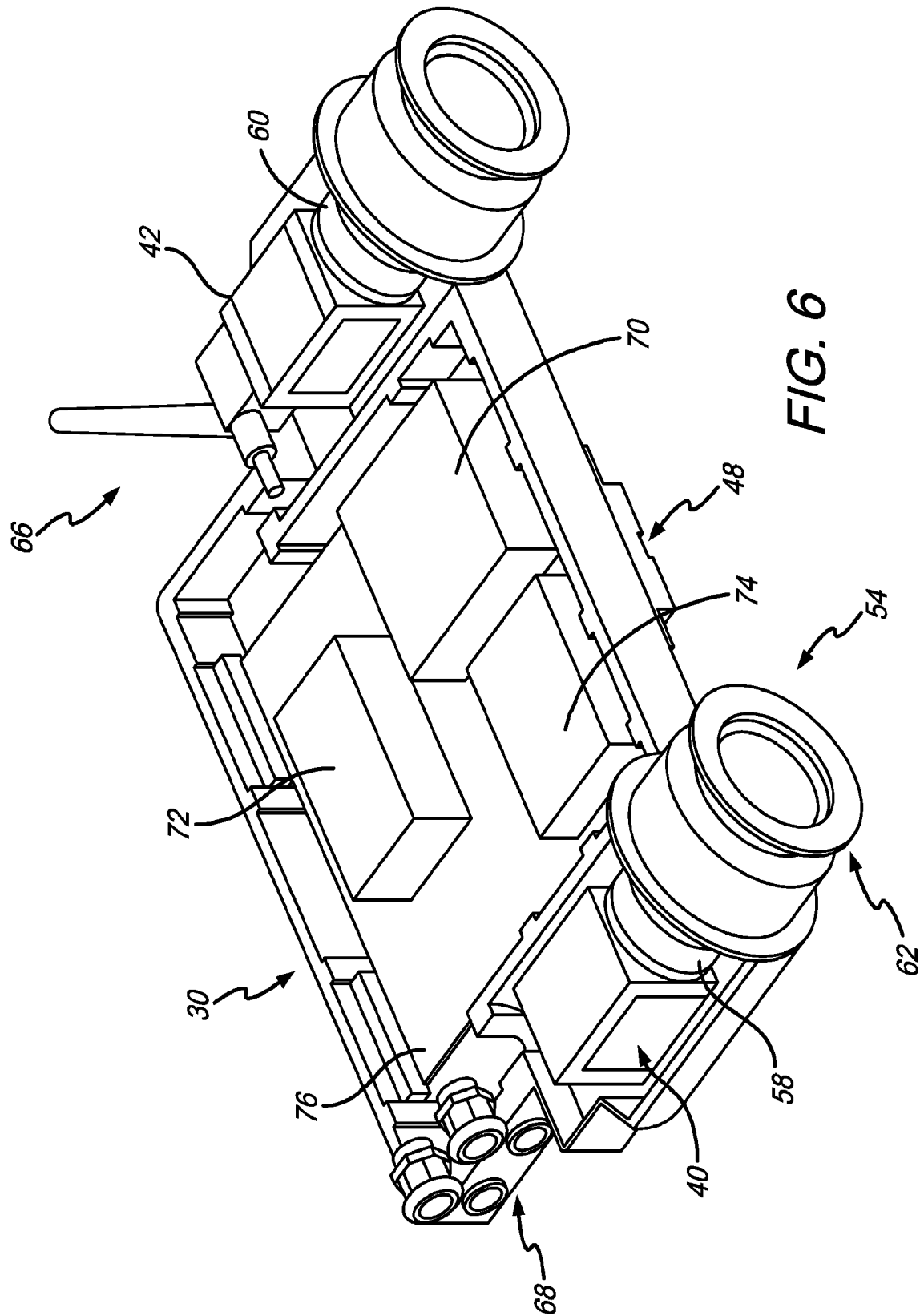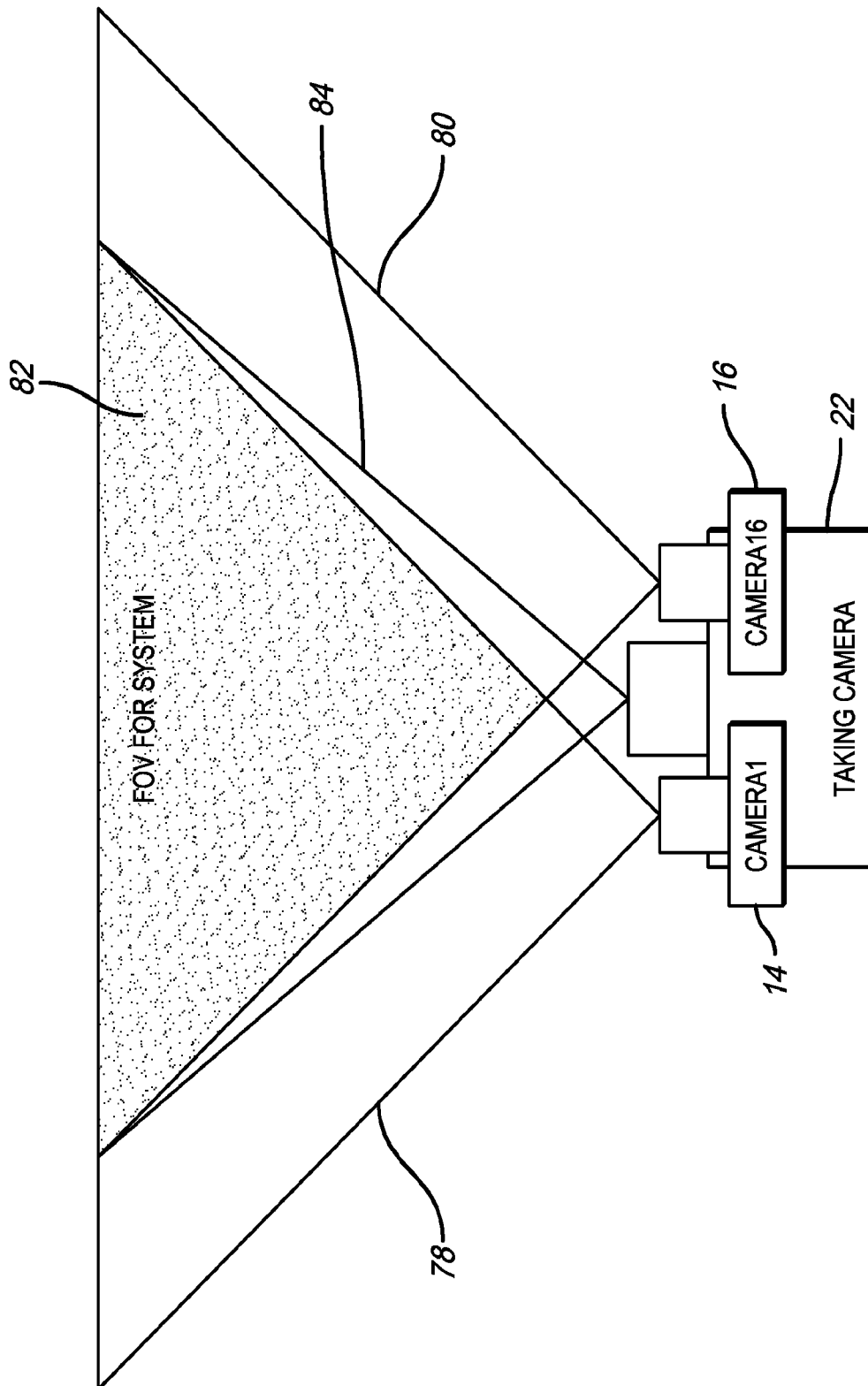
FIG. 8

$$R(x, y) = \frac{\sum_{x', y'} (T'(x', y') \cdot I'(x + x', y + y'))}{\sqrt{\sum_{x', y'} T'(x', y')^2 \cdot \sum_{x', y'} I'(x, x', y + y')^2}}$$

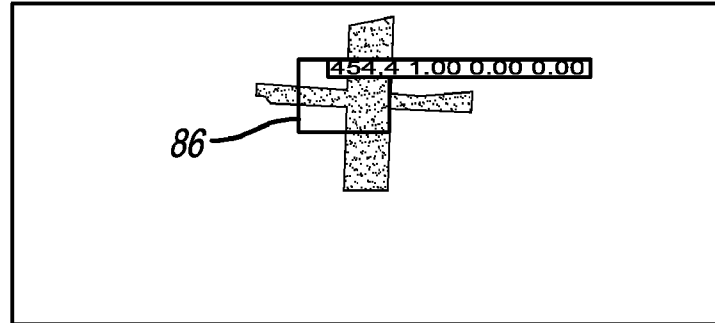- WITH I AS THE IMAGE. T AS THE TEMPLATE, R AS THE RESULT AND

$$T'(x', y') = T(x', y') - 1/(w \cdot h) \cdot \sum_{x'', y''} T(x'', y'')$$

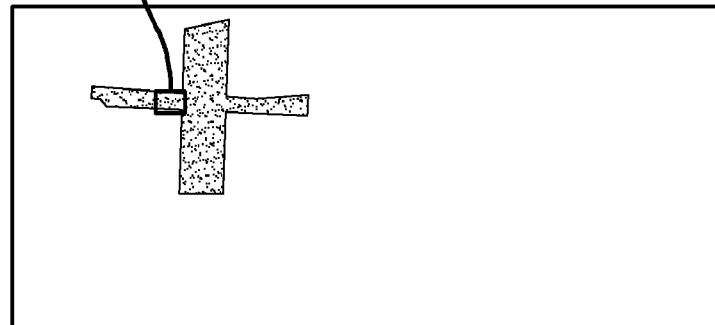$$I'(x + x', y + y') = I(x + x', y + y') - 1/(w \cdot h) \cdot \sum_{x'', y''} I(x + x'', y + y'')$$

FIG. 9

LEFT

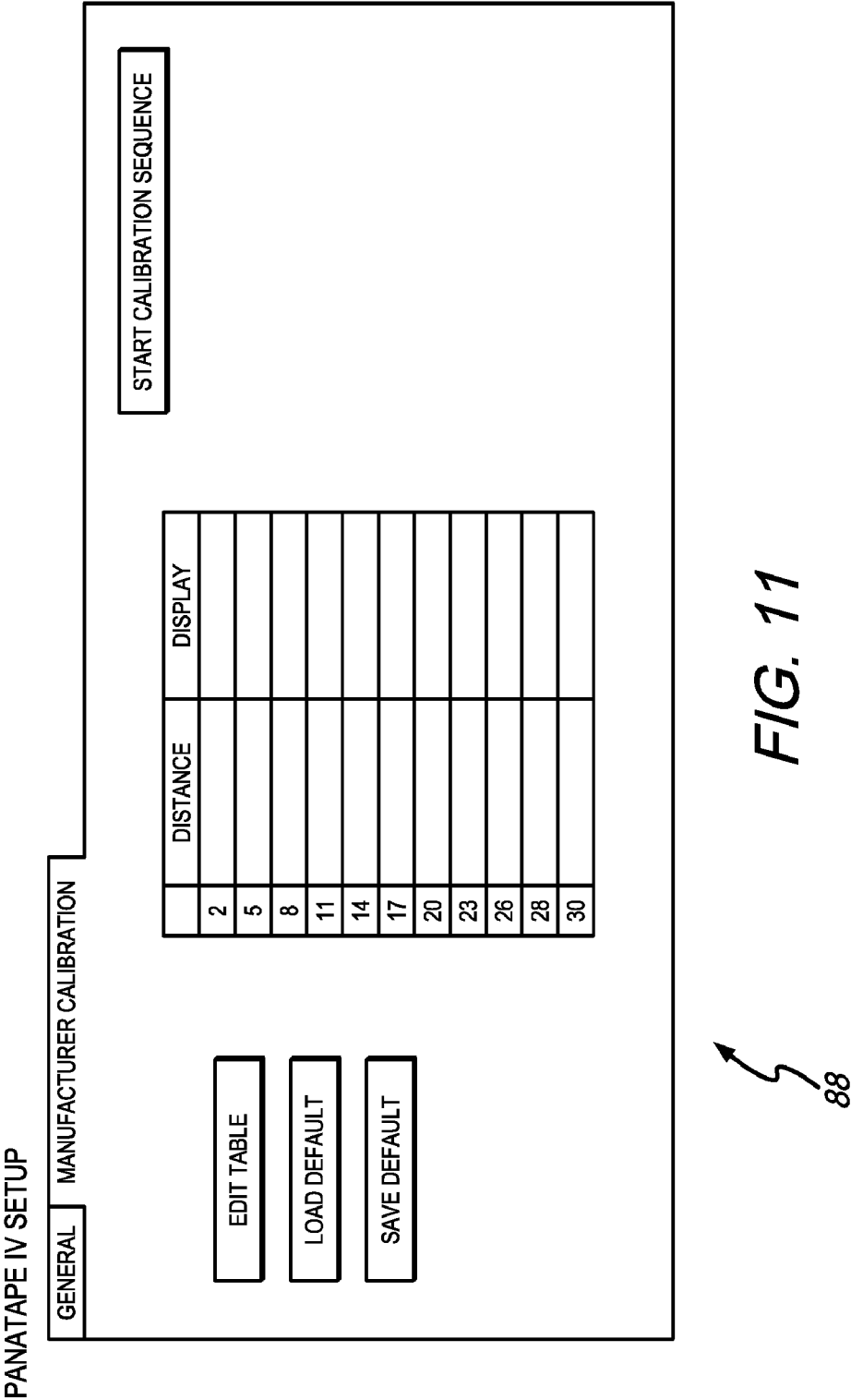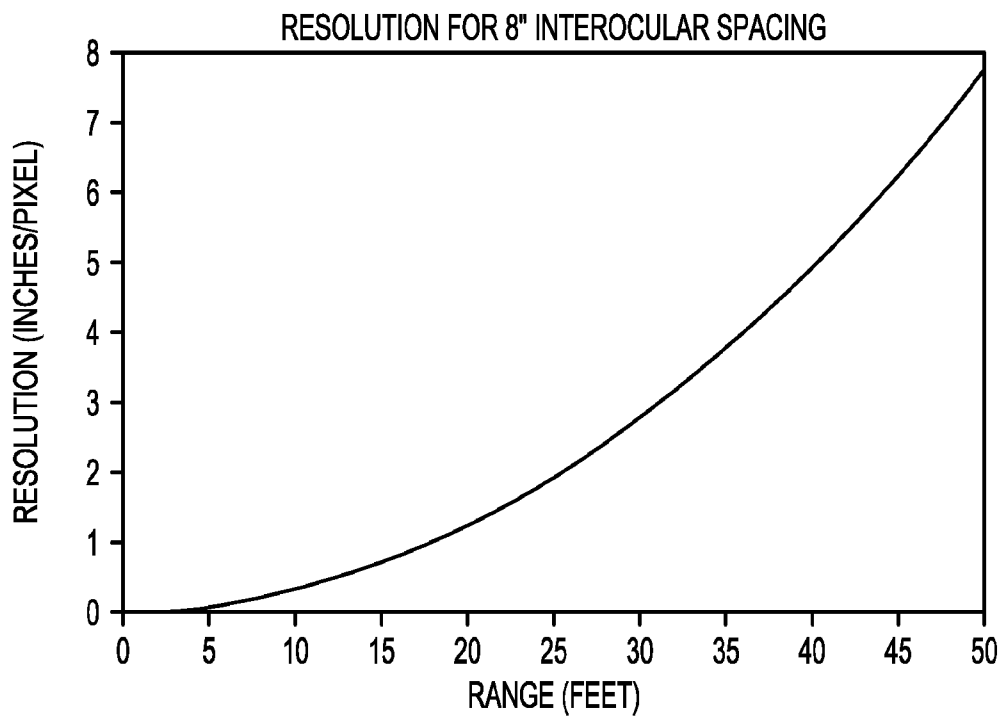
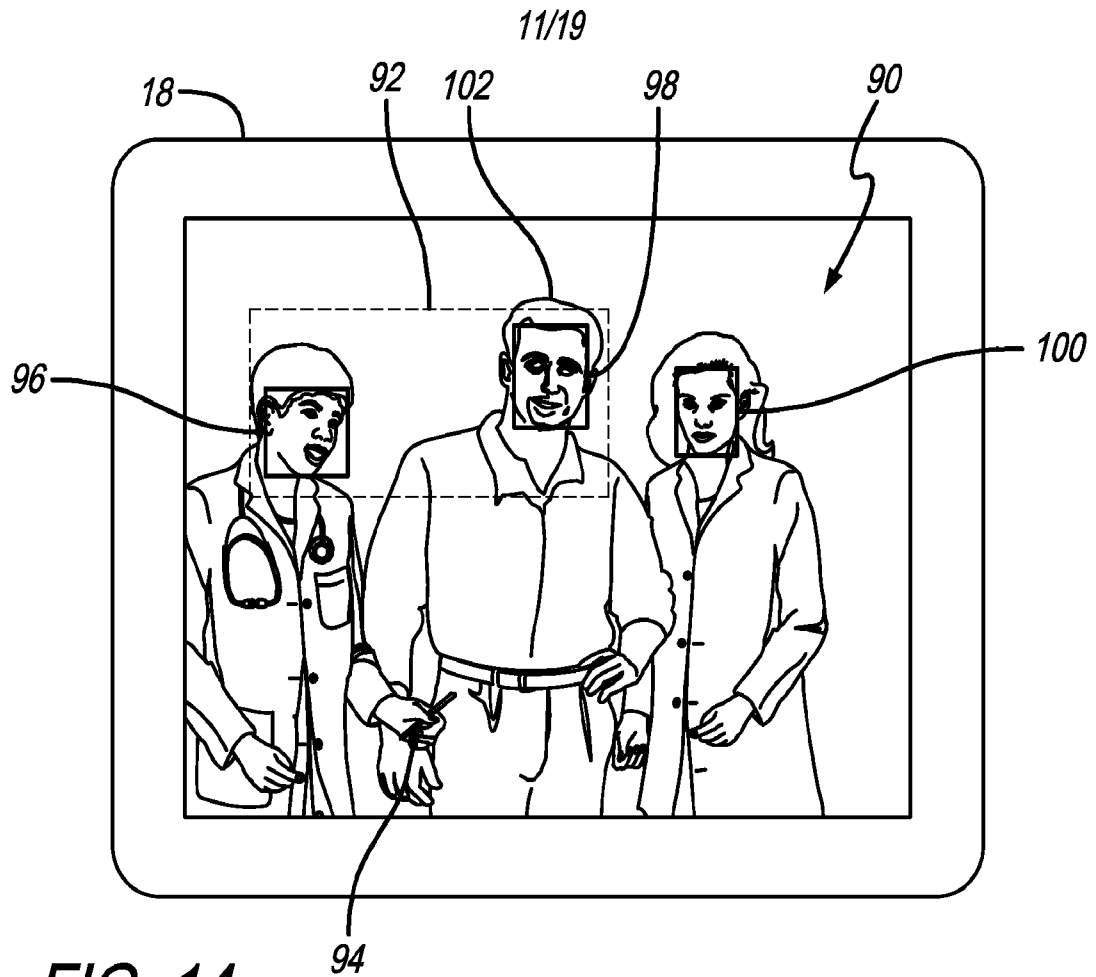454.4 1.00 0.00 0.00

86

86

RIGHT

FIG. 10

PANATAPE IV SETUP

GENERAL	MANUFACTURER CALIBRATION

START CALIBRATION SEQUENCE

	DISTANCE	DISPLAY
2		
5		
8		
11		
14		
17		
20		
23		
26		
28		
30		

EDIT TABLE

LOAD DEFAULT

SAVE DEFAULT

88

FIG. 11

RANGE	F=12.5mm (~26° FOV) INCH/PIXEL DISPARITY
5'	0.079"
10'	0.316"
15'	0.710"
20'	1.261"
25'	1.967"
30'	2.829"
35'	3.845"
40'	5.016"
45'	6.340

FIG. 12

FIG. 13

FIG. 14

FIG. 15

FIG. 16

FIG. 17

FIG. 19

FIG. 18

FIG. 20

16/19

FIG. 21

FIG. 22

128 TRACK MARK SELECTION/ FACE DETECT

130 MATCHING AND DISPARITY CALCULATIONS

134 DISTANCE CALCULATIONS

132 SYSTEM + CAMERA CALIBRATION PARAMETERS

136 OVERLAY DISTANCE FOR EACH WITNESS MARK/ FACE
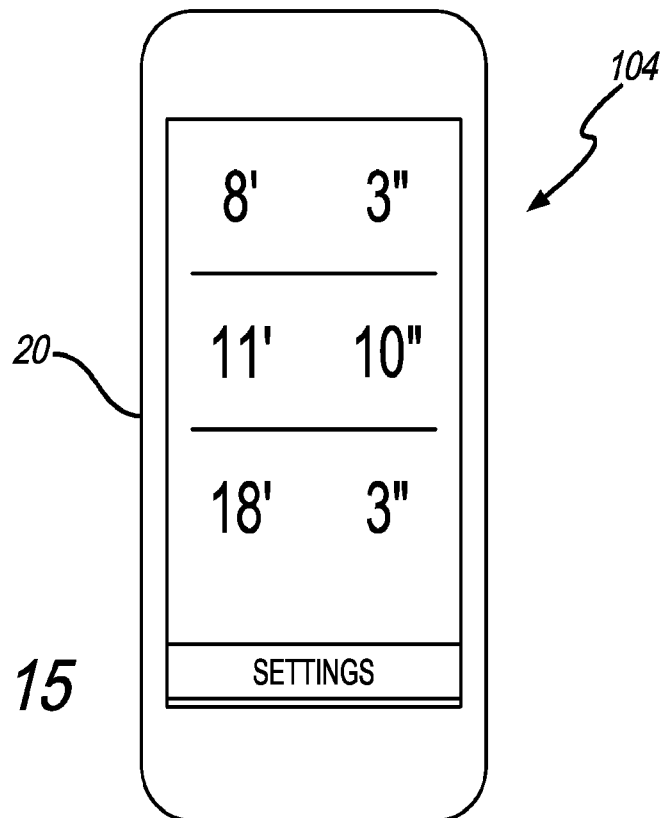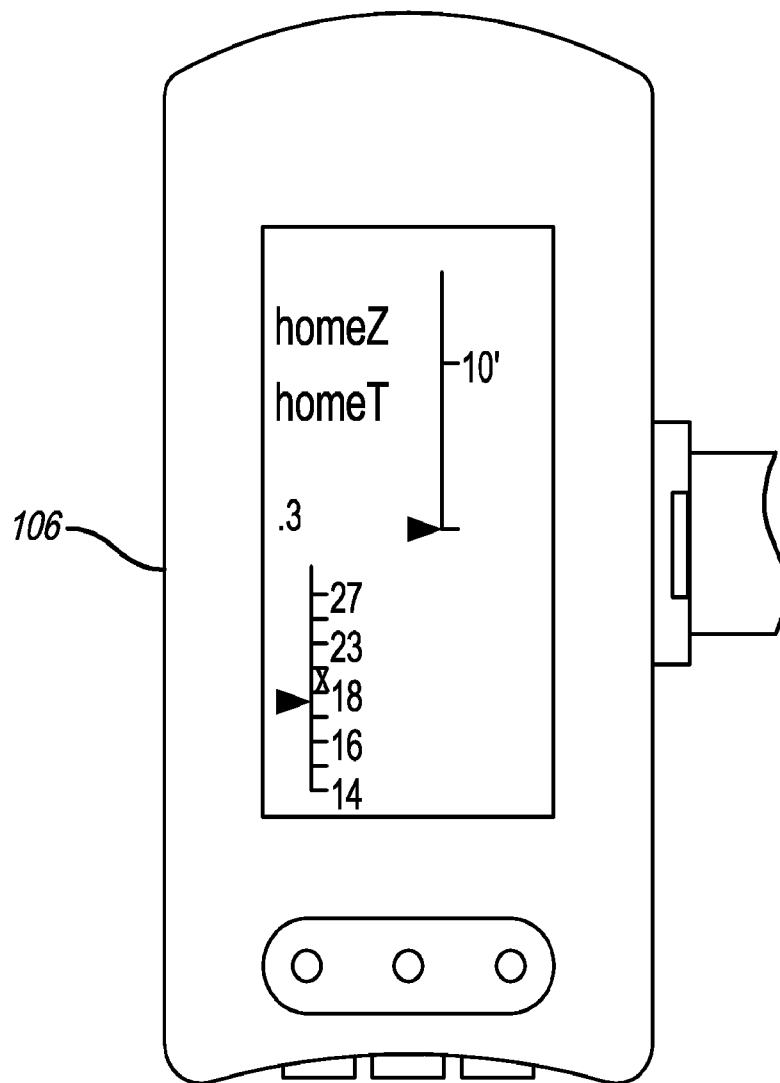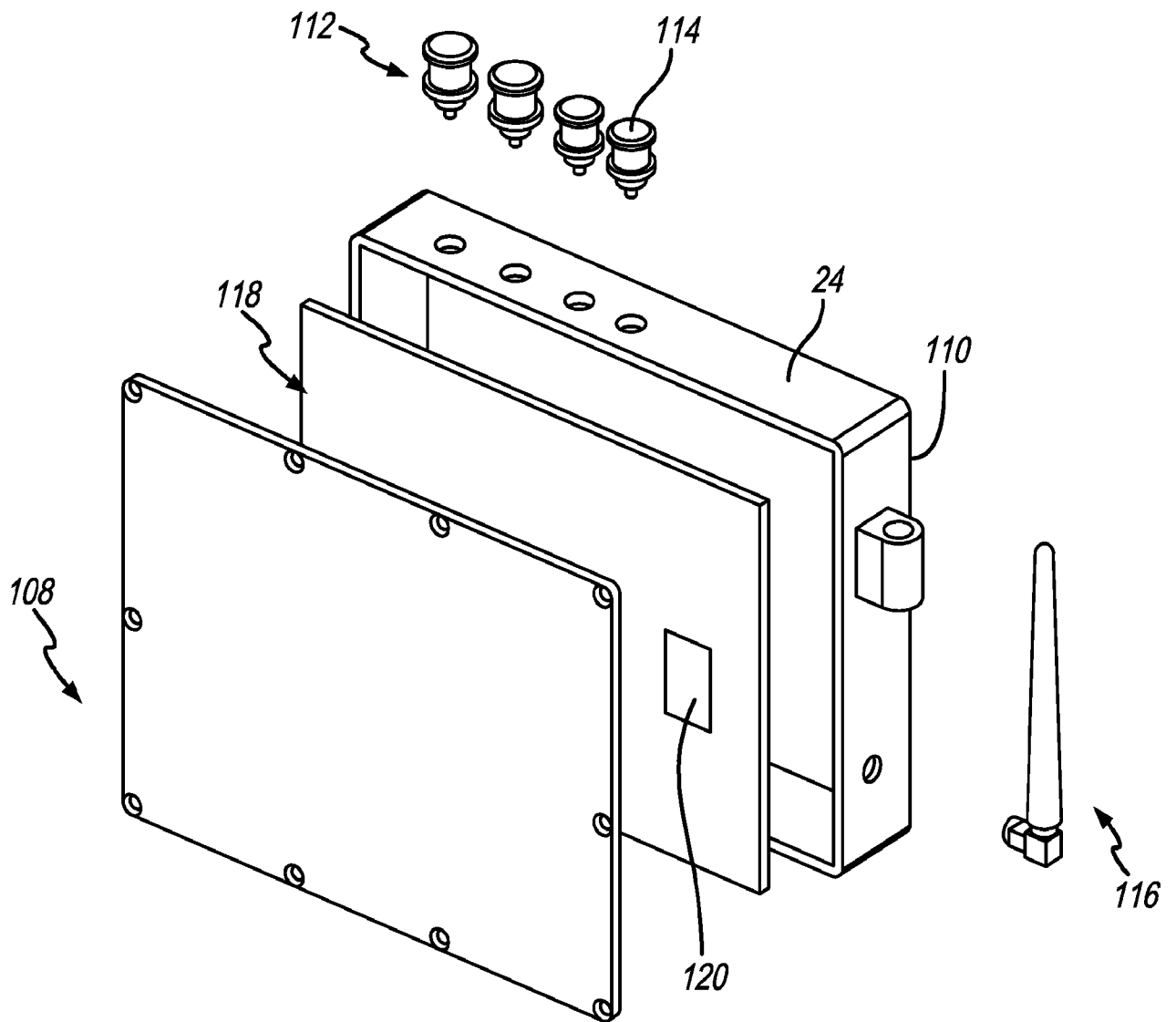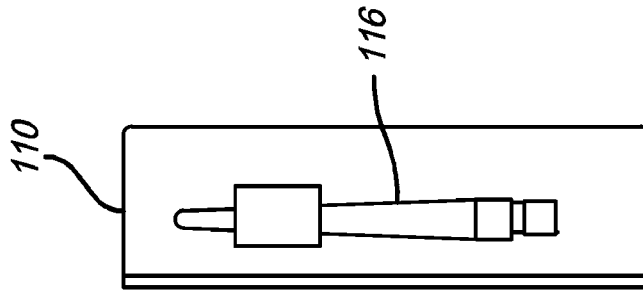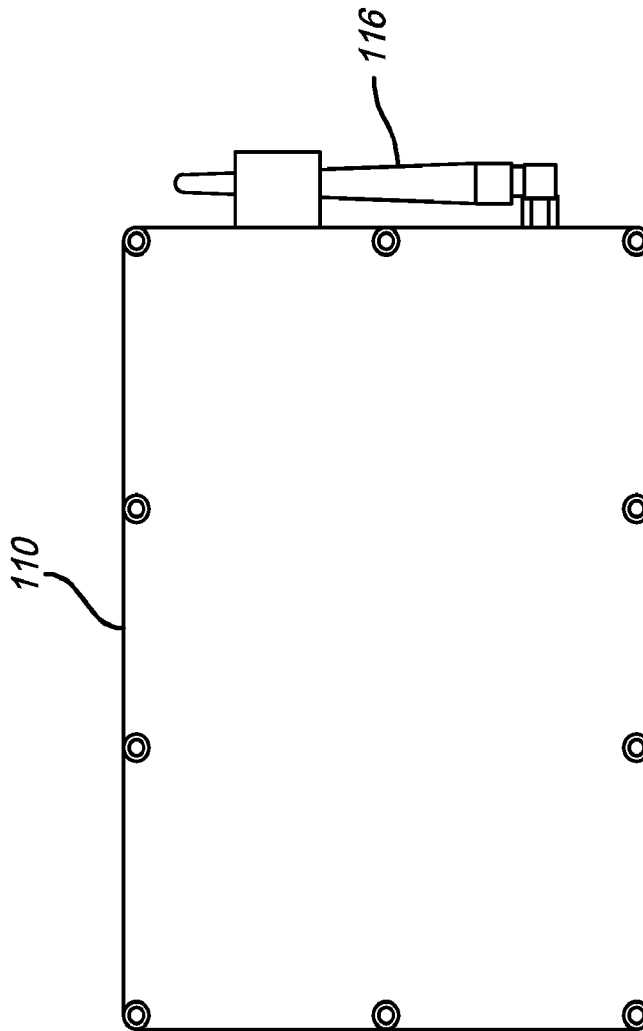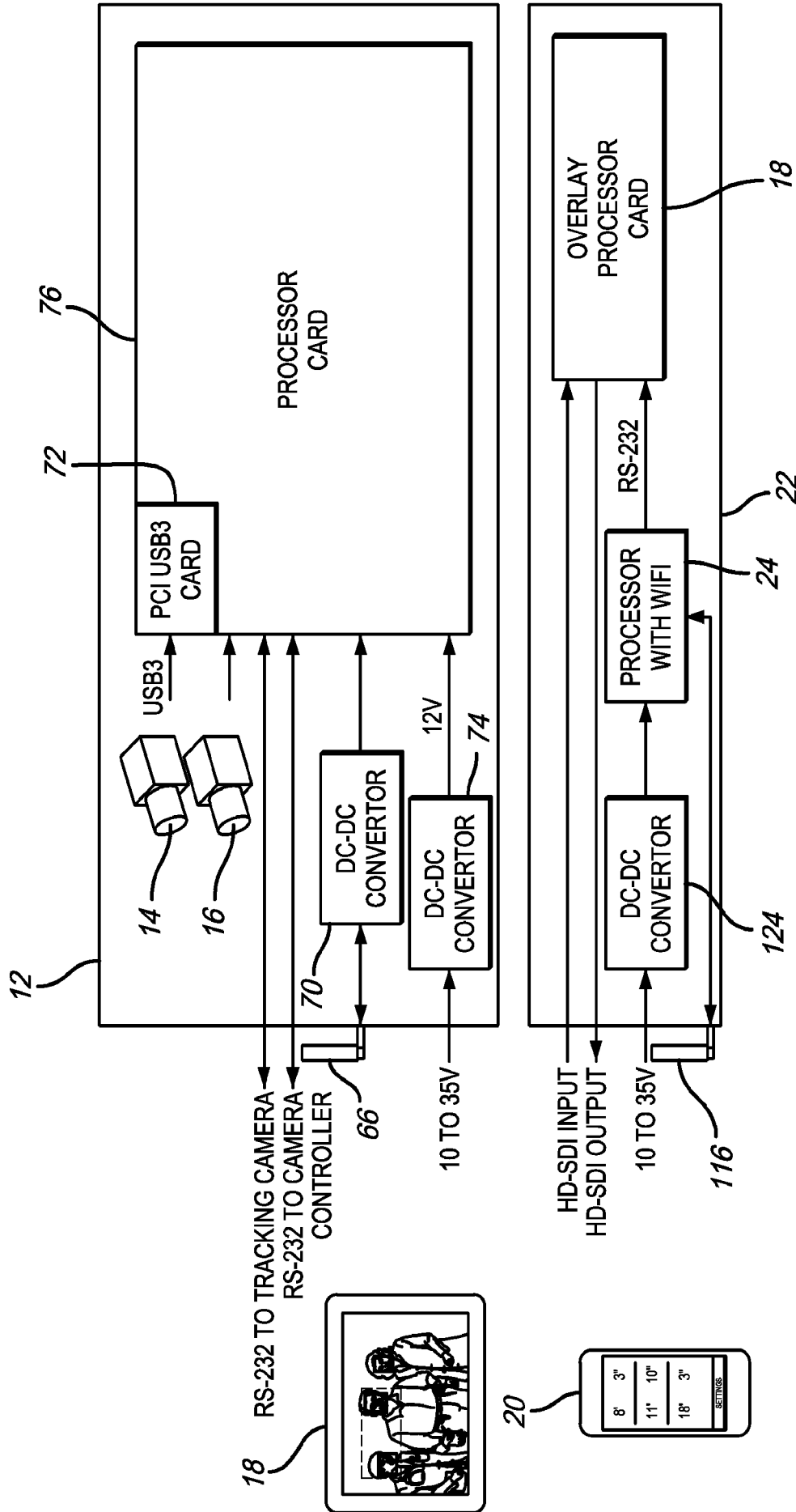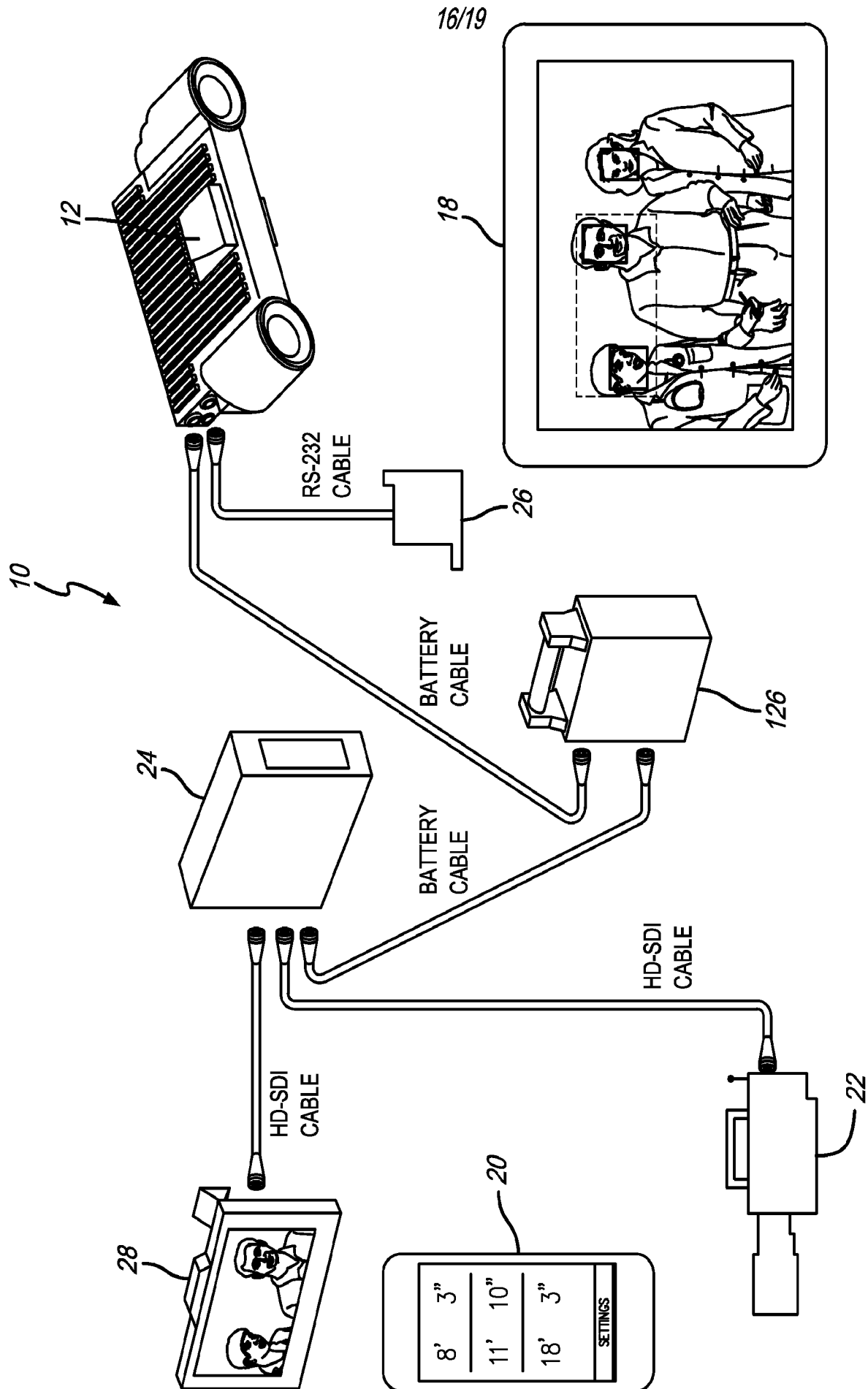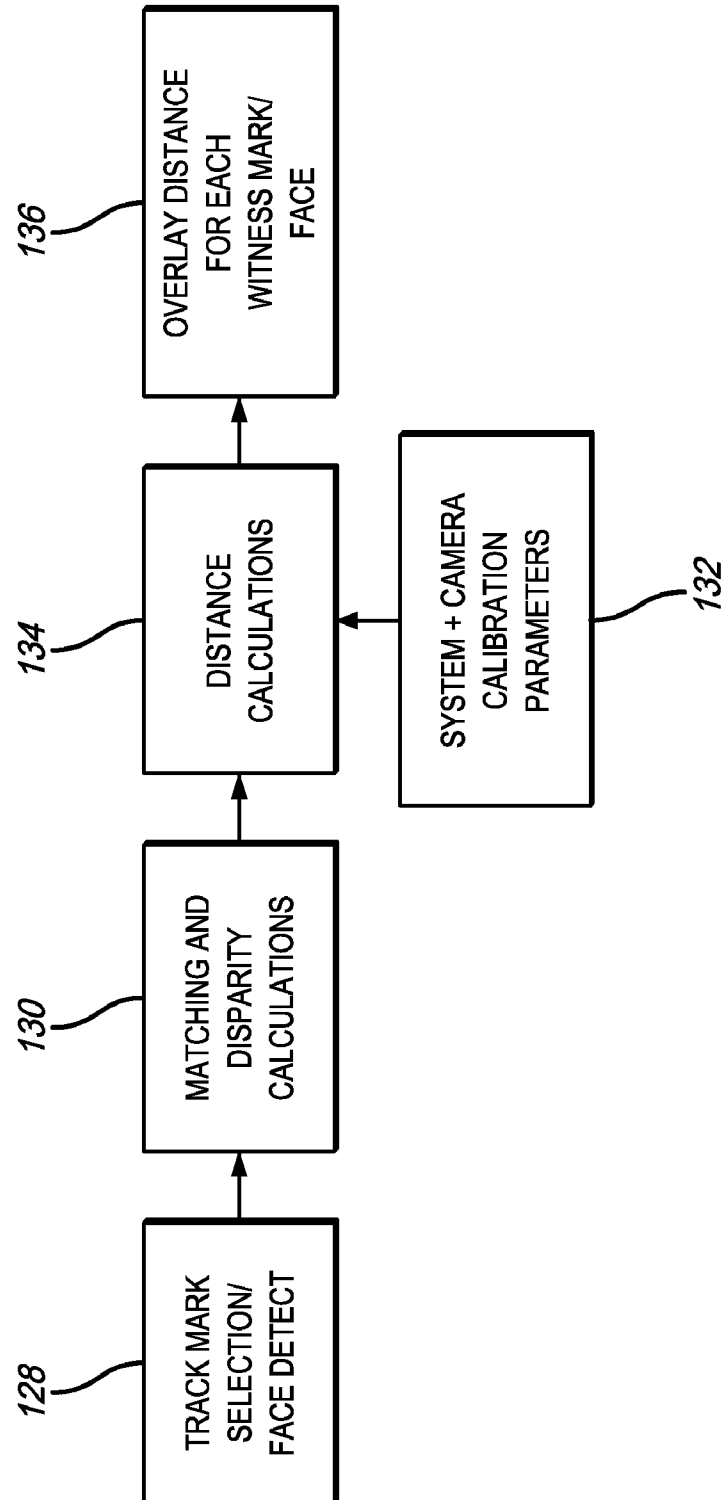
DATA   (04)

THE DATA COMMAND IS USED TO TRANSFER DATA BETWEEN TRHE CLIENT AND THE MDR. THE FIRST DATA BYTE (DATA DESCRIPTIONBYTE) INDICATES WHAT DATA IS SENT AND IS FOLLOWED BY THE ACTUAL DATA (2-BYTES EACH). THIS COMMAND CAN HAVE TWO DIFFERENT MEANINGS:

• WHEN THE DATA COMMAND IS SENT WITH ONE DATA BYTYE (DATA DESCRIPTION BYTE), IT IS INTERPRETED BY THE MDR AS THE REQUEST FOR DATA, WHERE THE DATA DESCRIPTION BYTE INDICATES WHAT DATA IS REQUESTED.

• IF THE PACKET CONTAINS: 3, 5, 7, 9, 11 OR 13 BYTES, DATA CONTAINS REQUESTED DATA. THE FIRST DATA BYTE (DATA DESCRIPTION BYTE) INDICATES WHAT DATA WAS SENT. LOWER SELECTED DATA GOES FIRST (IRIS, FOCUS, ZOOM...)

DATA DESCRIPTION BYTE

	DISTANCE	SPEED	SHUTTER	ZOOM	FOCUS	IRIS

BITS 7,8 - RESERVED

EXAMPLE WHERE THE CLIENT IS REQUESTING IRIS AND FOCUS DATA:

CLIENT: $02 $30 $34 $30 $31 $30 $33 $32 $41 $03
MDR: $06 (ACK)
MDR SENDS I&F DATA
              $02 $30 $34 $30 $33 $38 $42 $32 $45 $32 $37 $41 $38 $46 $46 $03
CLIENT: $06 (ACK)
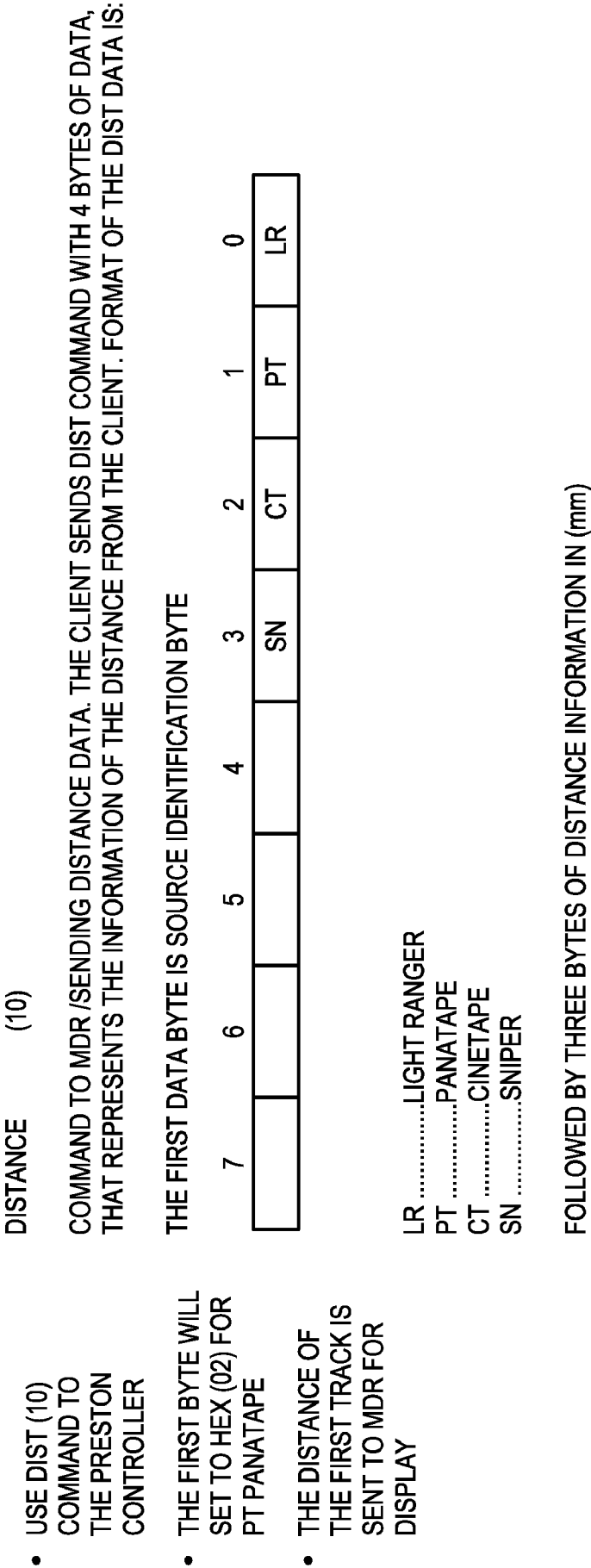
• USE DIST (04) COMMAND TO READ:

- ZOOM (ENCODER COUNT, LINEAR)

- FOCUS (ENCODER COUNT, NON LINEAR)

- IRIS (ENCODER COUNT, NON LINEAR)

FIG. 23

DISTANCE   (10)

COMMAND TO MDR /SENDING DISTANCE DATA. THE CLIENT SENDS DIST COMMAND WITH 4 BYTES OF DATA, THAT REPRESENTS THE INFORMATION OF THE DISTANCE FROM THE CLIENT. FORMAT OF THE DIST DATA IS:

THE FIRST DATA BYTE IS SOURCE IDENTIFICATION BYTE

7	6	5	4	3	2	1	0
				SN	CT	PT	LR

LR ....LIGHT RANGER
PT ....PANATAPE
CT ....CINETAPE
SN ....SNIPER

FOLLOWED BY THREE BYTES OF DISTANCE INFORMATION IN (mm)

- USE DIST (10) COMMAND TO THE PRESTON CONTROLLER

- THE FIRST BYTE WILL SET TO HEX (02) FOR PT PANATAPE

- THE DISTANCE OF THE FIRST TRACK IS SENT TO MDR FOR DISPLAY

FIG. 24

FOV FOR SYSTEM

82

84

78

80

14

16

CAMERA1

CAMERA16

TAKING CAMERA

22