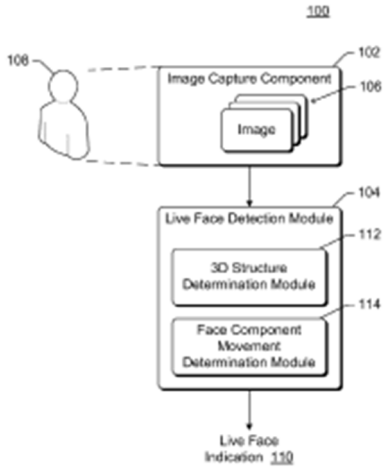
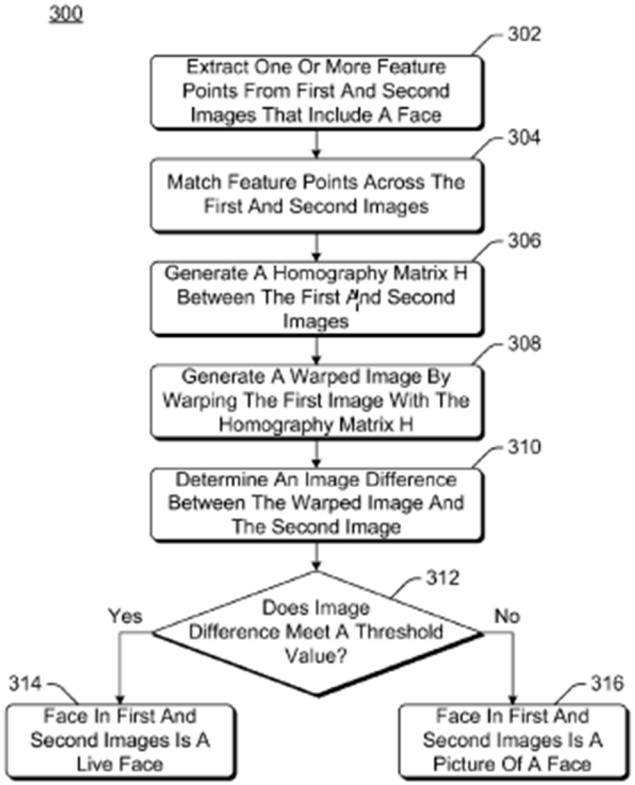
INVALIDITY CLAIM CHART
U.S. Patent 10,776,471

U.S. Patent Application Pub. No. 2011/0299741 A1 to Zhang et al. ("Zhang") qualifies as prior art under at least 35 U.S.C. § 102(a)(1) because it is a printed publication that was publicly available before the effective filing date of U.S. Patent No. 10,776,471 ("the '471 Patent"). Zhang also qualifies as prior art under at least 35 U.S.C. §§ 102(a)(2) because it is a published patent application that was filed before the effective filing date of '471 Patent.

The asserted claims of the '471 Patent are anticipated by Zhang. The asserted claims of the '471 Patent are also invalid under 35 U.S.C. § 103 as obvious in view of Zhang alone or in combination with one or more other references identified in Defendant's Invalidity Contentions.

Asserted Claims of the '471 Patent	Prior Art
Claim 1	
[471.10(p)] A method for authenticating three-dimensionality of a user via a user's camera equipped computing device, the method, during an authentication session comprising:	To the extent the preamble is limiting, Zhang discloses a method for authenticating three-dimensionality of a user via a user's camera equipped computing device. Multiple images including a face presented by a user are accessed. One or more determinations are made based on the multiple images, such as a determination of whether the face included in the multiple images is a 3-dimensional structure or a flat surface and/or a determination of whether motion is present in one or more face components (e.g., eyes or mouth). If it is determined that the face included in the multiple images is a 3-dimensional structure or that that motion is present in the one or more face components, then an indication is provided that the user can be authenticated. However, if it is determined that the face included in the multiple images is a flat surface or that motion is not present in the one or more face components, then an indication is provided that the user cannot be authenticated. [Abstract]

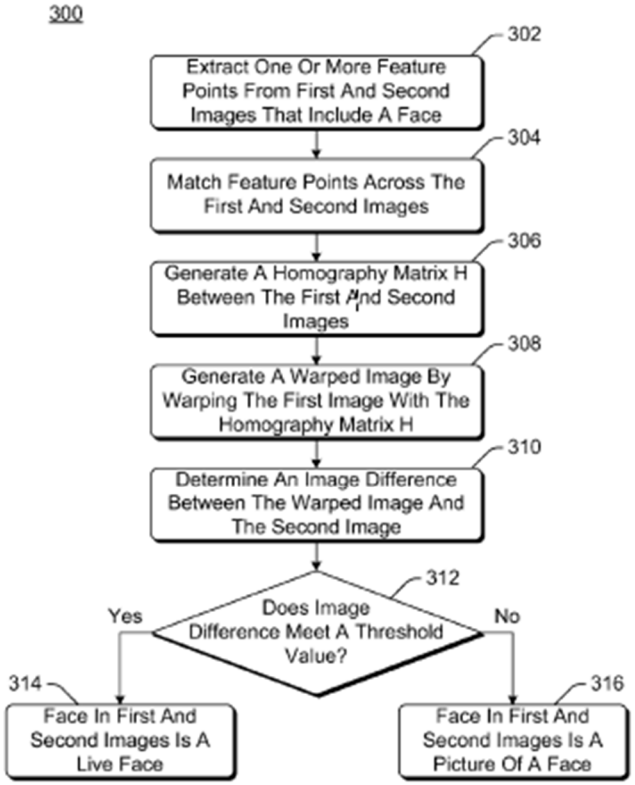
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 1** [Fig. 1]

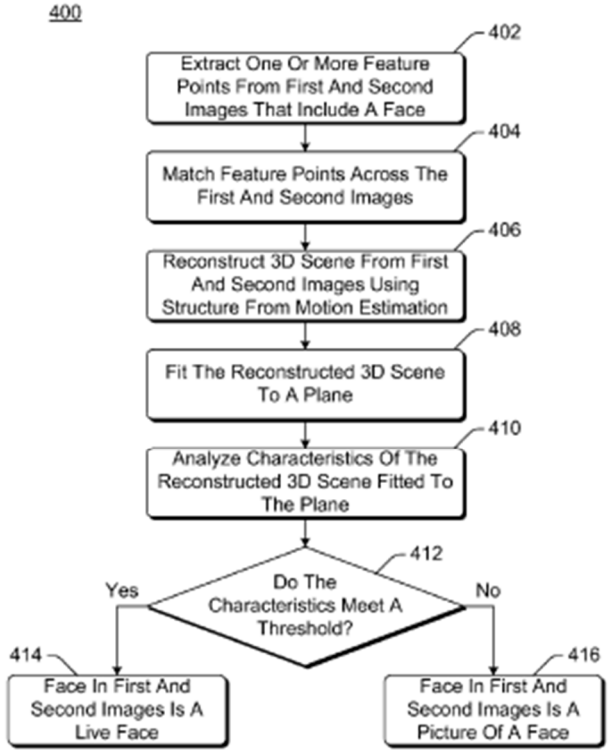
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	In accordance with one or more aspects, multiple images including a face presented by a user are accessed. A determination is made, based on the multiple images, of whether the face included in the multiple images is a 3-dimensional (3D) structure or a flat surface. If it is determined that the face included in the multiple images is a 3-dimensional structure, then an indication is provided that the user can be authenticated. However, if it is determined that the face included in the multiple images is a flat surface, then an indication is provided that the user cannot be authenticated. In accordance with one or more aspects, multiple images including a face presented by a user are accessed. A determination is made, based on the multiple images, of whether motion is present in one or more components (e.g., eyes, mouth, etc.) of the face. If it is determined that motion is present in the one or more components of the face, then an indication is provided that the user can be authenticated. However, if it is determined that motion is not present in the one or more components of the face, then an indication is provided that the user cannot be authenticated. [0003]-[0004] Distinguishing live faces from flat surfaces is discussed herein. In order to authenticate a user for particular access (e.g., to a computer or network, to a building or other location, etc.), multiple images of a face presented by the user are captured and analyzed. The face presented by the user can be the user's actual face, or could be a picture of a face of the user that is presented by an imposter. An attempt is made to determine whether the images include a live face (e.g., the captured images are of a live human being) or a picture of a face. If it is determined that the images include a live face, then it is assumed that the face presented by the user is the face of the actual user that is requesting the particular access, and the user can be authenticated for access. However, if it is determined that the images include a picture, then it is assumed that the face presented by the user is the face of an imposter using a picture, and the user cannot be authenticated for access. [0012] Live face detection module 104 analyzes images 106 to determine whether images 106 include a live face or a picture of a face, and outputs an indication 110 of whether images 106 include a live face or a picture of a face. Indication 110 can be, for example, a first value to indicate

Asserted Claims of the '471 Patent	Prior Art
	images 106 include a live face (e.g., "live", "yes", "authenticate", etc.) and a second value to indicate images 106 include a picture of a face (e.g., "picture", "no", "do not authenticate", etc.). A live face refers to the face of an actual human being (i.e., image capture component 102 captured images of an actual human being), rather than a picture of the face of a human being. If detection module 104 determines that images 106 include a live face, then live face indication 110 indicates that images 106 include a live face. In such situations, live face indication 110 indicates that user 108 can be authenticated for access (e.g., to whatever system, resource, location, etc. that user 108 is requesting access) because it is assumed that the actual human being that is user 108 is requesting particular access. The authentication of user 108 can be performed by another component or module (not shown) in a variety of different manners, such as by comparing one or more of images 106 to previously captured images of user 108. Alternatively, the authentication can be performed prior to the live face detection performed by module 104, in which case live face indication 110 indicates that any previous authentication of user 108 is valid. [0017] Live face detection module 104 can determine whether images 106 include a live face or a picture of a face in a variety of different manners. In one or more embodiments, live face detection module 104 includes one or both of a 3-dimensional (3D) structure determination module 112 and a face component movement determination module 114. Generally, 3D structure determination module 112 determines whether images 106 include a face that is a 3D structure (e.g., an actual human being) or a flat surface (e.g., a photograph), and face component movement determination module 114 determines whether motion is present in one or more components of the face in images 106. The manner in which these determinations are made by modules 112 and 114 is discussed in more detail below. [0019] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***CAMERA-BASED 3D AUTHENTICATION*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person*

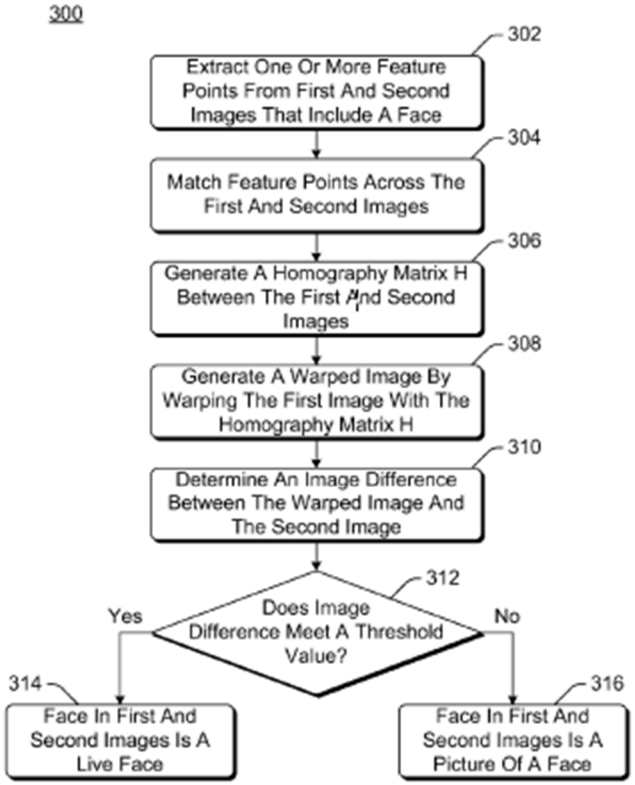
Asserted Claims of the '471 Patent	Prior Art
	*having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(a)] capturing at least one first image of the user taken with the camera of the computing device at a first location which is a first distance from the user;	Zhang discloses capturing at least one first image of the user taken with the camera of the computing device at a first location which is a first distance from the user. Multiple images including a face presented by a user are accessed. One or more determinations are made based on the multiple images, such as a determination of whether the face included in the multiple images is a 3-dimensional structure or a flat surface and/or a determination of whether motion is present in one or more face components (e.g., eyes or mouth). If it is determined that the face included in the multiple images is a 3-dimensional structure or that that motion is present in the one or more face components, then an indication is provided that the user can be authenticated. However, if it is determined that the face included in the multiple images is a flat surface or that motion is not present in the one or more face components, then an indication is provided that the user cannot be authenticated. [Abstract]

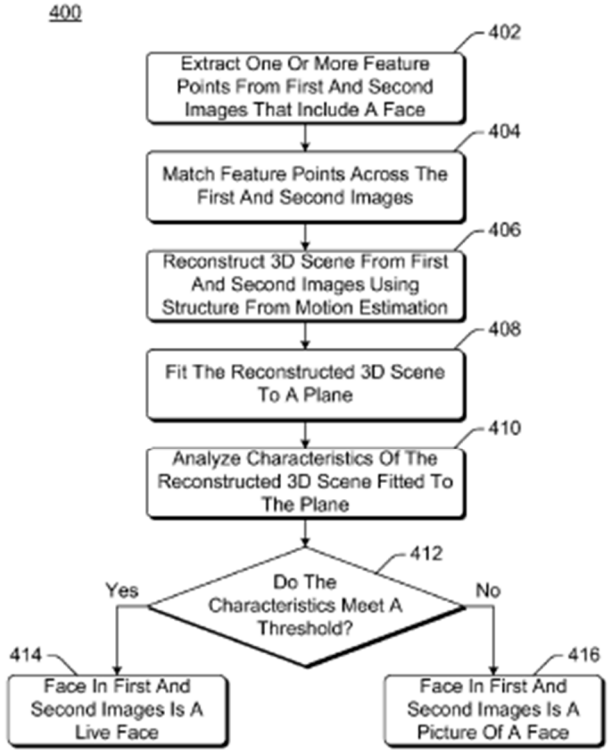
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	In order to authenticate a user for particular access (e.g., to a computer or network, to a building or other location, etc.), multiple images of a face presented by the user are captured and analyzed. [0012] Image capture component 102 captures multiple images 106 each including a face presented by a user 108, and makes images 106 available to live face detection module 104. Image capture component 102 can capture images 106 in a variety of different manners, such as using various digital imaging technologies (e.g., charge-coupled devices (CCDs), complementary metal-oxide-semiconductor (CMOS) sensors, and so forth). [0016] These multiple images can be images including a live face or images including a picture of a face. The multiple images are images that have been captured by an image capture component (e.g., image capture component 102 of FIG. 1). [0021] In one or more embodiments, the first and second images in process 300 are adjacent images in a sequence of three or more images. For example, multiple images (such as 30 or 60 images) can be accessed by the 3D structure determination module implementing process 300. Assume the multiple images are, in their order of capture, image 1, image 2, image 3, image 4, . . . image z. The first and second images in process 300 can be adjacent or sequential images in the sequence of multiple images, such as image 1 and image 2, image 4 and image 5, and so forth. Alternatively, the first and second images in process 300 can be non-adjacent images, having one or more intervening images between them in the sequence of images. For example, the first and second images in process 300 can be image 1 and image 10, image 12 and image 37, and so forth. Additionally, even if the first and second images in process 300 are not adjacent or sequential images in the sequence, at least part of process 300 can be performed for each adjacent pair of images in the sequence. For example, the feature point extraction and feature point matching in acts 302 and 304 can be generated for each adjacent pair of images in the sequence, which can

Asserted Claims of the '471 Patent	Prior Art
	facilitate the feature matching process when matching features across two images with one or more intervening images. [0035-0036] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **MULTIPLE IMAGES** references (see cover document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(b)] processing the at least one first image or a portion to create first data;	Zhang discloses processing the at least one first image or a portion to create first data.

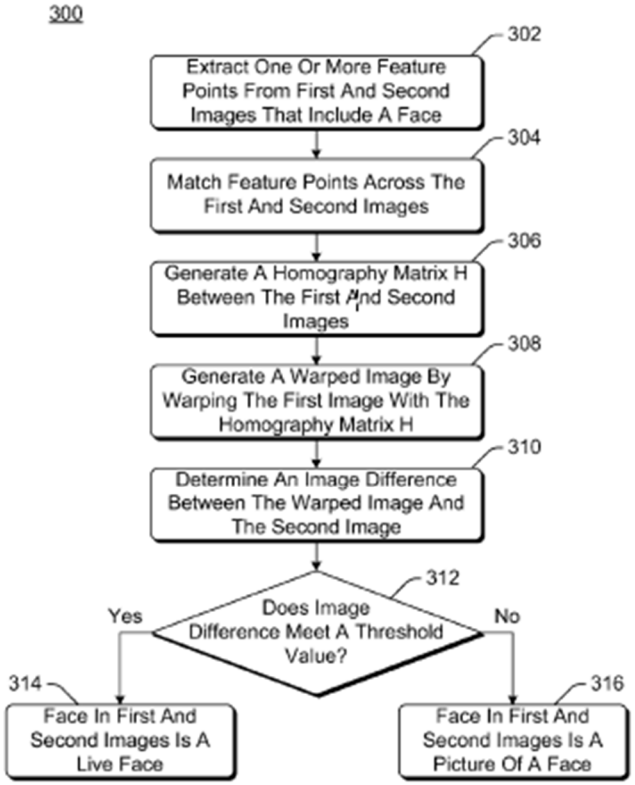
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

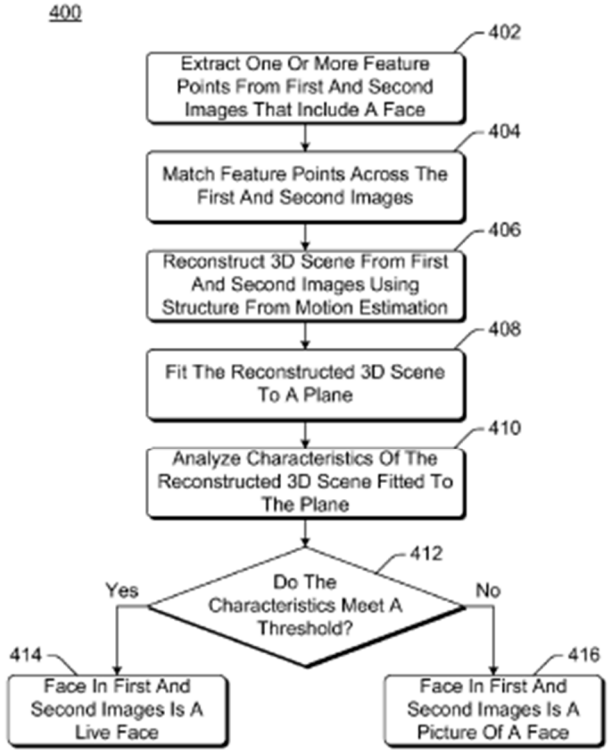
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	Returning to FIG. 1, in one or more embodiments 3D structure determination module 112 uses a homography based technique for determining whether a face included in images 106 is a 3D structure or a flat surface. Alternatively, other techniques can be used, such as a structure from motion estimation technique. The homography based technique uses a 3×3 homography matrix, also referred to herein as matrix H. The homography based technique leverages the fact that two views of a flat (planar) surface are related based on a homography matrix H. Accordingly, in analyzing a first image and a second image, the first image can be warped or transformed using the homography matrix H to generate a warped image. The warped image is then compared to the second image. If the first and second images are views of a flat surface (e.g., a picture of a face), then the warped image will be similar to the second image. Thus, if the difference between the second image and the warped image is small (e.g., below a threshold value), then the first and second images include a face that is a flat surface rather than a live face. However, if the difference between the second image and the warped image is larger (e.g., at least a threshold value), then the first and second images include a facet that is a live face rather than a flat surface. [0024]-[0025] In process 300, one or more feature points are extracted from two images, referred to in process 300 as the first and second images (act 302). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. These feature points can be extracted in a variety of different conventional manners, such as using template matching algorithms, feature matching algorithms, and so forth. [0027] In process 400, one or more feature points are extracted from two images, referred to in process 400 as the first and second images (act 402). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature

Asserted Claims of the '471 Patent	Prior Art
	points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. [0041] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **BIOMETRIC DATA** references (see cover document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(c)] moving the camera from the first location to a second location, the second location being a second distance from the user, or the user moving from the first location to the second location to change the distance between the user and the camera from the first distance to a second distance;	Zhang discloses moving the camera from the first location to a second location, the second location being a second distance from the user, or the user moving from the first location to the second location to change the distance between the user and the camera from the first distance to a second distance. FIG. 5 is a flowchart illustrating an example process 500 for determining whether motion is present in one or more components of a face in accordance with one or more embodiments. Process 500 is carried out by a face component movement determination module, such as face component movement determination module 114 of FIG. 1, and can be implemented in software, firmware, hardware, or combinations thereof. Process 500 can implement, for example, act 206 of FIG. 2. Process 500 is shown as a set of acts and is not limited to the order shown for performing the operations of the various acts. [0052] Motion is determined as being present in the face component if the face component difference between two images meets a threshold value. The face component difference between the two images can meet the threshold value by, for example, being greater than the threshold value, being greater than or equal to the threshold value, and so forth. [0056] Alternatively, whether motion is present in the face component can be determined in other manners. For example, a neural net, decision tree, or other learning machine can be trained to

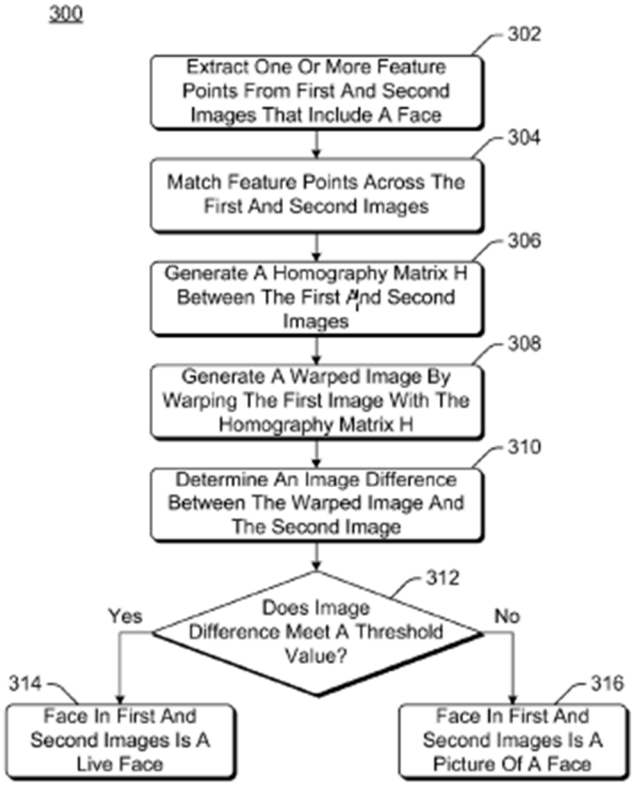
Asserted Claims of the '471 Patent	Prior Art
	determine whether eyes in a face or open or closed. Motion can be determined as begin present in the face component if the neural net, decision tree, or other learning machine determines that the face component goes from eyes open to eyes closed (or vice versa) in the multiple images. If motion is determined as being present in the face component, then the face in the multiple images is determined to be a live face (act 508). However, if motion is not determined as being present in the face component, then the face in the multiple images is determined to be a flat surface and thus a picture of a face (act 510). [0057-0058] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **CHANGING CAMERA LOCATION** references (see cover document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(d)] capturing at least one second image of the user taken with the camera of the computing device at the second distance from the user, the second distance being different than the first distance;	Zhang discloses capturing at least one second image of the user taken with the camera of the computing device at the second distance from the user, the second distance being different than the first distance. Multiple images including a face presented by a user are accessed. One or more determinations are made based on the multiple images, such as a determination of whether the face included in the multiple images is a 3-dimensional structure or a flat surface and/or a determination of whether motion is present in one or more face components (e.g., eyes or mouth). If it is determined that the face included in the multiple images is a 3-dimensional structure or that that motion is present in the one or more face components, then an indication is provided that the user can be authenticated. However, if it is determined that the face included in the multiple images is a flat surface or that motion is not present in the one or more face components, then an indication is provided that the user cannot be authenticated. [Abstract]

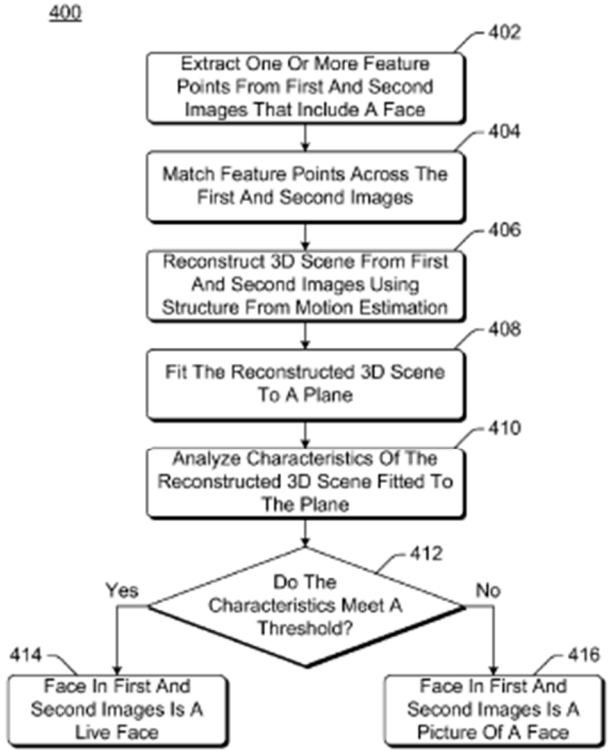
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	Image capture component 102 captures multiple images 106 each including a face presented by a user 108, and makes images 106 available to live face detection module 104. Image capture component 102 can capture images 106 in a variety of different manners, such as using various digital imaging technologies (e.g., charge-coupled devices (CCDs), complementary metal-oxide-semiconductor (CMOS) sensors, and so forth). [0016] These multiple images can be images including a live face or images including a picture of a face. The multiple images are images that have been captured by an image capture component (e.g., image capture component 102 of FIG. 1). [0021] In one or more embodiments, the first and second images in process 300 are adjacent images in a sequence of three or more images. For example, multiple images (such as 30 or 60 images) can be accessed by the 3D structure determination module implementing process 300. Assume the multiple images are, in their order of capture, image 1, image 2, image 3, image 4, . . . image z. The first and second images in process 300 can be adjacent or sequential images in the sequence of multiple images, such as image 1 and image 2, image 4 and image 5, and so forth. Alternatively, the first and second images in process 300 can be non-adjacent images, having one or more intervening images between them in the sequence of images. For example, the first and second images in process 300 can be image 1 and image 10, image 12 and image 37, and so forth. Additionally, even if the first and second images in process 300 are not adjacent or sequential images in the sequence, at least part of process 300 can be performed for each adjacent pair of images in the sequence. For example, the feature point extraction and feature point matching in acts 302 and 304 can be generated for each adjacent pair of images in the sequence, which can facilitate the feature matching process when matching features across two images with one or more intervening images. [0035-0036] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **MULTIPLE IMAGES** references (see cover*

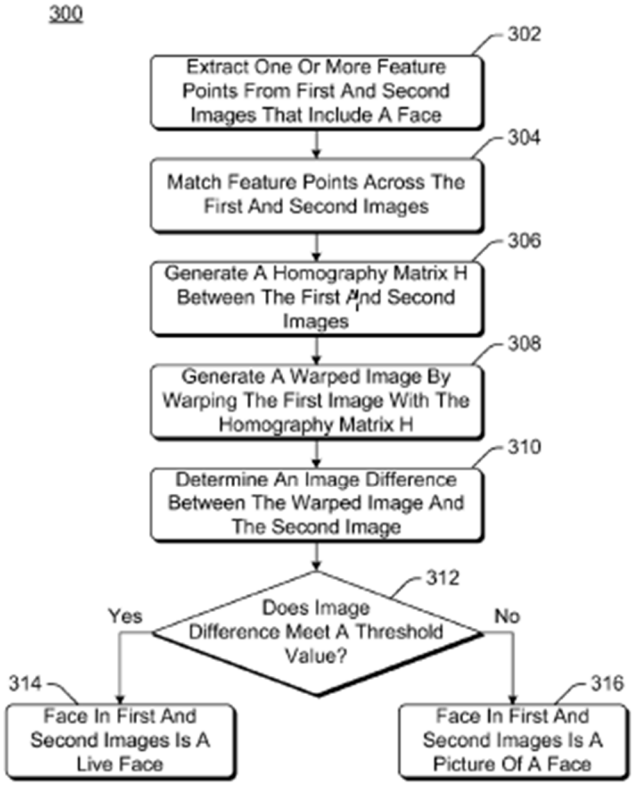
Asserted Claims of the '471 Patent	Prior Art
	*document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(e)] processing the at least one second image or a portion thereof to create second data;	Zhang discloses processing the at least one second image or a portion thereof to create second data.

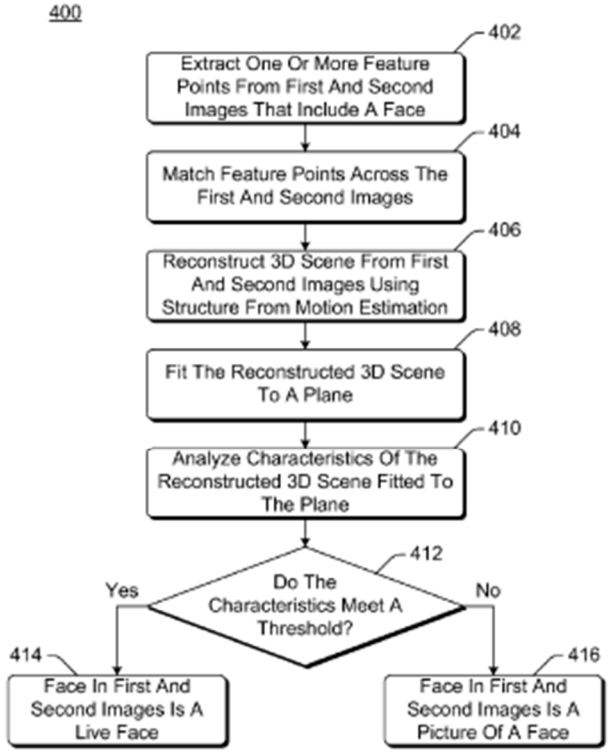
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	Returning to FIG. 1, in one or more embodiments 3D structure determination module 112 uses a homography based technique for determining whether a face included in images 106 is a 3D structure or a flat surface. Alternatively, other techniques can be used, such as a structure from motion estimation technique. The homography based technique uses a 3×3 homography matrix, also referred to herein as matrix H. The homography based technique leverages the fact that two views of a flat (planar) surface are related based on a homography matrix H. Accordingly, in analyzing a first image and a second image, the first image can be warped or transformed using the homography matrix H to generate a warped image. The warped image is then compared to the second image. If the first and second images are views of a flat surface (e.g., a picture of a face), then the warped image will be similar to the second image. Thus, if the difference between the second image and the warped image is small (e.g., below a threshold value), then the first and second images include a face that is a flat surface rather than a live face. However, if the difference between the second image and the warped image is larger (e.g., at least a threshold value), then the first and second images include a facet that is a live face rather than a flat surface. [0024]-[0025] In process 300, one or more feature points are extracted from two images, referred to in process 300 as the first and second images (act 302). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. These feature points can be extracted in a variety of different conventional manners, such as using template matching algorithms, feature matching algorithms, and so forth. [0027] In process 400, one or more feature points are extracted from two images, referred to in process 400 as the first and second images (act 402). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature

Asserted Claims of the '471 Patent	Prior Art
	points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. [0041] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **BIOMETRIC DATA** references (see cover document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.10(f)] comparing the first data to the second data to determine whether expected distortion exist between the first data and the second data which indicated three-dimensionality of the user;	Zhang discloses comparing the first data to the second data to determine whether expected distortion exist between the first data and the second data which indicated three-dimensionality of the user.

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	Returning to FIG. 1, in one or more embodiments 3D structure determination module 112 uses a homography based technique for determining whether a face included in images 106 is a 3D structure or a flat surface. Alternatively, other techniques can be used, such as a structure from motion estimation technique. The homography based technique uses a 3×3 homography matrix, also referred to herein as matrix H. The homography based technique leverages the fact that two views of a flat (planar) surface are related based on a homography matrix H. Accordingly, in analyzing a first image and a second image, the first image can be warped or transformed using the homography matrix H to generate a warped image. The warped image is then compared to the second image. If the first and second images are views of a flat surface (e.g., a picture of a face), then the warped image will be similar to the second image. Thus, if the difference between the second image and the warped image is small (e.g., below a threshold value), then the first and second images include a face that is a flat surface rather than a live face. However, if the difference between the second image and the warped image is larger (e.g., at least a threshold value), then the first and second images include a facet that is a live face rather than a flat surface. [0024]-[0025]

[0029] A homography matrix H between the first and second images is generated (act **306**). The first and second images are related by the homography matrix H as follows:

$$\tilde{x}'=\lambda H\tilde{x}$$

where $\tilde{x}$ refers to a location in the first image, $\tilde{x}'$ refers to a location in the second image, H refers to a homography matrix, and λ refers to a non-zero scalar value. A location in the first image is represented as $[u,v]^T$, where u and v are the coordinates of the location in the first image. A location in the second image is represented as $[u',v']^T$, where u' and v' are the coordinates of the location in the second image. When calculating the homography matrix H, $\tilde{x}=[u, v,1]^T$ and $\tilde{x}'=[u',v',1]^T$. Given two locations in the two images and with z being the location in the first of the two images, a homography matrix H is calculated by determining a homography matrix H for which the difference between $\tilde{x}'$ as calculated by $\tilde{x}'=\lambda H\tilde{x}$ and the actual location in the second image is small. This homography matrix can be determined in different manners, such as using any of a variety of conventional algorithms to determine that the difference between $\tilde{x}'$ as calculated by $\tilde{x}'=\lambda H\tilde{x}$ and the actual location in the second image is minimized, is below a threshold value, and so forth. In one or more embodiments, the homography matrix can be determined from 4 or more pairs of corresponding locations in the two images, as described below. Let $\{(x_i,x_i')|i=1, \ldots N\}$ be the N pairs ($N\geqq 4$). Each pair gives an equation $\tilde{x}_i'=\lambda_i H\tilde{x}_i$. Eliminating the unknown scalar factor λ_i yields two scalar equations:

$$\tilde{x}_i^T h_1-u_i'\tilde{x}_i^T h_3=0$$

$$\tilde{x}_i^T h_2-v_i'\tilde{x}_i^T h_3=0$$

Asserted Claims of the '471 Patent	Prior Art
	where $h_j=[H_{j1},H_{j2},H_{j3}]^t$ is the j-th row vector of the homography matrix H. In matrix form: $B_ih=0$, where $h=[H_{11}, H_{12}, H_{13}, \ldots, H_{33}]^T$ is a 9-D vector consisting of the unknown homography elements, and $$B_i = \begin{bmatrix} \tilde{x}_i^T & 0 & -u_i'\tilde{x}_i^T \\ 0 & \tilde{x}_i^T & -v_i'\tilde{x}_i^T \end{bmatrix}$$ is a 2×9 matrix. With N pairs, a 2N×9 matrix B is formed by stacking all B_i's, and an equation $Bh=0$ is obtained. As h is defined up to a scale factor, the solution is well known to be the eigenvector of the 9×9 matrix B^TB associated with the smallest eigenvalue. This solution includes the elements of homography matrix H (the eigenvector of the solution) to be used in warping the first image as discussed below. [0029]

	[0030] A warped image is then generated by warping the first image with the homography matrix H (act **308**). This homography matrix H is the homography matrix H generated in act **306**. The first image is warped based on the calculation $y=\lambda H\tilde{x}$ (which is the same as $\tilde{x}'=\lambda H\tilde{x}$, except that y refers to the warped image so y is being used instead of $\tilde{x}'$). Each pixel in the first image has a value $\tilde{x}$ that is used to calculate a value y using $y=H\tilde{x}$. The value y is a vector, and the first and second elements of y are each divided by the third element of y to obtain a location of a pixel in the warped image. In other words, for a value $y=[y_1, y_2, y_3]$, the location of the pixel in the warped image is

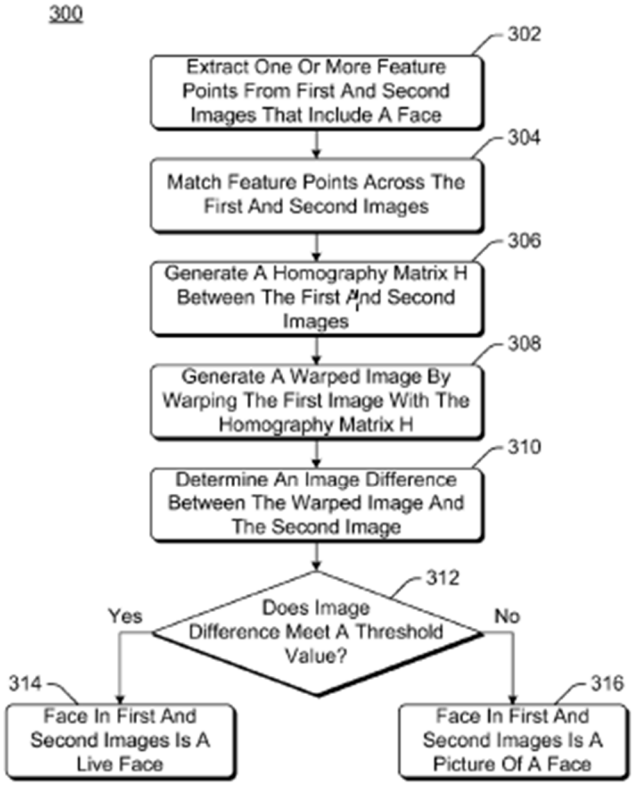
Asserted Claims of the '471 Patent	Prior Art
	$\left[\frac{y_1}{y_3}, \frac{y_2}{y_3}\right]$. The intensity or color of the pixel in the first image (having the value $\tilde{x}$) is then applied to the pixel at the location $\left[\frac{y_1}{y_3}, \frac{y_2}{y_3}\right]$ in the warped image. These intensities or colors of pixels can be represented in a variety of different manners, such as using conventional RGB values, conventional CMYK values, and so forth. [0030] An image difference between the warped image (generated in act 308) and the second image is determined (act 310). The image difference can be computed in different manners. In one or more embodiments, the warped image and the second image are superimposed and the difference in color or intensity values at the same pixels (locations) in the two images is determined. In other words, for each location [u,v] in the warped image, the difference between the color or intensity value at the location [u,v] in the warped image and the location [u,v] in

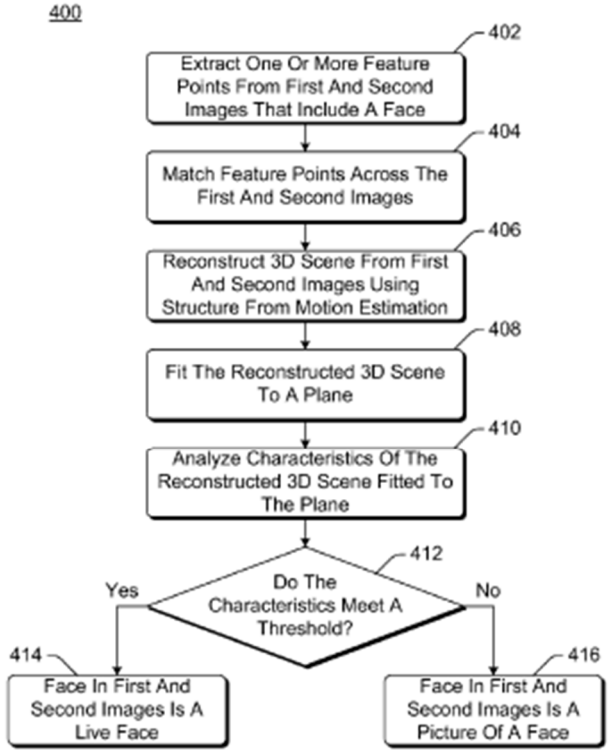
Asserted Claims of the '471 Patent	Prior Art
	the second image is determined. The differences determined for these different locations are then combined to generate the image difference. [0031] A determination is then made as to whether the image difference determined in act 310 meets a threshold value (act 312). The image difference can meet the threshold value by, for example, being greater than the threshold value, being greater than or equal to the threshold value, and so forth. This threshold value can be, for example 10 in situations where the color values can be one of 256 gray levels. This threshold value can be a fixed value (e.g., 10 gray levels) or can be a relative value (e.g., 5% of the number of possible color or intensity values). [0033] If the image difference meets the threshold value, then the face in the first and second images is determined to be a live face (act 314). However, if the image difference does not meet the threshold value, then the face in the first and second images is determined to be a flat surface and thus a picture of a face (act 316). [0034] A 3D scene is reconstructed from the first and second images using structure from motion estimation (act 406). This reconstructed 3D scene is a 3-dimensional description of the scene represented by the first and second images based on estimated motion between the first and second images. The reconstructed 3D scene can be generated in a variety of different conventional manners using well-known structure from motion estimation and stereoscopic vision technology techniques. Such structure from motion estimation and stereoscopic vision technology techniques are based on the matching feature points in act 404. [0043] Characteristics of the reconstructed 3D scene fitted to the plane (generated in act 408) are analyzed (act 410). The characteristics can be analyzed in different manners, such as by comparing ratios of various facial components or feature points to one another. These various facial components or feature points can be, for example, eyes, corners of eyes, corners of mouths, noses, tips of noses, and so forth. For example, the characteristics can be analyzed by obtaining a first value that is a maximum distance from a particular feature (e.g., tip of a nose) in the reconstructed 3D scene to the plane, a second value that is the distance between two

Asserted Claims of the '471 Patent	Prior Art
	facial components on the plane (e.g., the distance between the eyes or between the corners of the eyes), and calculating a ratio of the first value to a second value. [0045] A determination is then made as to whether the analyzed characteristics in act 410 meet a threshold (act 412). The characteristics can meet the threshold by, for example, being greater than a threshold value, being greater than or equal to a threshold value, and so forth. This threshold can be a fixed value (e.g., the ratio of the first value to the second value from act 410 is greater than 10%) or a relative value (e.g., the ratio of the first value to the second value from act 410 is greater than 5% of the second value). If the analyzed characteristics meet the threshold value, then the face in the first and second images is determined to be a live face (act 414). However, if the analyzed characteristics do not meet the threshold value, then the face in the first and second images is determined to be a flat surface and thus a picture of a face (act 416). [0046-0047] In process 500, a face component is extracted from multiple images that include a face (act 502). These first and second images include a face, and can be, for example, images 106 of FIG. 1. A face component can be a variety of different parts of a face, and typically is a part of a face that is expected to change over short durations of time. In one or more embodiments a face component is one or both eyes, which are typically expected to change over short durations of time, for example as the person blinks or looks at different objects. In other embodiments, a face component is a mouth, which is typically expected to change over short durations of time, for example as the person talks. Alternatively, other face components can be extracted in act 502. [0053] The face component extracted in act 502 is matched across the multiple images (act 504). This matching of the face component across the multiple images refers to identifying the locations of the same face component in each of the multiple images. For example, the locations of the same eye in the face in the multiple images are identified. The matching of a face component across the multiple images can be performed in a variety of different conventional manners, and in one

Asserted Claims of the '471 Patent	Prior Art
	or more embodiments is performed using the same or similar techniques as are used to match feature points across images discussed above with respect to act 304 of FIG. 3. [0054] A check is then made as to whether motion is present in the face component (act 506). Whether motion is present in the face component can be determined in a variety of different manners. [0055] In one or more embodiments, a face component difference between the face components in two images is generated. The difference between the face components in two images can be determined by, for example, superimposing the face components of the two images and determining the difference in color or intensity values at the same pixels (locations) of the face components, analogous to the determination of the image difference discussed above with reference to act 310 in FIG. 3. [0056] Alternatively, whether motion is present in the face component can be determined in other manners. For example, a neural net, decision tree, or other learning machine can be trained to determine whether eyes in a face or open or closed. Motion can be determined as begin present in the face component if the neural net, decision tree, or other learning machine determines that the face component goes from eyes open to eyes closed (or vice versa) in the multiple images. [0057] In one or more embodiments, the determination of whether motion is present in the face component in act 506 is made by analyzing (e.g., and determining a face component difference between face components of) two adjacent images in a sequence of three or more images. For example, multiple images (such as 30 or 60 images) can be accessed by the face component movement determination module implementing process 500. Assume the multiple images are, in their order of capture, image 1, image 2, image 3, image 4, . . . image z. The two images that are analyzed (e.g., and for which the face component difference is determined) in act 506 can be adjacent or sequential images in the sequence of multiple images, such as image 1 and image 2, image 4 and image 5, and so forth. Alternatively, the two images that are analyzed (e.g., and

Asserted Claims of the '471 Patent	Prior Art
	for which the face component difference is determined in act 506) can be non-adjacent images, having one or more intervening images between them in the sequence of images. For example, the two images that are analyzed in act 506 can be image 1 and image 9, image 18 and image 39, and so forth. [0060] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***COMPARING IMAGES*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*
[471.10(g)] authenticating the user when the differences between the first data and the second data have expected distortion resulting from movement of the camera from the first location to the second location or movement of the user from the first location to the second location, which causes the	Zhang discloses authenticating the user when the differences between the first data and the second data have expected distortion resulting from movement of the camera from the first location to the second location or movement of the user from the first location to the second location, which causes the change in distance between the user and the camera.

Asserted Claims of the '471 Patent	Prior Art
change in distance between the user and the camera.	 **Fig. 3** [Fig. 3]

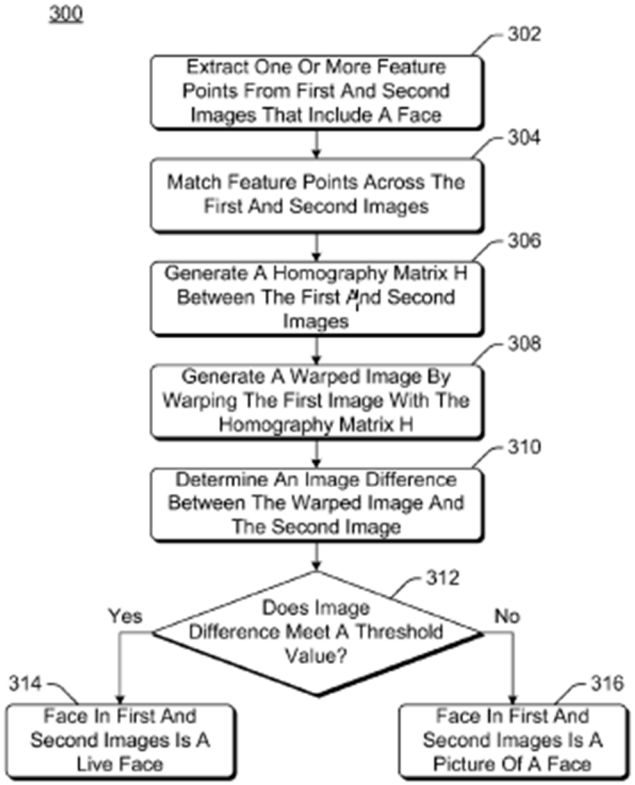
Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

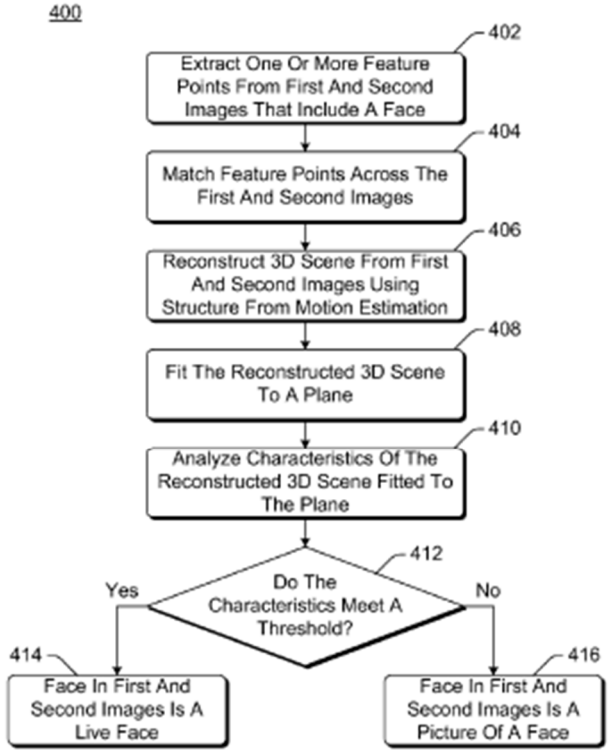
Asserted Claims of the '471 Patent	Prior Art
	Returning to FIG. 1, in one or more embodiments 3D structure determination module 112 uses a homography based technique for determining whether a face included in images 106 is a 3D structure or a flat surface. Alternatively, other techniques can be used, such as a structure from motion estimation technique. The homography based technique uses a 3×3 homography matrix, also referred to herein as matrix H. The homography based technique leverages the fact that two views of a flat (planar) surface are related based on a homography matrix H. Accordingly, in analyzing a first image and a second image, the first image can be warped or transformed using the homography matrix H to generate a warped image. The warped image is then compared to the second image. If the first and second images are views of a flat surface (e.g., a picture of a face), then the warped image will be similar to the second image. Thus, if the difference between the second image and the warped image is small (e.g., below a threshold value), then the first and second images include a face that is a flat surface rather than a live face. However, if the difference between the second image and the warped image is larger (e.g., at least a threshold value), then the first and second images include a facet that is a live face rather than a flat surface. [0024]-[0025] An image difference between the warped image (generated in act 308) and the second image is determined (act 310). The image difference can be computed in different manners. In one or more embodiments, the warped image and the second image are superimposed and the difference in color or intensity values at the same pixels (locations) in the two images is determined. In other words, for each location [u,v] in the warped image, the difference between the color or intensity value at the location [u,v] in the warped image and the location [u,v] in the second image is determined. The differences determined for these different locations are then combined to generate the image difference. [0031] If the image difference meets the threshold value, then the face in the first and second images is determined to be a live face (act 314). However, if the image difference does not meet the threshold value, then the face in the first and second images is determined to be a flat surface and thus a picture of a face (act 316). [0034]

Asserted Claims of the '471 Patent	Prior Art
	A check is then made as to whether motion is present in the face component (act 506). Whether motion is present in the face component can be determined in a variety of different manners. [0055] In one or more embodiments, the determination of whether motion is present in the face component in act 506 is made by analyzing (e.g., and determining a face component difference between face components of) two adjacent images in a sequence of three or more images. For example, multiple images (such as 30 or 60 images) can be accessed by the face component movement determination module implementing process 500. Assume the multiple images are, in their order of capture, image 1, image 2, image 3, image 4, . . . image z. The two images that are analyzed (e.g., and for which the face component difference is determined) in act 506 can be adjacent or sequential images in the sequence of multiple images, such as image 1 and image 2, image 4 and image 5, and so forth. Alternatively, the two images that are analyzed (e.g., and for which the face component difference is determined in act 506) can be non-adjacent images, having one or more intervening images between them in the sequence of images. For example, the two images that are analyzed in act 506 can be image 1 and image 9, image 18 and image 39, and so forth. [0060] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the **AUTHENTICATION BASED ON IMAGE DIFFERENCES** references (see cover document **Section II.d.vii.** for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in **Section II.d.** of the cover document to Defendant's Invalidity Contentions.*
[471.13] The method according to claim 10, wherein	Zhang discloses the method of claim 10.

Asserted Claims of the '471 Patent	Prior Art
the computing device is configured to display one or more prompts on a screen of the computing device to guide the user to capture the at least one first image at the first distance and the at least on second image at the second distance.	*See* disclosures for claims 471.10 above. *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***USER PROMPTS*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*
[471.14] The method according to claim 13, wherein the one or more prompts are ovals on the screen within which the face of the user is placed to capture the at least one first image and the at least one second image.	Zhang discloses the method of claim 13. *See* disclosures for claims 471.13 above. *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***OVAL PROMPTS*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*
[471.15] The method according to claim 10, wherein the computing device is a hand-	Zhang discloses the method of claim 10. *See* disclosures for claim 471.10 above.

Asserted Claims of the '471 Patent	Prior Art
held device, and the user holds the device at the first and second distances to capture the at least one first image and the at least one second image.	Zhang further discloses the computing device is a hand-held device, and the user holds the device at the first and second distances to capture the at least one first image and the at least one second image. A variety of different types of computing devices can be used to implement image capture component 102 and live face detection module 104, such as a desktop computer, a laptop or notebook computer, a notepad computer, a mobile station, an entertainment appliance, a set-top box communicatively coupled to a display device, a television, a cellular or other wireless phone, a digital camera or video camera, a game console, an automotive computer, and so forth. [0013] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***HAND-HELD DEVICES*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*
[471.16] The method according to claim 10, wherein the first data and the second data comprise biometric data.	Zhang discloses the method of claim 10. *See* disclosures for claim 471.10 above. Zhang further discloses the first data and the second data comprise biometric data.

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 3** [Fig. 3]

Asserted Claims of the '471 Patent	Prior Art
	 **Fig. 4** [Fig. 4]

Asserted Claims of the '471 Patent	Prior Art
	Returning to FIG. 1, in one or more embodiments 3D structure determination module 112 uses a homography based technique for determining whether a face included in images 106 is a 3D structure or a flat surface. Alternatively, other techniques can be used, such as a structure from motion estimation technique. The homography based technique uses a 3×3 homography matrix, also referred to herein as matrix H. The homography based technique leverages the fact that two views of a flat (planar) surface are related based on a homography matrix H. Accordingly, in analyzing a first image and a second image, the first image can be warped or transformed using the homography matrix H to generate a warped image. The warped image is then compared to the second image. If the first and second images are views of a flat surface (e.g., a picture of a face), then the warped image will be similar to the second image. Thus, if the difference between the second image and the warped image is small (e.g., below a threshold value), then the first and second images include a face that is a flat surface rather than a live face. However, if the difference between the second image and the warped image is larger (e.g., at least a threshold value), then the first and second images include a facet that is a live face rather than a flat surface. [0024]-[0025] In process 300, one or more feature points are extracted from two images, referred to in process 300 as the first and second images (act 302). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. These feature points can be extracted in a variety of different conventional manners, such as using template matching algorithms, feature matching algorithms, and so forth. [0027] In process 400, one or more feature points are extracted from two images, referred to in process 400 as the first and second images (act 402). These first and second images each include a face of the same person, and can be, for example, images 106 of FIG. 1. The one or more feature points are feature points of the face in the first and second images. A variety of different feature

Asserted Claims of the '471 Patent	Prior Art
	points can be extracted, such as a corner of an eye, a corner of a mouth, a tip of a nose, and so forth. Each feature point is a single pixel or a region of multiple pixels. [0041] *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***BIOMETRIC DATA*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*
[471.19] The method according to claim 10, wherein the user's face is held steady and the camera moves from the first location to the second location.	Zhang discloses the method of claim 10. *See* disclosures for claim 471.10 above. *To the extent this element is not disclosed, it would be obvious to combine the disclosures of the reference charted herein with the knowledge of a person having ordinary skill in the art alone, or with the disclosures contained in any one or more of the* ***MOVEMENT OF DEVICES*** *references (see cover document* ***Section II.d.vii.*** *for relevant disclosures in these references). A person having ordinary skill in the art would have been motivated to make these combinations for the reasons set forth in* ***Section II.d.*** *of the cover document to Defendant's Invalidity Contentions.*